Nutraceutical, therapeutic, and pharmaceutical potential of
Aloe vera: A review

Ravi Kant Upadhyay

Department of Zoology, D D U Gorakhpur University, Gorakhpur, Uttar Pradesh, India

Abstract

The present review explains therapeutic and pharmaceutical potential of Aloe vera a well-known plant grows in semi-arid climate of tropical and subtropical regions. This article emphasizes important uses of A. vera constituents as dietary nutraceutical, medicinal, and therapeutic potential. Plant is cultivated for agricultural and medicinal and decoration purposes for indoors as a potted plant. Plant is a good depository of chemical constituents which display a very wide array of biological activities such as anticancer, antiparasitic, anti-diabetic, anti-inflammatory, anti-arthritic, anti-parasitic, antitumor, antioxidant, chemopreventive, hepatoprotective, and gastroprotective. Plant is used to prepare skin protective/care gels mainly for soothing, moisturizing, and wound healing. Thick watery plant sap works are added as key ingredient in many beauty products. Plant leaves are used to generate aroma, beverages, skin lotion, cosmetics, or ointments for minor burns. Plant contains vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids, and amino acids as main ingredients. Plant is a good source of Vitamins A, C, and E, which are antioxidants. It also contains Vitamin B12, folic acid, and choline watery juicy of A. vera leaf which contains important minerals such as calcium, chromium, copper, selenium, magnesium, manganese, and potassium. Plant ingredients were found active against gingivitis, psoriasis, and used for herbal therapy in inflammatory bowel disease. A. vera contains important fatty acids mainly steroids such as cholesterol, campesterol, β-sitosterol, and lupeol. Aloin and emodin act as analgesics, antibacterials, and antivirals while lupeol shows antiseptic and analgesic properties. It also contains auxins and gibberellin hormones that help in wound healing and have anti-inflammatory action. Saponins that are the soapy substances display cleansing and antiseptic properties.

Key words: Aloe vera, natural products, nutritional, pharmaceutical potential, therapeutic

INTRODUCTION

Aloe vera is a short-stemmed plant which belongs to genus aloe. The name A. vera derives from the Arabic word “Alloeh” meaning “shining bitter substance,” while “vera” in Latin means “true,” 2000 years ago. Plant attains a smaller height 60–100 cm, spread by fleshy leaf offsets [Figure 1]. It belongs to Asphodelaceae (Liliaceae) family. It is a wild, shrubby or arborescent, perennial, xerophytic, succulent, pea-green color plant grown in a tropical climate. Plant possesses small leaves which are thick and fleshy, green to gray–green. It has some varieties that show white flecks on the upper and lower side of stem surface. Margin of the leaf is serrated and possesses small white teeth. The flowers are produced in summer on a spike up to 70–90 cm tall, each flower being pedulus, with a yellow tubular corolla. Plant is used in the preparation of consumer products including beverages, skin lotion, cosmetics, or ointments for minor burns and sunburns. Plant is cultivated for agricultural and medicinal uses. This is also grown in small pots for the decoration of houses and for ornamental purposes.[1] Plant is basically grown for its juice, preparation of gel and face creams, and other cosmetic purposes. A. vera plant forms arbuscular mycorrhiza, a symbiosis that allows the plant better access to mineral nutrients in soil.[2] It grows mainly in the dry regions of Africa, Asia, Europe, and America. In India, it is found in Rajasthan, Andhra Pradesh, Gujarat, Maharashtra, and Tamil Nadu. Plant is grown at larger scale
for medicinal use in A. vera in Australia,[3] Bangladesh, Cuba,[4] the Dominican Republic, China, Mexico,[5] India,[6] Jamaica,[7] Kenya, Tanzania, and South Africa,[8] along with the USA.[9] Plant has its larger use in both medicinal and cosmetics production industries. Plant succulence forms can grow in low rainfall zones and rocky and sloppy lands. Plant can grow in warmer climates but susceptible and intolerant of heavy frost and snow,[2,10] The species is relatively resistant to most insect pests though spider, mites, mealy bugs, scale insects, and aphid species may cause a decline in plant health.[11,12] This plant has gained the Royal Horticultural Society’s Award of Garden Merit.[13] Aloe plants can burn under too much sun or shrivel when the pot does not drain water.

Medicinal Uses

A. vera is used in traditional medicine as a skin treatment. Plant is documented in Ebers Papyrus from the 16th century BC and in Dioscorides’ De Materia Medica and Pliny the Elder’s Natural History - both written in the mid-first century AD.[15] The plant is used widely in the traditional herbal medicine of many countries. Despite this, the cosmetic and alternative medicine industries regularly make claims regarding the soothing, moisturizing, and healing properties of A. vera.[16,17] Aloe juice and gel provide protection for humans from sunburn.[18] A. vera gel is used commercially as an ingredient in yogurts, beverages, and some desserts,[19-21] although at certain doses, its toxic properties could be severe whether ingested or topically applied.[22] The same is true for aloe latex, which was taken orally for conditions ranging from glaucoma to multiple sclerosis.[23] Anthraquinones present in latex are a potent laxative. It increases intestinal water content, stimulates mucus secretion, and increases intestinal peristalsis.[15] There is no good evidence. A. vera is of use in treating wounds or burns.[24,25] There is no good evidence that topical application of A. vera is effective for treating genital herpes or psoriasis.[26] Topical application of A. vera is provided to treat or prevent phlebitis caused by intravenous infusion.[27]

A. vera extract is used for the dilution of semen for the artificial fertilization of sheep.[28] Plant juice is used as a fresh food preservative,[29] while plant canopy is used for water conservation in small farms.[30] A. vera seeds are also tried for obtaining biofuels.[31] Orally ingested non-decolorized A. vera leaf extract along with goldenseal is used for lower down cancer risks and reproductive toxicity.[32] Its topical use is not associated with significant side effects,[13] but sometimes ingested non-decolorized liquid[33] found to be carcinogenic in animals.[34] Its yellow juice from few varieties found carcinogenic to humans as well.[35] A. vera is used as moisturizer to keep facial skin tissues soft and shining, and it acts as anti-irritant to reduce chafing of the nose. Cosmetic companies use thick plant sap to prepare makeup products, tissues, moisturizers, soaps, sunscreens, incense, shaving cream, or shampoos.[19] Fresh plant sap is used in the preparation of many hygiene products which create moisturizing emollient effect.[56] Aloin found in the exudate of some Aloe species is used as laxative natural product.[33] A. vera shows potential toxicity, with side effects occurring at higher dose levels both when ingested and applied topically.[22] Before adding A. vera sap to prepare fairness creams, aloin is removed by processing. More specifically, Aloe species that contains aloin in excess amounts is not commonly used because it causes side effects.[16,37,38]

Nutraceutical Uses

A. vera juice is marketed to support the health of the digestive system. Although Ayurveda supports its use for many medicinal preparations, there is no scientific evidence available.[39] In old texts, it is known as Ghrit Kumari and is a significant part of a number of digestive preparations. Now, it is scientifically reported that overuse of plant extract is said to be harmful and its toxicity appears to be dose-dependent for toxic effects.[40] A. vera is a good nutrition supplementation for diabetic wound healing,[41] while processed Aloe food products contain ingredients which show cancer prevention.[42] A. vera ingredients suppress common foodborne enteropathogens.[43] Aloe barbadensis Miller affects survivability, proteolysis, and ACE inhibition of potential probiotic cultures in fermented milk.[44] A. vera polysaccharides are used in blend modification of soy protein/lauric acid to make edible films.[45] A. vera L. gel from different germ plasms does mushroom tyrosinase inhibition.[46] A. vera polysaccharides were found active against chronic alcohol-induced hepatotoxicity in mice,[47] while its gel extract attenuates ethanol-induced hepatic lipid accumulation by suppressing the expression of lipogenic genes in mice.[48] A. vera L. shows hypoglycemic and hypolipidemic effect in non-insulin-dependent diabetics.[49] Probiotic Lactobacillus rhamnosus GG and A. vera gel improve lipid profiles in hypercholesterolemic rats.[50] Chemical constituents of A. barbadensis Miller show inhibitory effects on phosphodiesterase-4D activity.[51] Oral ingestion of a high amount of crude A. vera causes abdominal cramps and diarrhea that decrease the absorption of drugs.[33] A. vera juice affects growth and activities of Lactobacilli in vitro.[52] Its gel showed bacteriostatic and/or bactericidal effects on cultures of Listeria monocytogenes.[53] A. vera gel does microbiological stabilization due to high hydrostatic pressure.
treatment.[54] Dried A. vera gel powder reduces body fat mass in diet-induced obesity rats,[55] while its gel protects the liver from oxidative stress-induced damage in experimental rat model.[56] A. vera gel powder is used for colour stability during storage of different packaging materials because of its high shelf-life.[57] For long storage, apple slices are coated with A. vera gel.[58] Purified decolorized (low anthraquinone) whole leaf A. vera (L.) Burn juice is toxic to rats.[59] Aloe ferox seed is a potential source of oil for cosmetic and pharmaceutical use,[60] while Aloe emodin, rhein, and emodin oral administration shows therapeutic effects in rats.[61]

A. vera gel and extract are used in herboprotective therapy used for cardioprotection.[62] Dietary use of the low dosage of A. vera extract showed antioxidant effects, induced cytokine synthesis,[63] and displayed immune modulatory effects.[64] Aloe polyamniont multinutrient complex affects cognitive and immune functioning in Alzheimer’s disease.[65] A. vera anthraquinones were found effective in severe acute pancreatitis.[66] Anthraquinones also showed antioxidant effects[67] in normal and thrombotic focal cerebral ischemia-induced rats.[68] Aloin showed α-glucosidase inhibitory and antioxidant activity with and without camel β-casein and its peptides[69] in different growth stages.[70] A. vera is antidiabetic,[71] but its overuse showed carcinogenic effects in F344/N rats.[72] Stabilized diluted A. vera gel is used to make good supplement drink to beat dehydration.[73]

### ANTI-INFLAMMATORY

Mucilaginous leaf gel of A. vera is used to treat inflammatory-based disorders. Aloe emodin from rhubarb (Rheum rhabarbarum) inhibits lipopolysaccharide-induced inflammatory responses in RAW264.7 macrophages.[74] It contains anti-inflammatory ingredients[75] which also show antioxidant effects in rats.[76] A. vera adventitious root extracts show enhancement of anti-inflammatory activity through the alteration of primary and secondary metabolites through salicylic acid elicitation.[77] Transemulgel prepared using nimesulide with A. vera reduces inflammation.[78] A. vera polysaccharides showed hepatoprotective potential against chronic alcohol-induced hepatotoxicity in mice.[47] A. vera downregulates LPS-induced inflammatory cytokine production and expression of NLRP3 inflammasome in human macrophages.[79] A. vera inhibits the cyclooxygenase pathway and reduces prostaglandin E2 production from arachidonic acid. C-glucosyl chromone was isolated from A. vera gel extracts which showed anti-inflammatory activity.[49]

### Immunomodulatory Effect

A. vera shows immunomodulatory properties and its fractions on the response of macrophages against Candida albicans.[80] A. vera gel shows immunostimulatory and immunomodulatory properties.[81] A. barbadensis Mill. extract (AVH200®) shows potential to reduce the activation, proliferation, and cytokine secretion of healthy human blood T-cells. AVH200® shows a suppressive effect on human blood T cells in vitro.[81] A. vera components act as antioxidants or immunostimulants and showed immunomodulatory effects on phorbol myristate acetate-stimulated leukocytes in a dose-dependent manner (P ≤ 0.05).[82] A. vera (A. barbadensis Miller)-supplemented probiotic lassi prevents Shigella infiltration from epithelial barrier into systemic blood flow in mice model.[83]

An aqueous extract of Aloe arborescens (A. arborescens Mill.) contains lectins (glycoproteins) and mannans (polysaccharides) which show immunomodulatory, anti-inflammatory, antiviral, and antibacterial activities.[84] A. vera polysaccharides showed antitumor, antioxidant, anticoagulant, antidiabetic, and radioprotective activities. These also showed antiviral, hypolipidemic, and immunomodulatory activities.[85] Aloe emodin exerts a potent anticancer and immunomodulatory activity on BRAF-mutated human melanoma cells.[86] Aloe polysaccharide is used as adjuvants as they possess immunity-enhancing functions. These can be used in the formulation for the development of poultry vaccines.[87] A. vera downregulates LPS-induced inflammatory cytokine production and expression of NLRP3 inflammasomes in human macrophages.[79] A. vera is used to treat ocular diseases conjunctivitis, dry eye, dacryocystitis, or degenerative diseases. A. vera (A. barbadensis Mill [Lilaceae]) possesses wound-healing properties. It also shows immunomodulatory, anti-inflammatory, or antioxidant activities. A. vera extract is used to restore the function of human corneal cells.[88] A. vera ethanol and ethyl acetate extracts are also used in eye drops to treat inflammations and other ailments of external parts of the eye such as the cornea.

Aloctin I found in A. vera leaf pulp extract shows prophyllactic effect and assists in cancer prevention.[89] A. vera leaf pulp extract decreases serum sialic acid and tumor necrosis factor alpha levels which is an important tumor markers. Aloctin I showed immunomodulatory and mitogenic effects of lectins A. vera which could be proposed as a prophylactic. A. vera leaf pulp lectin (Aloctin I) shows tumor preventive effects on Ehrlich ascites tumors in mice. Aloe gel shows antidiabetic, anticancer, and antibiotic activities if its ingredients are used in dosable quantities/limits.[89] Plant contains polysaccharides which consist of several monosaccharides of which mannose is dominant. Polysaccharides inhibit the opsonization of zymosan HPS and display adjuvant activity on specific antibody production and the induction of delayed-type hypersensitivity in mice.[91]

### Wound Healing

A. vera affects on corneal wound closure and collagenase activity.[92] Its nutrition supplementation is used for diabetic wound healing.[93] Polymeric films loaded with Vitamin E and A. vera are topically applied for the treatment of burn
wounds. Poly saccharides of Aloe Vera induce MMP-3 and TIMP-2 gene expression during the skin wound repair of the rat. A. vera gel is also used as decontamination agent during wound healing. A. vera influences water absorption and enzymatic degradation of alginate hydrogel films. In vitro. Its nanoscaffold impregnated with human Wharton’s jelly stem cells or its secretions improves healing of wounds. Crosslinking chitosan/A. vera-based membranes have many biomedical applications. A. vera gel is used in burn wound dressing in second-degree burns and found much effective than 1% silver sulfadiazine cream. A. vera shows pharmacological attribute and works well in wound cleansing for pressure ulcers. It is used as moisturizing creams to protect skin during radiotherapy for breast cancer.

Glucomannan, a man noso- rich polysaccharide, and gibberellin, a growth hormone, interact with growth factor receptors on the fibroblast, thereby stimulating its activity and proliferation, which in turn significantly increases collagen synthesis after topical and oral A. vera treatment. Aloe gel not only increased collagen content of the wound but also changed collagen composition (more type III) and increased the degree of collagen cross-linking. Due to this, it accelerated wound contraction and increased the breaking strength of resulting scar tissue. An increased synthesis of hyaluronic acid and dermatan sulfate in the granulation tissue of a healing wound following oral or topical treatment has been reported.

ANTIOXIDANT

Aqueous leaf extract of A. vera showed antioxidant activity. It also shows the preventive effect on gentamicin-induced nephrotoxicity in male Wistar rats. It reduces the action of carcinogenic effect induced in pulmonary tissue of mice by cigarette smoke inhalation. It also reduces oxidative stress caused due to diabetics. A. vera (A. barbadensis) gel showed in vitro and in vivo antioxidant activities. Aloe saponaria showed antioxidant activity in UVB-induced paw sunburn in rats. A. vera gel protects the liver from oxidative stress-induced damage in experimental rat model. Both polysaccharides and phenolic constituents A. vera showed antioxidant and antimycoplasmic activities. Barbaloin and folate showed pharmacological potential. A. arborescens Mill. extract induces prooxidant–antioxidant equilibrium and cytokine synthesis in rows. Combination of A. vera and Matricaria recutita mixture reduce chances of rat irritable bowel syndrome of antioxidant and spasmolytic effects.

Skin

A. vera is used to prepare aromatic, natural, and bacteriostatic skin care gel. It is also found effective in wound healing and is used in the management of skin disorders. Its natural ingredients are used to treat in atopic dermatitis and other inflammatory skin disease. Leaf skin and flowers of A. vera (L.) and A. saponaria showed anti-inflammatory and antioxidant effects in a model of UVB-induced paw sunburn in rats. Similarly, polymeric films loaded with Vitamin E and A. vera are used for topical application in the treatment of burn wounds. Poly saccharides of A. vera induce MMP-3 and TIMP-2 gene expression during the skin wound repair of the rat. A. vera extract is used to prepare decontaminant and wound healing formulation to treat sulfur mustard-induced skin injury. Microparticles of A. vera/Vitamin E/chitosan are used in nuclear imaging and an in vivo test analysis for burn treatment.

Burn

A. vera crude gel is a well-reported remedy of burns in Ayurveda. Polymeric films loaded with Vitamin E and A. vera are used for topical application in the treatment of burn wounds. A. vera gel was found effective in wound dressing of second-degree burns. It prevents infections from burn injuries. It reduces inflammation effects due to thermal injury and induces wound healing activities. A. vera is also used for treating acute and chronic wounds. It is topically used in the treatment of Klebsiella pneumoniae B5055-induced burn wound infection in mice using natural products. Effects of A. vera cream reduced post-hemorrhoidectomy pain and wound healing blind. It also inhibits the growth of infectious microbes on injury sites and shows better healing of burn skin. A. vera gel is a protective effect against radiation damage to the skin. It induces the production of an antioxidant protein and metallothionein in the skin, which scavenges hydroxyl radicals and prevents suppression of superoxide dismutase and glutathione peroxidase. Thereby, it reduces the production and release of skin keratinocyte-derived immunosuppressive cytokines such as interleukin-10 (IL-10) and hence prevents UV-induced suppression of delayed type hypersensitivity.

PSORIASIS

A. vera leaf extract using is used in the topical management of psoriasis. It contains bioactive natural ingredients which show better skin care. A. vera plant extract is highly beneficial for skin and skin disorders. It can be used in alternative therapies for common dermatologic disorders. A. vera with 0.1% triamcinolone acetonide is topically applied to treat plaque psoriasis. Its mineralized cream showed protective effects against UVB-induced stress in human skin. A. vera gel is a good topical herbal product which is clinically effective and safe for dermatological use. It contains natural anthraquinone that shows laxative actions.

A. vera processed components are used as supplementation for diabetic wound healing systematic review of current

**ANTIDIABETES**

A. vera shows nutritional and metabolic effects in animal models.[149] It has great ethnomedicinal values as local healers use its extract to treat diabetes mellitus.[150,151] It is good among native remedies used against diabetes and related complications.[152] Aloe is famous for its use in herbal self-care remedies for type 2 diabetes and obese pre-diabetes patients.[153,154] Its blended fibroin/loe gel film was found effective in wound healing in streptozotocin-induced diabetic rats. It can also be used as nutritional supplement in diabetic wound healing.[51] Metabolic effects of A. vera gel complex in obese pre-diabetes and early non-treated diabetic patients: Randomized controlled trial.[155] A. vera gel shows better wound healing than topical nitroglycerin formulations in diabetes-induced foot ulcer.[156] UP780, a chromone-enriched aloe composition, improves insulin sensitivity.[157] It is a good nutraceutical to control diabetes naturally.[158] A. barbadensis Miller extracts showed the presence of antidiabetic effects in streptozotocin-induced type 2 diabetic model rats.[159] A. vera supplementation shows curative effects in subjects with pre-diabetes/metabolic syndrome.[71] Dietary Aloe QDM complex reduces obesity-induced insulin resistance and adipogenesis in obese mice fed a high-fat diet.[160]

**Juice**

A. vera juice is topically used for cure for lichen planus disease.[161] Oral lichen planus is a difficult condition to treat because of its chronic nature It is also used in herbal therapy in inflammatory bowel disease.[162] Aloe vera gel is used to finish cross reactive effects of two drugs when applied topically for skin treatment simultaneously.[163,162] A. vera mixed with the extract of citrus lemon and essential oils are used as nasal spray to treat allergic rhinopathy.[164] Regular use of A. vera juice is effective in controlling diabetes[158] and treatment of ulcerative colitis.[165] Thick juice contains with 4% hydroquinone/10% L-ascorbic acid treatment to keep skin fair and glowing.[166] A. vera juice shows dual mechanistic inhibition of CYP3A4 and CYP2D6.[167]

**Oral**

A. vera gel shows in vivo inhibitory effect on mouse parental splenic lymphocytes to induce cutaneous angiogenesis. [168] A. vera is used to prepare scented mouthwash to keep periodontal system healthy.[169] A. vera is used in various root canal filling materials along with used in primary teeth.[170] It is found highly effective in prevention and clinical management of dental trauma in individuals during their developmental age.[171] A. vera suppresses common foodborne enteropathogens, but Lactobacillus brevis strains survive in gastroodudenal environment and.[43] A. vera gel is used as an adjuvant treatment of oral submucous fibrosis.[172] A. vera - and myrrh-based oral mucodelhesive gels are used in the management of minor recurrent aphthous stomatitis.[173] Nimesulide-incorporated A. vera transemulgel is used to relieve pain.[78] Effects of Japanese traditional herbal medicines (Kampo) contain Aloe extract which shows potential against growth and virulence of Porphyromonas gingivalis and viability of oral epithelial cells.[174] Aloe extract contains aloe emodin and emodin which can be used to control the growth of C. albicans and Enterococcus faecalis in root canals.[175]

**Antimicrobial**

Fresh A. vera gel is used against multidrug-resistant bacteria in infected leg ulcers[176] and as skin moisturizer.[24] A. vera gel shows antimicrobial properties[177] and is used as antimicrobial agents in traditional medicinal soft soaps.[178] Plant is used in preparation of eye drops containing both Aloe and neomycin sulfate.[179] A. vera is also used in various root canal filling materials to check primary microbiological infection.[180] Retardation of wound healing by silver sulfadiazine is reversed by A. vera and nystatin. It is also used for wound dressings.[108,181] Aloe and aloe emodin in A. vera show antipsosomal potential.[182] and A. pulcherrima leaves showed antipsosomal activities[183] while its latex antimarialar activity[184] is used by Luhyia Community of Kakamega East sub-County, Kenya.[185] A new compound, 9-dihydroxy-2'-O-(Z)-cinnamoyl-7-methoxy-aloesin (1), and eight known compounds (2-9) were isolated from Aloe vera tyrosinase inhibitory activity in Pepper mild mottle virus.[186] The extracts show better antimicrobial activity against bacterial strains as compared to fungal strains.[187] Crude extract of A. arborescens Mill. found active against enteropathogens Salmonella enterica serovar Typhimurium, a pathogen causes diarrhea.[188] Leaf latex of Aloe calidophila Reynolds shows antileishmanial activity.[189] Aloe and its derivatives showed antim-Trypanosoma congolense activity.[190] A. vera contains 6 antiseptic agents: Lupeol, salicylic acid, urea nitrogen, cinnamic acid, phenols, and sulfur. They all have inhibitory action on fungi, bacteria, and viruses.

**Anticancer Activity**

A. vera contains Aloe emodin that shows antineoplastic activity.[191] Aloe emodin also inhibit invasion and metastasis of high metastatic breast cancer MDA-MB-231 cells.[192] Aloe emodin-loaded solid lipid nanoparticles showed strong
Aloe vera gel showed protective effect on the permeability transition pore in the inner membrane of rat liver mitochondria in vitro. A. vera products target cancer progression, reduce inflammatory activity and restore other signal pathways. It also has wider clinical applications. Tyrosinase inhibitory components from A. vera showed antiviral activity. Non-colorized whole leaf extract of A. barbadensis Miller (A. vera) was found active in F344/N rats and B6C3F1 mice. It showed reduction of intestinal polyp formation in mice fed a high-fat diet with A. vera gel extract. A. vera shows prevention of radiation-induced dermatitis. It enhances induction of cell cycle arrest and apoptosis through the mitochondrial membrane potential disruption in human U87 malignant glioma cells by aloe emodin. Emodin and aloe modin suppress breast cancer cell proliferation through ER α Inhibition.


Aloe emodin-loaded solid lipid nanoparticles potential antineoplastic effects formulation design and in vitro anti-cancer study. A non-colorized whole leaf extract of A. barbadensis Miller (A. vera) shows anticarcinogenic effects in F344/N rats and B6C3F1 mice. Oral administration of decolorized whole leaf A. vera extract impose adverse effects in rat colon. Aloin inhibits angiogenesis and growth of human colorectal cancer in vitro and in vivo. Whole leaf extract of A. barbadensis Miller (A. vera) shows antitumor activity in F344/N rats. A. vera mouthwash may reduce radiation-induced oral mucositis in head-and-neck cancer patients. A. vera components can reduce the chances of chronic lymphocytic leukemia, HCV infection and B-cell non-Hodgkin’s, but its before treatment its dosage and toxicological evaluation is important for knowing its therapeutic potential. A. vera gel protects the acute skin side effects in patients treated with radiotherapy for breast cancer. A. vera also shows melanogenesis and anti-tyrosinase activity of selected South African plants.

A. vera polysaccharide fraction has shown to inhibit the binding of benzopyrene to primary rat hepatocytes. These potentially prevent the formation of potentially cancer-initiating benzopyrene-DNA adducts. Aloe gel assists in cancer chemoprevention and inhibits tumor-promoting effects of phorbol myristic acetate in animal experimental models. A. barbadensis Miller polysaccharides showed chemopreventive effects. A. vera products are safe, after processing, and food applications. Higher dose of A. vera is harmful for human health, but lower dose in supplementation is highly beneficial and used as herbal medicine.

Antiparasitic

Natural products from Aloe vera such as aloe-emodin show antineoplastic effects. It potentially inhibits angiogenesis and growth human colorectal cancer both in vitro and in vivo. Contrary to this whole leaf extract of Aloe barbadensis miller shows carcinogenic activity in rats. Decolorized low anthraquinone whole leaf Aloe vera showed less antiplasmodial potential in comparison to crude extracts. Chemical Constituents found in leaf latex of Aloe pulcherrima shows antiplasmodial activities.

Constipation

Aqueous leaf extract of A. ferox Mill improve intestinal motility, increased fecal volume and normalized body weight in the constipated rats. It reduces the chances of colorectal cancer. A. vera gel is found active against H. pylori strains. Anthraquinones present in latex are a potent laxative. It increases intestinal water content, stimulates mucus secretion, and increases intestinal peristalsis.

ULCERATIVE COLITIS

A. vera is used as complementary and alternative medicine in herbal therapy for the treatment of inflammatory bowel disease. A. vera gel is also used as herbal medicine in the treatment of ulcerative colitis. A. vera gel also showed anti-inflammatory effects in human colorectal mucosa in vitro. Dietary aloin, aloesin, or aloe-gel exert anti-inflammatory activity in a rat colitis model. Oral treatment of A. vera gel found active in ulcerative colitis. It also shows the protective and healing effects of against dextran sulfate-induced ulcerative colitis in rats.

Commercial Use

A. vera natural products are important resources in traditional medicine and have been long used for prevention and treatment of many diseases. It has many natural bioorganic components which are of multiple uses. The genus Aloe
is also renowned for its medicinal and cosmetic properties. There are several species of Aloe occur around the world with long history of use. However, those which are cultivable are surviving well, and wild ones are threatened with extinction or facing mass replacement by modern farm practices. Plant is highly commercially useful, and hence, its wild species are exploited a lot. There must be sound conservation strategies to protect this plant. Different ethnic groups in Africa recognize their most-valued Aloe at the genus level as “the aloe” and add explanatory names for the other species, such as the “spotted aloe” and the one-legged aloe. Plant is heavily used as medicinal purposes by pastoral and agro-pastoral communities living in African, Asian and European dry-eclimatic regions. In India, plant is traditionally used by many ethnic groups for various household and medicinal purposes. Plant is used for the treatment of various human diseases, as well as assessed the species of interest for bioprospecting potential. A. vera (A. barbadensis Miller) is used for a wide variety of ailments, mouth washers, and tooth gel and the toothpastes.

A. vera paste found effective against C. albicans, Streptococcus mutans, Lactobacillus acidophilus, E. faecalis, Prevotella intermedia, and Peptostreptococcus anaerobius. The most frequently cited medicinal uses were the treatment of infections and internal parasites, digestive ailments, and injuries. A. vera tooth gel protects against Streptococcus mitis infection, while its juice found effective against P. gingivalis and plaque-induced gingivitis. A. vera gel shows antimicrobial efficacy against buccal cavity microbial infection, and it is also used to prepare tooth powder. Aloe vera blended collagen-chitosan composite scaffold for tissue engineering applications. Polysaccharides found in juice, gel, and flower of A. vera are antiparasitic in nature.

A. vera is used in natural passive ultrasonic irrigation in comparison with 1% sodium hypochlorite for removal of E. faecalis biofilm. Its natural products were found effective against gastrointestinal nematodes of sheep. Mucopolysaccharides from A. vera help in binding moisture into the skin. Aloe stimulates fibroblast which produces the collagen and elastin fibers making the skin more elastic and less wrinkled. It also has cohesive effects on the superficial flaking epidermal cells by sticking them together, which softens the skin.

The amino acids also soften hardened skin cells, and zinc acts as an astringent to tighten pores. Its moisturizing effects have also been studied in the treatment of dry skin associated with occupational exposure where A. vera gel gloves improved the skin integrity, decreases appearance of fine wrinkle, and decreases erythema. It also has antiacne effect. A. vera is used for the treatment and management of cancer. Juice is used for the treatment of abdominal cramps, diarrhea, red urine, hepatitis, dependency, or worsening of constipation. Plant also shows allergic reactions which are mostly due to anthraquinones, such as aloin and barbaloin. Prolonged use of plant juice is reported to increase the risk of colorectal cancer. Various A. vera constituents and extracts were found active against number of diseases such as Seborrheic dermatitis, psoriasis vulgaris, genital herpes, skin burns, diabetes (type 2), HIV infection, cancer prevention, and ulcerative colitis and used in wound healing, pressure ulcers, mitigate potential worsening and dermal wound and mucositis, radiation dermatitis, acne vulgaris, lichen planus, frostbite, aphthous stomatitis, and constipation.

**PHYTOCHEMISTRY**

A. vera has wide spectrum of the properties and uses. It contains more than 75 constituents among which important are vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids, and amino acids [Table 1]. Plant contains Vitamins A (beta-carotene), C, and E, which are antioxidants. It also contains Vitamin B12, folic acid, and choline [Table 2]. Antioxidant neutralizes free radicals. A. vera also contains 8 enzymes with different catalytic activity, i.e., aiiase, alkaline phosphatase, amylase, bradykinase, carboxypeptidase, catalase, cellulase, lipase, and peroxidase. Bradykinase helps to reduce excessive inflammation when applied to the skin topically, while others help in the breakdown of sugars and fats. A. vera watery juice contains ample amount of important minerals such as calcium, chromium, copper, selenium, magnesium, manganese, potassium, sodium, and zinc. They are essential for the proper functioning of various enzyme systems in different metabolic pathways and few are antioxidants. It also contains sugars mainly monosaccharides, i.e., glucose and fructose and polysaccharides, i.e., glucosamannopolysaccharose [Figure 2]. These are derived from the mucilage layer of the plant and are known as mucopolysaccharides. The most prominent monosaccharide is mannose-6-phosphate, and the most common polysaccharides are called glucosamanns [beta-(1,4)-acetylated mannan]. Acemannan, a prominent glucosamann, has also been found. Recently, a glycoprotein with antiallergic properties, called alprogen and novel anti-inflammatory compound, C-glucosyl chroneme, has been isolated from A. vera gel. Plant also contains 12 anthraquinones, which are phenolic compounds traditionally known as laxatives. Aloin and emodin act as analgesics, antibacterials, and antivirals [Table 1]. A. vera contains important fatty acids mainly steroids such as cholesterol, campesterol, beta-sitosterol, and lupeol. All these have anti-inflammatory action, and lupeol also possesses antiseptic and analgesic properties. It also contains auxins and gibberellin hormones that help in wound healing and have anti-inflammatory action. Plant provides 20 of the 22 human required amino acids and 7 of the 8 essential amino acids. It also contains salicylic acid that possesses anti-inflammatory and antibacterial properties. Lignin, an inert substance, when included in topical preparations, enhances penetrative effect of the other ingredients into the skin. Saponins are
Table 1: Therapeutic and biological efficacy of various major and minor bioorganic natural products isolated from A. vera plant species

<table>
<thead>
<tr>
<th>Aloespecies plant parts</th>
<th>Major component/s</th>
<th>Sub-constituents</th>
<th>Biological activity</th>
<th>Anti-cancer/antitumor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant juice</td>
<td>Anthraquinones/anthrones</td>
<td>Phenolic compounds, aloe emodin, aloetic acid, anthranol, aloin A and B, isobarbaloin, emodin, ester of cinnamic acid</td>
<td>Analgesics, antibacterials and antivirals</td>
<td>Antitumor, laxative/cathartic compound, antiproliferative</td>
</tr>
<tr>
<td>Plant juice</td>
<td>Anthrones</td>
<td>Aloin, Aloetine, Aloesin</td>
<td>α-Glucosidase inhibitory action antioxidant activity</td>
<td>Purgative, anticancer, antiviral, antibacterial laxative anti-inflammatory</td>
</tr>
<tr>
<td>Plant juice</td>
<td>Anthrones</td>
<td>Lapel, anthracing, anthranol, aloetine acid, emodin, and aloe emodin</td>
<td>Analgesic</td>
<td>-</td>
</tr>
<tr>
<td>Plant juice</td>
<td></td>
<td>Cinnamic acid, lupeol (natural salicylic acid), phenol, saponins, urea nitrogen, sulfur, resistanol</td>
<td>Antiseptic</td>
<td>-</td>
</tr>
<tr>
<td>Plant juice</td>
<td></td>
<td>Brady kinase, beta-sitosterol, campesterol, HDL-cholesterol</td>
<td>Anti-inflammatory</td>
<td>Antitumor</td>
</tr>
<tr>
<td>Inner mass and juice</td>
<td>Carbohydrates</td>
<td>Pure mannann, acetylated mannan, acetylated glucosannan, glucogalactomannan, galactan, galactogalacturan, arabinogalactan, galactoglucarabinomannan, pectic substance, xylan, cellulose</td>
<td>Hepatoprotective, antiaggregating, antimicrobial, anti-inflammatory</td>
<td>Antitumor</td>
</tr>
<tr>
<td>Chromones</td>
<td></td>
<td>8-C-β-d-glucopyranosyl-2-[(S)‑2-hydroxypropyl]-7-hydroxy-5-methylchromone (8-C-glucosyl-(S)‑aloesol), 8-C-β-d-glucopyranosyl-2-(1′,2'-dihydroxypropyl)-7-methoxy-5-methylchromone (8-C-glucosyl-7-O-methylaloediol) and 8-C-β-d-[2′-O-(E)-caffeoyl] glucopyranosyl-2-[(S)-2-hydroxypropyl]-7-methoxy-5-methylchromone</td>
<td>Inhibitory action against tyrosine oxidation</td>
<td>Antitumor</td>
</tr>
<tr>
<td>Mucopolysaccharides</td>
<td>Glucosannans [β-(1,4)-acetylated mannan]</td>
<td>Antibacterial</td>
<td>Hepatoprotective potential</td>
<td></td>
</tr>
<tr>
<td>Watery juice</td>
<td>Vitamins</td>
<td>Vitamins A (beta-carotene), C and E, Vitamin B12, folic acid</td>
<td>Act as coenzymes</td>
<td>Anticancer</td>
</tr>
<tr>
<td>Rind and latex</td>
<td>Saponins</td>
<td>Soapy substances</td>
<td>Antioxidants, antimicrobial, antiseptic</td>
<td>Anticancer</td>
</tr>
<tr>
<td>Rind and latex</td>
<td>Fatty acids mainly steroids</td>
<td>Cholesterol, campesterol, β-sitosterol and lupeol</td>
<td>Inflammatory action and lupeol also possesses</td>
<td>Anticancer</td>
</tr>
<tr>
<td>Inner leaf juice</td>
<td>Enzymes</td>
<td>Aliiase, alkaline phosphatase, amyrase, bradykinase, carboxypeptidase, catalase, cellulase, lipase, and peroxidase. bradykinase</td>
<td>Reduce excessive inflammation</td>
<td>Breakdown of sugars and fats.</td>
</tr>
<tr>
<td>A. vera gel</td>
<td>Aliprogen</td>
<td>Glycoprotein</td>
<td>Antiallergic</td>
<td>Antiallergic</td>
</tr>
<tr>
<td>A. vera gel</td>
<td>C-glucosyl chromone</td>
<td>Chromone</td>
<td>Anti-inflammatory</td>
<td>Anticancer</td>
</tr>
<tr>
<td></td>
<td>Sugars</td>
<td>Glucose</td>
<td>Nutritional</td>
<td>Anticancer</td>
</tr>
</tbody>
</table>

(Contd...
Aloe vera: A review

Upadhyay

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the soapy substances showed antiseptic properties. A. vera polysaccharides showed hepatoprotective potential against chronic alcohol-induced hepatotoxicity in mice.[234] Aloe polymannose multinutrient complex shows positive effects on cognitive and immune functioning in Alzheimer’s disease.[65] Aloin shows α-glucosidase inhibitory action of aloin and its antioxidant activity with and without camel β-casein and its peptides.[69]

CONCLUSION

A. vera is a small farm field plant that has a wide spectrum of the properties and uses. It contains multiple pharmacologically active substances with diverse biological activity. As literature reveals, plant is of immense therapeutic value as it is used to cure constipation, skin burns, wounds, psoriasis, dermatitis, potential worsening, pressure ulcers, mucositis, acne, lichen planus, frostbite, and aphthous stomatitis. Plant contains anticancer, antioxidant, anti-inflammatory, antiparasitic, and antimicrobial activities. Its sap is used to treat glaucoma to multiple sclerosis. In Ayurveda, so many therapeutic preparations are based on A. vera. The plant is used widely in the traditional herbal medicine of many countries. Plant is a good choice of cosmetic and pharmaceutical industries as they are using it for preparation of pain soothing, moisturizing, face shining creams, makeup products, tissues, moisturizers, soaps, sunscreens, incense, shaving cream, or shampoos. Aloe juice and gel provide protection for humans from sunburn. A. vera gel is used commercially as an ingredient in yogurts and beverages in tropical countries. Anthraquinones present in latex are a potent laxative. It increases intestinal water content, stimulates mucus secretion, and increases intestinal peristalsis. Plant also shows allergic reactions which are mostly due to presence of anthraquinones, such as aloin and barbaloin. Prolonged use or overuse of plant juice increases the risk of colorectal cancer. Plant juice is used as a fresh food preservative while plant canopy assists in water conservation in small farms. Aloin found in the exudate is a laxative natural product. A. vera shows potential toxicity, with side effects occurring at higher dose levels both when ingested and applied topically. Before adding A. vera sap to prepare fairness creams, aloin is removed by processing. A. vera juice is marketed to support the health of the

<table>
<thead>
<tr>
<th>Aloespecies plant parts</th>
<th>Major component/s</th>
<th>Sub-constituents</th>
<th>Biological activity</th>
<th>Anti-cancer/antitumor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rind and latex</td>
<td>Salicylic acids</td>
<td>Acids</td>
<td>Anti-inflammatory, antibacterial</td>
<td>Not reported</td>
</tr>
<tr>
<td>Rind and latex</td>
<td>Lignin</td>
<td>Complex organic polymers</td>
<td>Renewable aromatic resource</td>
<td>Membrane penetrative property</td>
</tr>
<tr>
<td>Inner leaf juice</td>
<td>Hormones</td>
<td>Auxins and gibberellins</td>
<td>Wound healing and have anti-inflammatory</td>
<td>Not reported</td>
</tr>
<tr>
<td>Inner leaf juice</td>
<td>Amino acids</td>
<td>Acids</td>
<td>Nutritional</td>
<td>Anti-inflammatory, antitumor</td>
</tr>
<tr>
<td>A. vera watery juicy</td>
<td>Minerals</td>
<td>Calcium, chromium, copper, selenium, magnesium, manganese, potassium, sodium and zinc</td>
<td>Nutritional</td>
<td>Anti-inflammatory, antitumor</td>
</tr>
<tr>
<td></td>
<td>Estereol</td>
<td>Tranquilizing</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Aloetic acid</td>
<td>Antibiotic</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Anthranol</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ester of cinnamic acid</td>
<td>Analgesic and anesthetic</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Chrisophanic acid</td>
<td>Skin fungus</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Cinnamic acid</td>
<td>Detergent germicide and fungicidal</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Resistnol</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 1: (Continued)
**Figure 2:** Major biological active chemical constituents found in *Aloe vera* plant
Table 2: Important major and minor dietary bioorganic natural products found in A. vera plant species

<table>
<thead>
<tr>
<th>Supplement</th>
<th>% daily value</th>
<th>Sub-constituents (%)</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>25 mg</td>
<td>2</td>
<td>Mineral nutrient</td>
</tr>
<tr>
<td>Magnesium</td>
<td>42 g</td>
<td>11</td>
<td>Mineral nutrient</td>
</tr>
<tr>
<td>Sodium</td>
<td>30 mg</td>
<td>1</td>
<td>Nerve ion</td>
</tr>
<tr>
<td>Potassium</td>
<td>276 mg</td>
<td>6</td>
<td>Nerve ion</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>73 mg</td>
<td>10</td>
<td>Component for bone</td>
</tr>
<tr>
<td>Iron</td>
<td>&lt;0.1 mg</td>
<td>Trace</td>
<td>Hemoglobin base</td>
</tr>
<tr>
<td>Copper</td>
<td>&lt;0.1 mg</td>
<td>Trace</td>
<td>Trace element</td>
</tr>
<tr>
<td>Zinc</td>
<td>&lt;0.4 mg</td>
<td>4</td>
<td>Coenzyme inducer</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.225 mg</td>
<td>&lt;1</td>
<td>Coenzyme inducer</td>
</tr>
<tr>
<td>Total carbohydrates</td>
<td>11.95 g</td>
<td>&lt;1</td>
<td>Dietary/energy</td>
</tr>
<tr>
<td>Protein</td>
<td>2.89</td>
<td>3</td>
<td>Dietary/energy</td>
</tr>
<tr>
<td>Fat</td>
<td>0.34</td>
<td>0.34</td>
<td>Dietary/energy</td>
</tr>
<tr>
<td>Vitamins thiamine B1</td>
<td>0.05</td>
<td>4</td>
<td>Nutrient</td>
</tr>
<tr>
<td>Riboflavin B2</td>
<td>0.089</td>
<td>6</td>
<td>Nutrient</td>
</tr>
<tr>
<td>Niacin B3</td>
<td>0.111</td>
<td>1</td>
<td>Nutrient</td>
</tr>
<tr>
<td>Pantothenic acid B5</td>
<td>0.240 mg</td>
<td>5</td>
<td>Nutrient</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>0.081 mg</td>
<td>6</td>
<td>Nutrient</td>
</tr>
<tr>
<td>Organic A. vera Juice</td>
<td>58 mL</td>
<td>Partial use</td>
<td>Freshness</td>
</tr>
<tr>
<td>Organic polysaccharide-rich aloesorb</td>
<td>60 mg</td>
<td>0.03</td>
<td>Anticancer/burn</td>
</tr>
<tr>
<td>Folate B9</td>
<td>89 ug</td>
<td>22</td>
<td>Growth</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>7.4 mg</td>
<td>12</td>
<td>Nutrient</td>
</tr>
</tbody>
</table>

digestive system. A. vera is a good nutrition supplementation for diabetic wound healing. Its gel showed bacteriostatic and/or bactericidal effects on culture. A. vera is capable of modulating cellular phenotypes and functions. Stabilized diluted A. vera gel is used to make good supplement drink to beat dehydration. Because Aloe species found in various climates and possess various biologically active compounds which are of very high therapeutic value. Among them, some are cultivable and domestic, but more than 57 species of it are grown in wild which are of immense ethno pharmacological importance, they are facing stress of extinction. Hence, they need immediate concern of conservation and preservation of their germ plasm to carry forward genetically important plant diversity which is chemotypically too important to save the future of ethnic groups.

REFERENCES

11. British Broadcasting Corporation. Available from:
43. Kim YW, Jeong YJ, Kim AY, Son HH, Lee JA, Jung CH, et al. Lactobacillus brevis strains from fermented Aloe


154. Choi HC, Kim SJ, Son KY, Oh BJ, Cho BL. Metabolic


177. Kodym A, Bujak T. Physicochemical and microbiological properties as well as stability of ointments containing aloe extract (Aloe arborescens mill.) or aloe extract associated to neomycin sulphate. Pharmazie 2002;57:834-7.


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