REVIEW ARTICLE

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

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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, antidiabetic, anti-inflammatory, anti-arthritic, antiparasitic, 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

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Received: 08-02-2018
Revised: 18-02-2018
Accepted: 24-02-2018

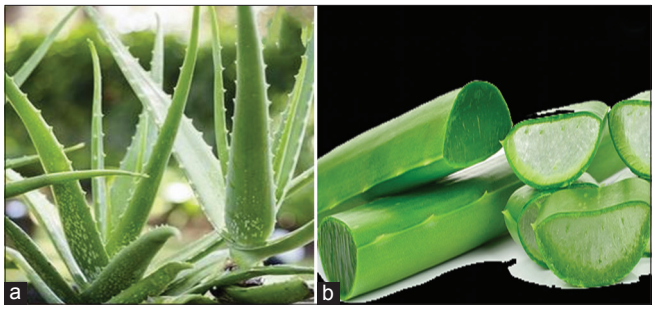

Figure 1: (a and b) Vegetative parts of *Aloe vera* plant

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,[33] 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.[36] 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.) Burm 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 herboprobiotic 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 polymannose 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.[40]

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 ($P \leq 0.05$).[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* Miller [Liliaceae]) 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 prophylactic 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.[90] 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.[41] Polymeric films loaded with Vitamin E and *A. vera* are topically applied for the treatment of burn

wounds.[93,94] Polysaccharides of Aloe A. vera induce MMP-3 and TIMP-2 gene expression during the skin wound repair of the rat.[95] *A. vera* gel is also used as decontamination agent during wound healing.[96,97] *A. vera* influences water absorption and enzymatic degradation of alginate hydrogel films. *in vitro*.[98] Its nanoscaffold impregnated with human Wharton's jelly stem cells or its secretions improves healing of wounds.[99] Crosslinking chitosan/*A. vera*-based membranes have many biomedical applications.[100] *A. vera* gel is used in burn wound dressing in second-degree burns and found much effective than 1% silver sulfadiazine cream.[101] *A. vera* shows pharmacological attribute and works well in wound cleansing for pressure ulcers.[102] It is used as moisturizing creams to protect skin during radiotherapy for breast cancer.[103]

Glucomannan, a mannose-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.[104] 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.[105] 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.[106]

ANTIOXIDANT

Aqueous leaf extract of *A. vera* showed antioxidant activity.[107,108] It also shows the preventive effect on gentamicin-induced nephrotoxicity in male Wistar rats.[109] It reduces the action of carcinogenic effect induced in pulmonary tissue of mice by cigarette smoke inhalation.[110] It also reduces oxidative stress caused due to diabetics.[111] *A. vera* (*A. barbadensis*) gel showed *in vitro* and *in vivo* antioxidant activities.[112,113] *Aloe saponaria* showed antioxidant activity in UVB-induced paw sunburn in rats.[76] *A. vera* gel protects the liver from oxidative stress-induced damage in experimental rat model.[56] Both polysaccharides and phenolic constituents *A. vera* showed antioxidant and antimycoplasmic activities.[114] Barbaloin and folate showed pharmacological potential.[115] *A. arborescens* Mill. extract induces prooxidant–antioxidant equilibrium and cytokine synthesis in rowers.[63] Combination of *A. vera* and *Matricaria recutita* mixture reduce chances of rat irritable bowel syndrome of antioxidant and spasmolytic effects.[116]

Skin

A. vera is used to prepare aromatic, natural, and bacteriostatic skin caregel.[117,118] It is also found effective in wound healing[97,119] and is used in the management of skin disorders.[120] Its natural ingredients are used to treat in atopic dermatitis and other inflammatory skin disease.[121] 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.[122] Similarly, polymeric films loaded with Vitamin E and *A. vera* are used for topical application in the treatment of burn wounds.[56,94,98] Polysaccharides of *A. vera* induce MMP-3 and TIMP-2 gene expression during the skin wound repair of rat.[95] *A. vera* extract is used to prepare decontaminant and wound healing formulation to treat sulfur mustard-induced skin injury.[96] Microparticles of *A. vera*/Vitamin E/chitosan are used in nuclear imaging and an *in vivo* test analysis for burn treatment.[98]

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.[98] *A. vera* gel was found effective in wound dressing of second-degree burns.[101,123-125] It prevents infections from burn injuries.[126,127] It reduces inflammation effects due to thermal injury[128] and induces wound healing activities.[129] *A. vera* is also used for treating acute and chronic wounds.[25] It is topically used in the treatment of *Klebsiella pneumoniae* B5055-induced burn wound infection in mice using natural products.[130] Effects of *A. vera* cream reduced post-hemorrhoidectomy pain and wound healing blind.[131] It also inhibits the growth of infectious microbes on injury sites[132] and shows better healing of burn skin.[24] *A. vera* gel is a protective effect against radiation damage to the skin.[133,134] 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.[135]

PSORIASIS

A. vera leaf extract using is used in the topical management of psoriasis.[27,136] It contains bioactive natural ingredients which show better skin care.[137] *A. vera* plant extract is highly beneficial for skin and skin disorders.[138] It can be used in alternative therapies for common dermatologic disorders.[139] *A. vera* with 0.1% triamcinolone acetonide is topically applied to treat plaque psoriasis.[140-143] Its mineralized cream showed protective effects against UVB-induced stress in human skin.[24,144] *A. vera* gel is a good topical herbal product which is clinically effective and safe for dermatological use.[17] It contains natural anthraquinone that shows laxative actions.[145]

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

literature. Plant extracts for the topical management of psoriasis: A systematic review and meta-analysis.[146] Add one reference In vivo monitoring of oxidative burst on aloe under salinity stress using hemoglobin and single-walled carbon nanotubes modified carbon fiber ultramicroelectrode.[154] *A. vera* leaf gel is anti-hypercholesterolemic and[148] antioxidant capacity and possesses many pharmacological attributes.[108,148]

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/aloe 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.[41] Metabolic effects of *A. ver*a 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.[163,52] *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 brevi*s strains survive in gastroduodenal environment and.[43] *A. vera* gel is used as an adjuvant treatment of oral submucous fibrosis.[172] *A. vera* - and myrrh-based oral mucoadhesive 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] Aloin and aloe emodin in *A. vera* show antiplsomodial potential.[182] and *A. pulcherrima* leaves showed antiplasmodial activities[183] while its latex antimalarial activity[184] is used by Luhya Community of Kakamega East sub-County, Kenya;[185] A new compound, 9-dihydroxyl-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] Aloin and its derivatives showed anti-*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

chemotherapeutics *in vitro* anticancer activity.[191,193] *A. vera* gel showed protective effect on the permeability transition pore in the inner membrane of rat liver mitochondria *in vitro*.[194] *A. vera* products target cancer progression, reduce inflammatory activity and restore other signal pathways.[42,195] It also has wider clinical applications.[191] Tyrosinase inhibitory components from *A. vera* showed antiviral activity.[196] Non-colorized whole leaf extract of *A. barbadensis* Miller (*A. vera*) was found active in F344/N rats and B6C3F1 mice[72]. It showed reduction of intestinal polyp formation in mice fed a high-fat diet with *A. vera* gel extract.[197] *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.[198] Emodin and aloe modin suppress breast cancer cell proliferation through ER α Inhibition.[199]

A. arborescens leaf extract shows antiproliferative and prodifferentiative activity.[103] Aloe emodin stops invasion and metastasis of high metastatic breast cancer MDA-MB-231 cells.[192] *A. vera* polysaccharides showed hepatoprotective potential against chronic alcohol-induced hepatotoxicity in mice.[47] *A. vera* shows high antioxidant potential *in vitro* and *in vivo*[200] and assists in cancer prevention.[47] *A. barbadensis* Miller gel, leaf, and flowers of *A. vera* (L.) are skin protective. *A. vera* mouthwash may reduce radiation-induced oral mucositis in head-and-neck cancer patients.[201] *A. vera* shows nutritional and metabolic effects.[52] Its polysaccharides influence on proliferation and hyaluronic acid and hydroxyproline secretion of human fibroblasts *in vitro*.[202]

Aloe emodin-loaded solid lipid nanoparticles potential antineoplastic affects formulation design and *in vitro* anti-cancer study.[203] 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.[59] Aloin inhibits angiogenesis and growth of human colorectal cancer *in vitro* and *in vivo*.[204] Whole leaf extract of *A. barbadensis* Miller (*A. vera*) shows anticarcinogenic activity in F344/N rats.[205] *A. vera* mouthwash may reduce radiation-induced oral mucositis in head-and-neck cancer patients.[201] *A. vera* components can reduce the chances of chronic lymphocytic leukemia, HCV infection and B-cell non-Hodgkin's.[206] but its before treatment its dosage and toxicological evaluation is important for knowing its therapeutic potential.[207] *A. vera* gel protects the acute skin side effects in patients treated with radiotherapy for breast cancer.[103] *A. vera* also shows melanogenesis and anti-tyrosinase activity of selected South African plants.[208]

A. vera components cause stimulation of the immune system and put direct effect is due to anthraquinones. The anthraquinone aloin inactivates various enveloped viruses such as herpes simplex, varicella zoster, and influenza.[209] *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.[210,211] *A. barbadensis* Miller polysaccharides showed chemopreventive effects.[212] *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.[73,213,214]

Antiparasitic

Natural products from Aloe vera such as aloe-emodin show antineoplastic effects.[215] It potentially inhibits angiogenesis and growth human colorectal cancer both in vitro and in vivo [216]. Contrary to this whole leaf extract of Aloe barbadensis miller shows carcinogenic activity in rats.[217] Decolorized low anthraquinone whole leaf Aloe vera showed less antiplasmodial potential in comparison to crude extracts.[218] Chemical Constituents found in leaf latex of Aloe pulcherrima shows antiplasmodial activities activity.[219]

Constipation

Aaqueous leaf extract of *A. ferox* Mill improve intestinal motility, increased fecal volume and normalized body weight in the constipated rats.[223] It reduces the chances of colorectal cancer.[224] A. vera gel is found active against *H. pylori* strains.[225] Anthraquinones present in latex are a potent laxative. It increases intestinal water content, stimulates mucus secretion, and increases intestinal peristalsis.[226]

ULCERATIVE COLITIS

A. vera is used as complementary and alternative medicine[227-229] in herbal therapy for the treatment of inflammatory bowel disease.[171] *A. vera* gel is also used as herbal medicine in the treatment of ulcerative colitis.[175,230] *A. vera* gel also showed anti-inflammatory effects in human colorectal mucosa *in vitro*.[131] Dietary aloin, aloesin, or aloe-gel exert anti-inflammatory activity in a rat colitis model.[131] Oral treatment of *A. vera* gel found active in ulcerative colitis.[232] It also shows the protective and healing effects of against dextran sulfate-induced ulcerative colitis in rats.[191]

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.[80] 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.[233] Plant is heavily used as medicinal purposes by pastoral and agro-pastoral communities living in African, Asian and European dry eco-climatic regions.[234] 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.[235] *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*.[235] The most frequently cited medicinal uses were the treatment of infections and internal parasites, digestive ailments, and injuries.[234] *A. vera* tooth gel protects against *Streptococcus mitis* infection,[235] while its juice found effective against *P. gingivalis*[174] and plaque-induced gingivitis.[219] *A. vera* gel shows antimicrobial efficacy against buccal cavity microbial infection, and it is also used to prepare tooth popular commercial toothpastes[236,237] *A. vera* blended collagen-chitosan composite scaffold for tissue engineering applications.[237] Polysaccharides found in juice, gel, and flower of *A. vera* are antiparasitic in nature.[108,238] *A. vera* is used in natural passive ultrasonic irrigation in comparison with 1% sodium hypochlorite for removal of *E. faecalis* biofilm.[239] Its natural products were found effective against gastrointestinal nematodes of sheep.[240] 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.[40] It also has cohesive effects on the superficial flaking epidermal cells by sticking them together, which softens the skin.[241]

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.[242] It also has antiacne effect. *A. vera* is used for the treatment and management of cancer.[241] 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 activive against number of diseases such as Seborrheic dermatitis,[242] psoriasis vulgaris,[141,142] genital herpes,[243,244] skin burns,[245] diabetes (type 2),[246] HIV infection,[247] cancer prevention,[248,249] and ulcerative colitis[230] and used in wound healing,[250] pressure ulcers,[251] mitigate potential worsening and dermal wound[252,253] mucositis,[254] radiation dermatitis;[255] acne vulgaris,[256] lichen planus,[257] frostbite,[258] aphthous stomatitis,[259] and constipation[223].

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].[260-262] 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., aliiase, 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., glucomannans/polymannose [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 glucomannans [beta-(1,4)-acetylated mannan]. Acemannan, a prominent glucomannan, has also been found. Recently, a glycoprotein with antiallergic properties, called alprogen and novel anti-inflammatory compound, C-glucosyl chromone, has been isolated from *A. vera* gel.[263,264] 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, β-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

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

(Contd...)

Table 1: *(Continued)*

Aloespecies plant parts	Major component/s	Sub-constituents	Biological activity	Anti-cancer/ antitumor
	Polymannose multinutrient complex	Aloe polymannose	Cognitive and immune functioning in Alzheimer's disease	Antimicrobial, regeneration
Rind and latex	Salicylic acids	Acids	Anti-inflammatory, antibacterial	Not reported
Rind and latex	Lignin	Complex organic polymers	Renewable aromatic resource	Membrane penetrative property
Inner leaf juice	Hormones	Auxins and gibberellins	Wound healing and have anti-inflammatory	Not reported
Inner leaf juice	Amino acids	Acids	Nutritional	Anti-inflammatory, antitumor
A. vera watery juicy	Minerals	Calcium, chromium, copper, selenium, magnesium, manganese, potassium, sodium and zinc	Nutritional	Anti-inflammatory, antitumor
		Estereol	Tranquilizing	-
		Aloetic acid	Antibiotic	-
		Anthranol		-
		Ester of cinnamic acid	Analgesic and anesthetic	-
		Chrisophanic acid	Skin fungus	-
Resistnol			Protection against fungal and insect attack including termites	-
		Cinnamic acid	Detergent germicide and fungicidal	-

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

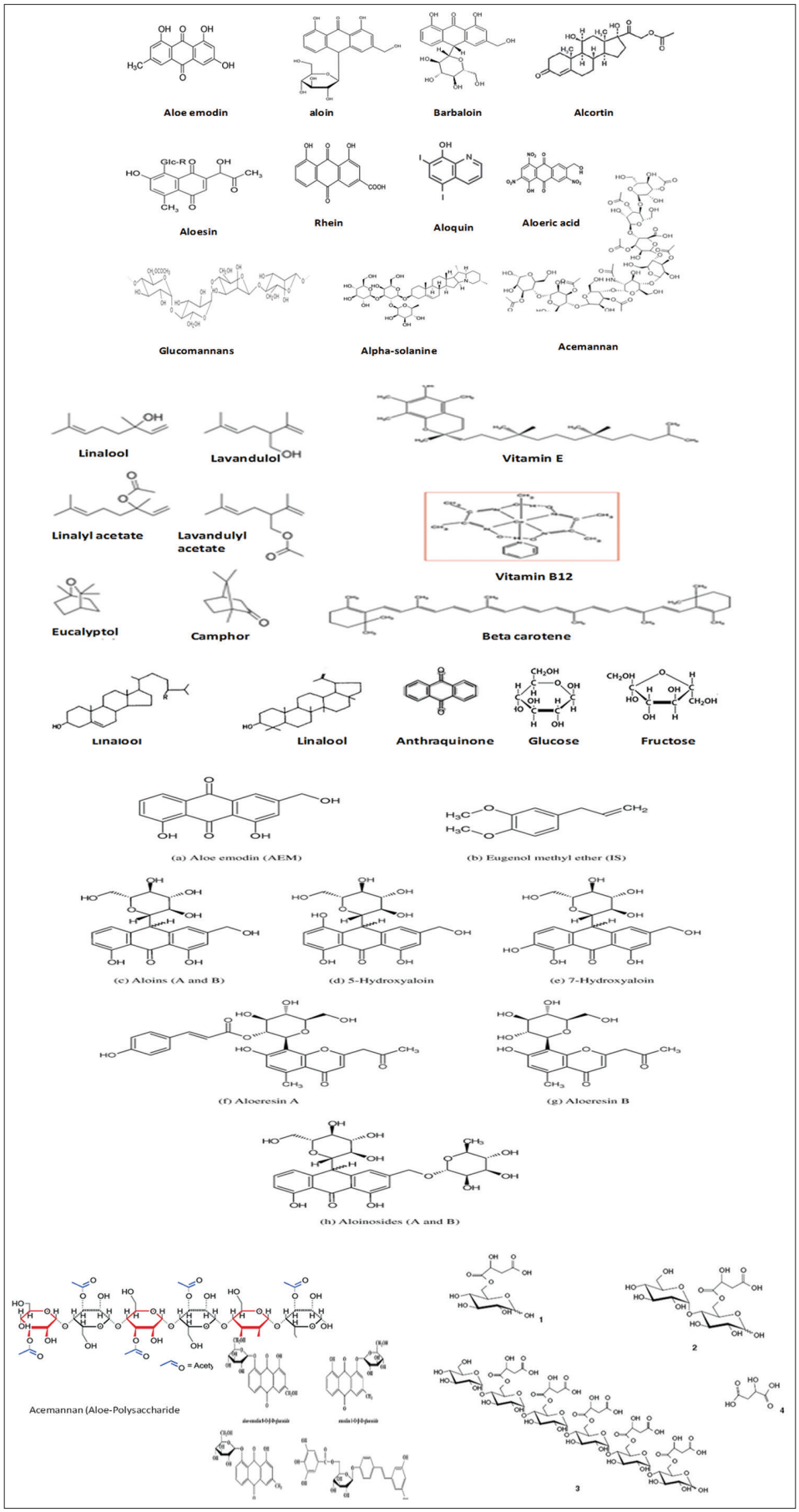

Figure 2: Major biological active chemical constituents found in *Aloe vera* plant

Table 2: Important major and minor dietary bioorganic natural products found in *A. vera* plant species

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

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

1. Perkins, Cyndi. Is Aloe a Tropical Plant? Available from: http//www.SFgate.com. [Last retrieved on 2016 Feb 13].
2. Random House Australia. Botanica's Pocket Gardening Encyclopedia for Australian. Australia: Gardeners Random House Publishers; 2001.
3. Gong M, Wang F, Chen Y. Study on application of arbuscular-mycorrhizas in growing seedings of *Aloe vera*. Zhong Yao Cai (in Chinese) 2002;25:1-3.
4. Coleby-Williams J. Fact Sheet: Aloes. Gardening Australia, Australian Broadcasting Corporation. Archived from the original; 2008. Available from: http://www.abc.net.au/news/2005-12-06/aloe-vera-producer-signs-3m-china-deal. [Last retrieved on 2008 Jul 08].
5. *Aloe ver*a Producer Signs $3m China Deal. Australian Broadcasting Corporation; 2005. Available from: http://www.abc.net.au/gardening/stories/s2280641.htm.
6. More Medicinal Plants Grow in Ciego de Ávila. Available from: http://www.Invasor.cu. [Last retrieved on 2008 Jun 25].
7. Korea interested in Dominican *'Aloe ver*a. DominicanToday.com-The Dominican Republic News Source in English. 2006. Archived from the original on 6 December 2008. Available from: http://www.dominicantoday.com/dr/economy/2006/7/7/15337.
8. Vaibhav V. India Experiments with Farming Medicinal Plants. Available from: http://www.Channelnewsasia.com. [Last accessed on 2005 Dec 11].
9. Harnessing the Potential of Our Aloe. Jamaica Gleaner. Archived from the original on 24 March 2008. Available from: http://www.jamaica-gleaner.com. [Last retrieved on 2008 Jul 19].
10. *Aloe ver*a (Linnaeus) Burman f., *Fl. Indica*. 83. 1768. In Flora of North America Vol. 26, p. 411. Available from: http://www.efloras.org.
11. British Broadcasting Corporation. Available from:

http://www.bbc.co.uk/gardening/plants/plant_finder/plant_pages/7686.shtml. [Last retrieved on 2008 Jul 11].
12. Pest Alert: *Aloe vera* aphid Aloephagus myersi Essi. Florida Department of Agriculture and Consumer Services. Archived from the original on 12 June 2008. Available from: http//www.doacs.state.fl.us/pi/enpp/ento/a-myersi. [Last retrieved on 2008 Jul 11].
13. Kemper Center for Home Gardening: *Aloe vera*. USA: Missouri Botanic Gardens. Available from: http://www.missouribotanicalgarden.org. [Last retrieved on 2008 Jul 11].
14. Aloe (*Aloe vera*). Available from: http//www.MayoClinic.com. [Last accessed on 2012 Sep 01; Last retrieved on 2012 Nov 09].
15. Barcroft A, Myskja A. *Aloe vera*: Nature's Silent Healer. USA: BAAM; 2003.
16. Boudreau MD, Beland FA. An evaluation of the biological and toxicological properties of *Aloe Barbadensis* (Miller), *Aloe vera*. J Environ Sci Health C Environ Carcinog Ecotoxicol Rev 2006;24:103-54.
17. Vogler BK, Ernst E. *Aloe vera*: A systematic review of its clinical effectiveness. Br J Gen Pract 1999;49:823-8.
18. Kunkel G. Plants for Human Consumption. Koenigstein, West Germany: Koeltz Scientific Books; 1984.
19. Zheng GH, Yang L, Chen HY, Chu JF, Mei L. *Aloe vera* for prevention and treatment of infusion phlebitis. Cochrane Database Syst Rev 2014;6:CD009162.
20. Tom R, editor. Medicinal and aromatic plants-industrial profiles. Aloes: The genus Aloe. USA: CRC Press; 2004.
21. Liza A. Clean and green. Australian Broadcasting Corporation. Archived from the original on 24 May 2008. [Last retrieved on 2008 Jun 20].
22. Yagua Unveils Cosmeceutical Beverage. Decision News Media. [Last retrieved on 2008 Jun 20].
23. Cosmetic Ingredient Review Expert Panel. Final report on the safety assessment of aloeAndongensis extract, aloe andongensis leaf juice, *Aloe arborescens* leaf extract, *Aloe arborescens* leaf juice, *Aloe arborescens* leaf protoplasts, *Aloe barbadensis* flower extract, *Aloe barbadensis* leaf, *Aloe barbadensis* leaf extract, *Aloe barbadensis* leaf juice, *Aloe barbadensis* leaf polysaccharides, *Aloe barbadensis* leaf water, *Aloe ferox* leaf extract, *Aloe ferox* leaf juice, and *Aloe ferox* leaf juice extract. Int J Toxicol 2007;26 Suppl 2:1-50.
24. Feily A, Namazi MR. *Aloe vera* in dermatology: A brief review. G Ital Dermatol Venereol 2009;144:85-91.
25. Dat AD, Poon F, Pham KB, Doust J. *Aloe vera* for treating acute and chronic wounds. Cochrane Database Syst Rev 2012;2:CD008762.
26. Maenthaisong R, Chaiyakunapruk N, Niruntraporn S, Kongkaew C. The efficacy of *Aloe vera* used for burn wound healing: A systematic review. Burns 2007;33:713-8.
27. Deng S, May BH, Zhang AL, Lu C, Xue CC. Plant extracts for the topical management of psoriasis: A systematic review and meta-analysis. Br J Dermatol 2013;169:769-82.
28. Umberto Q. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. Vol. 05. Boca Raton: CRC Press; 2012.
29. Rodriguez F, Baldassarre H, Simonetti J, Aste F, Ruttle JL. Cervical versus intrauterine insemination of ewes using fresh or frozen semen diluted with *Aloe vera* gel. Theriogenology 1988;30:843-54.
30. Serrano M, Valverde JM, Guillén F, Castillo S, Martínez-Romero D, Valero D, *et al.* Use of *Aloe vera* gel coating preserves the functional properties of table grapes. J Agric Food Chem 2006;54:3882-6.
31. Water conservation. Chennai, India: The Hindu. Archived from the original on 2 August 2008. Available from: https://epaper.thehindu.com. [Last accessed on 2008 Jul 10; Last retrieved on 2008 Jul 14].
32. Shukla S. *Aloe vera* has biodiesel potential, reveals MSU study. The Indian Express. Archived from the original on 14 January 2009. Available from: http://www.expressindia.com. [Last accessed on 2008 Jun 21].
33. *Aloe vera*: Science and Safety | NCCIH. Available from: http://www.Nccih.nih.gov. [Last retrieved on 2014 Jan 31].
34. Proposition 65. Chemicals Listed Effective December 4, 2015 as Known to the State of California to Cause Cancer: *Aloe ver*a, Non-Decolorized Whole Leaf Extract and Goldenseal Root Powder. U.S. Office of Environmental Health Hazard Assessment;2015. Available from: https://oehha.ca.gov/proposition-65/chemicals.
35. *Aloe vera*. NCCIH. Available from: http://www.NCCIH. [Last retrieved on 2016 Mar 01].
36. Eshun K, He Q. *Aloe vera*: A valuable ingredient for the food, pharmaceutical and cosmetic industries-a review. Crit Rev Food Sci Nutr 2004;44:91-6.
37. US Farms, Inc. A Different Kind of Natural Resource Company. Archived from the original on 17 September 2008. Available from: http://www.Resourceinvestor.com. [Last retrieved on 2008 Jul 19].
38. Food and Drug Administration, HHS. Status of certain additional over-the-counter drug category II and III active ingredients. Final rule. Fed Regist 2002;67:31125-7.
39. Bottenberg MM, Wall GC, Harvey RL, Habib S. Oral *Aloe vera*-induced hepatitis. Ann Pharmacother 2007;41:1740-3.
40. Surjushe A, Vasani R, Saple DG. *Aloe vera*: A short review. Indian J Dermatol 2008;53:163-6.
41. Maier HM, Ilich JZ, Kim JS, Spicer MT. Nutrition supplementation for diabetic wound healing: A systematic review of current literature. Skinmed 2013;11:217-24.
42. Khuda-Bukhsh AR, Das S, Saha SK. Molecular approaches toward targeted cancer prevention with some food plants and their products: Inflammatory and other signal pathways. Nutr Cancer 2014;66:194-205.
43. Kim YW, Jeong YJ, Kim AY, Son HH, Lee JA, Jung CH, *et al*. *Lactobacillus brevis* strains from fermented *Aloe*

vera survive gastroduodenal environment and suppress common food borne enteropathogens. PLoS One 2014;9:e90866.
44. Basannavar S, Pothuraju R, Sharma RK. Effect of *Aloe vera* (*Aloe barbadensis* miller) on survivability, extent of proteolysis and ACE inhibition of potential probiotic cultures in fermented milk. J Sci Food Agric 2014;94:2712-7.
45. Pan H, Jiang B, Chen J, Jin Z. Blend-modification of soy protein/lauric acid edible films using polysaccharides. Food Chem 2014;151:1-6.
46. Gupta SD, Masakapalli SK. Mushroom tyrosinase inhibition activity of *Aloe vera* L. Gel from different germplasms. Chin J Nat Med 2013;11:616-20.
47. Cui Y, Ye Q, Wang H, Li Y, Yao W, Qian H. Hepatoprotective potential of *Aloe vera* polysaccharides against chronic alcohol-induced hepatotoxicity in mice. J Sci Food Agric 2014;94(9):1764-71.
48. Saito M, Tanaka M, Misawa E, Yamada M, Yamauchi K, Iwatsuki K, *et al. Aloe vera* gel extract attenuates ethanol-induced hepatic lipid accumulation by suppressing the expression of lipogenic genes in mice. Biosci Biotechnol Biochem 2012;76:2049-54.
49. Choudhary M, Kochhar A, Sangha J. Hypoglycemic and hypolipidemic effect of *Aloe vera* L. In non-insulin dependent diabetics. J Food Sci Technol 2014;51:90-6.
50. Kumar M, Rakesh S, Nagpal R, Hemalatha R, Ramakrishna A, Sudarshan V, *et al.* Probiotic *Lactobacillus rhamnosus* GG and *Aloe vera* gel improve lipid profiles in hypercholesterolemic rats. Nutrition 2013;29:574-9.
51. Zhong J, Huang Y, Ding W, Wu X, Wan J, Luo H, *et al.* Chemical constituents of *Aloe barbadensis* miller and their inhibitory effects on phosphodiesterase-4D. Fitoterapia 2013;91:159-65.
52. Nagpal R, Kaur V, Kumar M, Marotta F. Effect of *Aloe vera* juice on growth and activities of *lactobacilli in-vitro*. Acta Biomed 2012;83:183-8.
53. Ramírez Mérida LG, Morón de Salim A, Catinella R, Castillo L. Bacteriostatic and/or bactericidal extract of *Aloe vera* gel on cultures of *Listeria monocytogenes*. Arch Latinoam Nutr 2012;62:73-8.
54. Reyes JE, Guanoquiza MI, Tabilo-Munizaga G, Vega-Galvez A, Miranda M, Pérez-Won M, *et al.* Microbiological stabilization of *Aloe vera* (*Aloe barbadensis* miller) gel by high hydrostatic pressure treatment. Int J Food Microbiol 2012;158:218-24.
55. Misawa E, Tanaka M, Nabeshima K, Nomaguchi K, Yamada M, Toida T, *et al.* Administration of dried *Aloe vera* gel powder reduced body fat mass in diet-induced obesity (DIO) rats. J Nutr Sci Vitaminol (Tokyo) 2012;58:195-201.
56. Nahar T, Uddin B, Hossain S, Sikder AM, Ahmed S. *Aloe vera* gel protects liver from oxidative stress-induced damage in experimental rat model. J Complement Integr Med 2013;10.
57. Ramachandra CT, Rao PS. Shelf-life and colour change kinetics of *Aloe vera* gel powder under accelerated storage in three different packaging materials. J Food Sci Technol 2013;50:747-54.
58. Song HY, Jo WS, Song NB, Min SC, Song KB. Quality change of apple slices coated with *Aloe vera* gel during storage. J Food Sci 2013;78:C817-22.
59. Shao A, Broadmeadow A, Goddard G, Bejar E, Frankos V. Safety of purified decolorized (low anthraquinone) whole leaf *Aloe vera* (L) burm. F. Juice in a 3-month drinking water toxicity study in F344 rats. Food Chem Toxicol 2013;57:21-31.
60. Dangarembizi R, Chivandi E, Erlwanger K. *Aloe ferox* seed: A potential source of oil for cosmetic and pharmaceutical use. Nat Prod Commun 2013;8:411-4.
61. Zhang YX, Li JS, Peng WW, Liu X, Yang GM, Chen LH, *et al.* Comparative pharmacokinetics of aloe-emodin, rhein and emodin determined by liquid chromatography-mass spectrometry after oral administration of a rhubarb peony decoction and rhubarb extract to rats. Pharmazie 2013;68:333-9.
62. Yadav H, Jain S. Herbo-probiotic therapy in cardioprotection: A new way of nature to nurture. Nutrition 2013;29:1070-1.
63. Basta P, Pilaczyńska-Szczęśniak Ł, Woitas-Ślubowska D, Skarpańska-Stejnborn A. Influence of *Aloe arborescens* mill. Extract on selected parameters of pro-oxidant-antioxidant equilibrium and cytokine synthesis in rowers. Int J Sport Nutr Exerc Metab 2013;23:388-98.
64. Picchietti S, Bernini C, Belardinelli MC, Ovidi E, Taddei AR, Guerra L, *et al.* Immune modulatory effects of *Aloe arborescens* extract on the piscine SAF-1 cell line. Fish Shellfish Immunol 2013;34:1335-44.
65. Lewis JE, McDaniel HR, Agronin ME, Loewenstein DA, Riveros J, Mestre R, *et al.* The effect of an aloe polymannose multinutrient complex on cognitive and immune functioning in Alzheimer's disease. J Alzheimers Dis 2013;33:393-406.
66. Yang YM, Wang P, Zhang Y. A comparative study on the absorption kinetics parameters of rhubarb free anthraquinones between normal dogs and dogs with severe acute pancreatitis. Zhongguo Zhong Xi Yi Jie He Za Zhi 2012;32:494-8.
67. Li H, Guo H, Wu L, Zhang Y, Chen J, Liu X, *et al.* Comparative pharmacokinetics study of three anthraquinones in rat plasma after oral administration of radix et rhei rhizoma extract and dahuang fuzi tang by high performance liquid chromatography-mass spectrometry. J Pharm Biomed Anal 2013;76:215-8.
68. Feng SX, Li JS, Qu LB, Shi YM, Zhao D. Comparative pharmacokinetics of five rhubarb anthraquinones in normal and thrombotic focal cerebral ischemia-induced rats. Phytother Res 2013;27:1489-94.
69. Ghamari F, Ghaffari SM, Salami M, Moosavi-Movahedi F, Farivar F, Johari A, *et al.* Synergic study of α-glucosidase inhibitory action of aloin and its antioxidant activity with and without camel β-casein and

its peptides. Protein Pept Lett 2013;20:607-12.
70. Lee S, Do SG, Kim SY, Kim J, Jin Y, Lee CH, *et al.* Mass spectrometry-based metabolite profiling and antioxidant activity of *Aloe vera* (*Aloe barbadensis* miller) in different growth stages. J Agric Food Chem 2012;60:11222-8.
71. Devaraj S, Yimam M, Brownell LA, Jialal I, Singh S, Jia Q, *et al.* Effects of *Aloe vera* supplementation in subjects with prediabetes/metabolic syndrome. Metab Syndr Relat Disord 2013;11:35-40.
72. Boudreau MD, Beland FA, Nichols JA, Pogribna M. Toxicology and carcinogenesis studies of a nondecolorized [corrected] whole leaf extract of *Aloe barbadensis* miller (*Aloe vera*) in F344/N rats and B6C3F1 mice (drinking water study). Natl Toxicol Program Tech Rep Ser 2013;577:1-266.
73. Sehgal I, Winters WD, Scott M, David A, Gillis G, Stoufflet T, *et al.* Toxicologic assessment of a commercial decolorized whole leaf *Aloe vera* juice, lily of the desert filtered whole leaf juice with aloesorb. J Toxicol 2013;2013:802453.
74. Hu B, Zhang H, Meng X, Wang F, Wang P. Aloe-emodin from rhubarb (*Rheum rhabarbarum*) inhibits lipopolysaccharide-induced inflammatory responses in RAW264.7 macrophages. J Ethnopharmacol 2014;153:846-53.
75. Wu JH, Xu C, Shan CY, Tan RX. Antioxidant properties and PC12 cell protective effects of APS-1, a polysaccharide from *Aloe vera* var. Chinensis. Life Sci 2006;78:622-30.
76. Silva SS, Caridade SG, Mano JF, Reis RL. Effect of crosslinking in chitosan/*Aloe vera*-based membranes for biomedical applications. Carbohydr Polym 2013;98:581-8.
77. Lee YS, Ju HK, Kim YJ, Lim TG, Uddin MR, Kim YB, *et al.* Enhancement of anti-inflammatory activity of *Aloe vera* adventitious root extracts through the alteration of primary and secondary metabolites via salicylic acid elicitation. PLoS One 2013;8:e82479.
78. Vandana KR, Yalavarthi PR, Sundaresan CR, Sriramaneni RN, Vadlamudi HC. *In-vitro* assessment and pharmacodynamics of nimesulide incorporated *Aloe vera* transemulgel. Curr Drug Discov Technol 2014;11:162-7.
79. Budai MM, Varga A, Milesz S, Tőzsér J, Benkő S. *Aloe vera* downregulates LPS-induced inflammatory cytokine production and expression of NLRP3 inflammasome in human macrophages. Mol Immunol 2013;56:471-9.
80. Farahnejad Z, Ghazanfari T, Yaraee R. Immunomodulatory effects of *Aloe vera* and its fractions on response of macrophages against *Candida albicans*. Immunopharmacol Immunotoxicol 2011;33:676-81.
81. Ahluwalia SK, Peng RD, Breysse PN, Diette GB, Curtin-Brosnan J, Aloe C, *et al.* Mouse allergen is the major allergen of public health relevance in Baltimore city. J Allergy Clin Immunol 2013;132:830-50.
82. Bulfon C, Galeotti M, Volpatti D. Medicinal plant extracts modulate respiratory burst and proliferation activity of rainbow trout (*Oncorhynchus mykiss*) leukocytes. Fish Physiol Biochem 2018;44:109-17.
83. Hussain SA, Patil GR, Reddi S, Yadav V, Pothuraju R, Singh RRB, *et al. Aloe vera* (*Aloe barbadensis* miller) supplemented probiotic lassi prevents *Shigella* infiltration from epithelial barrier into systemic blood flow in mice model. Microb Pathog 2017;102:143-7.
84. Fal AM, Schönknecht K, Jambor J. Immunomodulatory role of biostymina® and bioaron® C in the prevention and treatment of upper respiratory tract infections. Wiad Lek 2016;69:77-84.
85. Xie JH, Jin ML, Morris GA, Zha XQ, Chen HQ, Yi Y, *et al.* Advances on bioactive polysaccharides from medicinal plants. Crit Rev Food Sci Nutr 2016;56 Suppl 1:S60-84.
86. Tabolacci C, Cordella M, Turcano L, Rossi S, Lentini A, Mariotti S, *et al.* Aloe-emodin exerts a potent anticancer and immunomodulatory activity on BRAF-mutated human melanoma cells. Eur J Pharmacol 2015;762:283-92.
87. Yang J, Chen Z, Ching P, Shi Q, Li X. An integrated microfluidic platform for evaluating *in vivo* antimicrobial activity of natural compounds using a whole-animal infection model. Lab Chip 2013;13:3373-82.
88. Woźniak A, Paduch R. *Aloe vera* extract activity on human corneal cells. Pharm Biol 2012;50:147-54.
89. Akev N, Turkay G, Can A, Gurel A, Yildiz F, Yardibi H, *et al.* Tumour preventive effect of *Aloe vera* leaf pulp lectin (Aloctin I) on ehrlich ascites tumours in mice. Phytother Res 2007;21:1070-5.
90. Reynolds T, Dweck AC. *Aloe vera* leaf gel: A review update. J Ethnopharmacol 1999;68:3-7.
91. t'Hart LA, van den Berg AJ, Kuis L, van Dijk H, Labadie RP. An anti-complementary polysaccharide with immunological adjuvant activity from the leaf parenchyma gel of *Aloe vera.* Planta Med 1989;55:509-12.
92. Curto EM, Labelle A, Chandler HL. *Aloe vera*: An *in vitro* study of effects on corneal wound closure and collagenase activity. Vet Ophthalmol 2014;17:403-10.
93. Pereira RF, Carvalho A, Gil MH, Mendes A, Bártolo PJ. Influence of *Aloe vera* on water absorption and enzymatic *in vitro* degradation of alginate hydrogel films. Carbohydr Polym 2013;98:311-20.
94. Amoo SO, Aremu AO, Van Staden J. Unraveling the medicinal potential of South African aloe species. J Ethnopharmacol 2014;153:19-41.
95. Tabandeh MR, Oryan A, Mohammadalipour A. Polysaccharides of *Aloe vera* induce MMP-3 and TIMP-2 gene expression during the skin wound repair of rat. Int J Biol Macromol 2014;65:424-30.
96. Lomash V, Pant SC. A novel decontaminant and wound healant formulation of N,N'-dichloro-bis[2,4,6-trichlorophenyl]urea against sulfur mustard-induced skin injury. Wound Repair Regen 2014;22:85-95.
97. Khan AW, Kotta S, Ansari SH, Sharma RK, Kumar A, Ali J, *et al.* Formulation development, optimization

and evaluation of *Aloe vera* gel for wound healing. Pharmacogn Mag 2013;9:S6-10.
98. Pereira GG, Guterres SS, Balducci AG, Colombo P, Sonvico F. Polymeric films loaded with vitamin E and *Aloe vera* for topical application in the treatment of burn wounds. Biomed Res Int 2014;2014:641590.
99. Tam K, Cheyyatraviendran S, Venugopal J, Biswas A, Choolani M, Ramakrishna S, *et al.* A nanoscaffold impregnated with human Wharton's jelly stem cells or its secretions improves healing of wounds. J Cell Biochem 2014;115:794-803.
100. Shahzad MN, Ahmed N. Effectiveness of *Aloe vera* gel compared with 1% silver sulphadiazine cream as burn wound dressing in second degree burns. J Pak Med Assoc 2013;63:225-30.
101. Moore ZE, Cowman S. Wound cleansing for pressure ulcers. Cochrane Database Syst Rev 2013;3:CD004983.
102. Di Franco R, Sammarco E, Calvanese MG, De Natale F, Falivene S, Di Lecce A, *et al.* Preventing the acute skin side effects in patients treated with radiotherapy for breast cancer: The use of corneometry in order to evaluate the protective effect of moisturizing creams. Radiat Oncol 2013;8:57.
103. Chithra P, Sajithlal GB, Chandrakasan G. Influence of *Aloe vera* on collagen characteristics in healing dermal wounds in rats. Mol Cell Biochem 1998;181:71-6.
104. Heggers JP, Kucukcelebi A, Listengarten D, Stabenau J, Ko F, Broemeling LD, *et al.* Beneficial effect of aloe on wound healing in an excisional wound model. J Altern Complement Med 1996;2:271-7.
105. Chithra P, Sajithlal GB, Chandrakasan G. Influence of *Aloe vera* on the glycosaminoglycans in the matrix of healing dermal wounds in rats. J Ethnopharmacol 1998;59:179-86.
106. Asadi-Shahmirzadi A, Mozaffari S, Sanei Y, Baeeri M, Hajiaghaee R, Monsef-Esfahani HR, *et al.* Benefit of *Aloe vera* and *Matricaria recutita* mixture in rat irritable bowel syndrome: Combination of antioxidant and spasmolytic effects. Chin J Integr Med 2012.
107. Nejatzadeh-Barandozi F. Antibacterial activities and antioxidant capacity of *Aloe vera*. Org Med Chem Lett 2013;3:5.
108. Baradaran A, Nasri H, Nematbakhsh M, Rafieian-Kopaei M. Antioxidant activity and preventive effect of aqueous leaf extract of *Aloe vera* on gentamicin-induced nephrotoxicity in male wistar rats. Clin Ter 2014;165:7-11.
109. Koul A, Bala S, Yasmeen, Arora N. *Aloe vera* affects changes induced in pulmonary tissue of mice caused by cigarette smoke inhalation. Environ Toxicol 2015;30:999-1013.
110. Rahimifard M, Navaei-Nigjeh M, Mahroui N, Mirzaei S, Siahpoosh Z, D P, *et al.* Improvement in the function of isolated rat pancreatic islets through reduction of oxidative stress using traditional Iranian medicine. Cell J 2014;16:147-63.
111. Kang MC, Kim SY, Kim YT, Kim EA, Lee SH, Ko SC, *et al. In vitro* and *in vivo* antioxidant activities of polysaccharide purified from *Aloe vera* (*Aloe barbadensis*) gel. Carbohydr Polym 2014;99:365-71.
112. Kaithwas G, Singh P, Bhatia D. Evaluation of *in vitro* and *in vivo* antioxidant potential of polysaccharides from *Aloe vera* (*Aloe barbadensis* miller) gel. Drug Chem Toxicol 2014;37:135-43.
113. López A, de Tangil MS, Vega-Orellana O, Ramírez AS, Rico M. Phenolic constituents, antioxidant and preliminary antimycoplasmic activities of leaf skin and flowers of *Aloe vera* (L.) burm. F. (syn. *A. Barbadensis* mill.) from the canary islands (Spain). Molecules 2013;18:4942-54.
114. Patel DK, Patel K, Tahilyani V. Barbaloin: A concise report of its pharmacological and analytical aspects. Asian Pac J Trop Biomed 2012;2:835-8.
115. Jiménez-Encarnación E, Ríos G, Muñoz-Mirabal A, Vilá LM. Euforia-induced acute hepatitis in a patient with scleroderma. BMJ Case Rep 2012;2012.
116. Gao SH, Zhao GX, Yang XD, Xu LL. Preparation and antimicrobial effect of aromatic, natural and bacteriostatic foot wash with skin care. Zhongguo Zhong Yao Za Zhi 2013;38:2023-6.
117. Lall N, Kishore N. Are plants used for skin care in South Africa fully explored? J Ethnopharmacol 2014;153:61-84.
118. Amish Burn Study Group, Kolacz NM, Jaroch MT, Bear ML, Hess RF. The effect of burns & wounds (B&W)/burdock leaf therapy on burn-injured amish patients: A pilot study measuring pain levels, infection rates, and healing times. J Holist Nurs 2014;32:327-40.
119. Afolayan AJ, Grierson DS, Mbeng WO. Ethnobotanical survey of medicinal plants used in the management of skin disorders among the Xhosa communities of the Amathole district, Eastern Cape, South Africa. J Ethnopharmacol 2014;153:220-32.
120. Dohil MA. Natural ingredients in atopic dermatitis and other inflammatory skin disease. J Drugs Dermatol 2013;12:s128-32.
121. Silva MA, Trevisan G, Hoffmeister C, Rossato MF, Boligon AA, Walker CI, *et al.* Anti-inflammatory and antioxidant effects of *Aloe saponaria* haw in a model of UVB-induced paw sunburn in rats. J Photochem Photobiol B 2014;133:47-54.
122. Khorasani G, Hosseinimehr SJ, Azadbakht M, Zamani A, Mahdavi MR. Aloe versus silver sulfadiazine creams for second-degree burns: A randomized controlled study. Surg Today 2009;39:587-91.
123. Hosseinimehr SJ, Khorasani G, Azadbakht M, Zamani P, Ghasemi M, Ahmadi A, *et al*. Effect of aloe cream versus silver sulfadiazine for healing burn wounds in rats. Acta Dermatovenerol Croat 2010;18:2-7.
124. Lloyd EC, Rodgers BC, Michener M, Williams MS. Outpatient burns: Prevention and care. Am Fam Physician 2012;85:25-32.
125. Pereira GG, Santos-Oliveira R, Albernaz MS, Canema D, Weismüller G, Barros EB, *et al.* Microparticles of

Aloe vera/vitamin E/chitosan: Microscopic, a nuclear imaging and an *in vivo* test analysis for burn treatment. Eur J Pharm Biopharm 2014;86:292-300.
126. Pećanac M, Janjić Z, Komarcević A, Pajić M, Dobanovacki D, Misković SS, *et al.* Burns treatment in ancient times. Med Pregl 2013;66:263-7.
127. Silva MA, Trevisan G, Klafke JZ, Rossato MF, Walker CI, Oliveira SM, *et al.* Antinociceptive and anti-inflammatory effects of *Aloe saponaria* haw on thermal injury in rats. J Ethnopharmacol 2013;146:393-401.
128. Hajhashemi V, Ghannadi A, Heidari AH. Anti-inflammatory and wound healing activities of *Aloe littoralis* in rats. Res Pharm Sci 2012;7:73-8.
129. Kumari S, Harjai K, Chhibber S. Topical treatment of *Klebsiella pneumoniae* B5055 induced burn wound infection in mice using natural products. J Infect Dev Ctries 2010;4:367-77.
130. Eshghi F, Hosseinimehr SJ, Rahmani N, Khademloo M, Norozi MS, Hojati O, *et al.* Effects of *Aloe vera* cream on posthemorrhoidectomy pain and wound healing: Results of a randomized, blind, placebo-control study. J Altern Complement Med 2010;16:647-50.
131. Ndhlala AR, Amoo SO, Stafford GI, Finnie JF, Van Staden J. Antimicrobial, anti-inflammatory and mutagenic investigation of the South African tree aloe (*Aloe barberae*). J Ethnopharmacol 2009;124:404-8.
132. Roberts DB, Travis EL. Acemannan-containing wound dressing gel reduces radiation-induced skin reactions in C3H mice. Int J Radiat Oncol Biol Phys 1995;32:1047-52.
133. Sato Y, Ohta S, Shinoda M. Studies on chemical protectors against radiation. XXXI. Protection effects of *Aloe arborescens* on skin injury induced by X-irradiation. Yakugaku Zasshi 1990;110:876-84.
134. Byeon SW, Pelley RP, Ullrich SE, Waller TA, Bucana CD, Strickland FM, *et al. Aloe barbadensis* extracts reduce the production of interleukin-10 after exposure to ultraviolet radiation. J Invest Dermatol 1998;110:811-7.
135. Dhanabal SP, Priyanka Dwarampudi L, Muruganantham N, Vadivelan R. Evaluation of the antipsoriatic activity of *Aloe vera* leaf extract using a mouse tail model of psoriasis. Phytother Res 2012;26:617-9.
136. Fowler JF Jr., Woolery-Lloyd H, Waldorf H, Saini R. Innovations in natural ingredients and their use in skin care. J Drugs Dermatol 2010;9:S72-81.
137. Mantle D, Gok MA, Lennard TW. Adverse and beneficial effects of plant extracts on skin and skin disorders. Adverse Drug React Toxicol Rev 2001;20:89-103.
138. Morelli V, Calmet E, Jhingade V. Alternative therapies for common dermatologic disorders, Part 2. Prim Care 2010;37:285-96.
139. Choonhakarn C, Busaracome P, Sripanidkulchai B, Sarakarn P. A prospective, randomized clinical trial comparing topical *Aloe vera* with 0.1% triamcinolone acetonide in mild to moderate plaque psoriasis. J Eur Acad Dermatol Venereol 2010;24:168-72.
140. Syed TA, Ahmad SA, Holt AH, Ahmad SA, Ahmad SH, Afzal M, *et al.* Management of psoriasis with *Aloe vera* extract in a hydrophilic cream: A placebo-controlled, double-blind study. Trop Med Int Health 1996;1:505-9.
141. Paulsen E, Korsholm L, Brandrup F. A double-blind, placebo-controlled study of a commercial *Aloe vera* gel in the treatment of slight to moderate psoriasis vulgaris. J Eur Acad Dermatol Venereol 2005;19:326-31.
142. Seyger MM, van de Kerkhof PC, van Vlijmen-Willems IM, de Bakker ES, Zwiers F, de Jong EM, *et al.* The efficacy of a new topical treatment for psoriasis: Mirak. J Eur Acad Dermatol Venereol 1998;11:13-8.
143. Portugal-Cohen M, Soroka Y, Ma'or Z, Oron M, Zioni T, Brégégère FM, *et al.* Protective effects of a cream containing dead sea minerals against UVB-induced stress in human skin. Exp Dermatol 2009;18:781-8.
144. Anton R, Haag-Berrurier M. Therapeutic use of natural anthraquinone for other than laxative actions. Pharmacology 1980;20 Suppl 1:104-12.
145. Ren QQ, Yuan XJ, Huang XR, Wen W, Zhao YD, Chen W, *et al. In vivo* monitoring of oxidative burst on aloe under salinity stress using hemoglobin and single-walled carbon nanotubes modified carbon fiber ultramicroelectrode. Biosens Bioelectron 2013;50:318-24.
146. Dana N, Javanmard SH, Asgary S, Asnaashari H, Abdian N. The effect of *Aloe vera* leaf gel on fatty streak formation in hypercholesterolemic rabbits. J Res Med Sci 2012;17:439-42.
147. Gupta VK, Malhotra S. Pharmacological attribute of *Aloe vera*: Revalidation through experimental and clinical studies. Ayu 2012;33:193-6.
148. Foster M, Hunter D, Samman S. Evaluation of the nutritional and metabolic effects of *Aloe vera*. In: Benzie IF, Wachtel-Galor S, editors. Herbal Medicine: Biomolecular and Clinical Aspects. 2nd ed. Boca Raton (FL): CRC Press; 2011.
149. Semenya S, Potgieter M, Erasmus L. Ethnobotanical survey of medicinal plants used by bapedi healers to treat diabetes mellitus in the limpopo province, South Africa. J Ethnopharmacol 2012;141:440-5.
150. Rashidi AA, Mirhashemi SM, Taghizadeh M, Sarkhail P. Iranian medicinal plants for diabetes mellitus: A systematic review. Pak J Biol Sci 2013;16:401-11.
151. Mootoosamy A, Fawzi Mahomoodally M. Ethnomedicinal application of native remedies used against diabetes and related complications in Mauritius. J Ethnopharmacol 2014;151:413-44.
152. Amirehsani KA, Wallace DC. Tes, licuados, and capsulas: Herbal self-care remedies of latino/Hispanic immigrants for Type 2 diabetes. Diabetes Educ 2013;39:828-40.
153. Inpanya P, Faikrua A, Ounaroon A, Sittichokechaiwut A, Viyoch J. Effects of the blended fibroin/aloe gel film on wound healing in streptozotocin-induced diabetic rats. Biomed Mater 2012;7:035008.
154. Choi HC, Kim SJ, Son KY, Oh BJ, Cho BL. Metabolic

effects of *Aloe vera* gel complex in obese prediabetes and early non-treated diabetic patients: Randomized controlled trial. Nutrition 2013;29:1110-4.
155. Hotkar MS, Avachat AM, Bhosale SS, Oswal YM. Preliminary investigation of topical nitroglycerin formulations containing natural wound healing agent in diabetes-induced foot ulcer. Int Wound J 2015;12:210-7.
156. Yimam M, Zhao J, Corneliusen B, Pantier M, Brownell LA, Jia Q, *et al.* UP780, a chromone-enriched aloe composition improves insulin sensitivity. Metab Syndr Relat Disord 2013;11:267-75.
157. Srivastava N, Tiwari G, Tiwari R, Bhati LK, Rai AK. Neutraceutical approaches to control diabetes: A natural requisite approach. J Nat Sci Biol Med 2012;3:168-76.
158. Moniruzzaman M, Rokeya B, Ahmed S, Bhowmik A, Khalil MI, Gan SH, *et al. In vitro* antioxidant effects of *Aloe barbadensis* miller extracts and the potential role of these extracts as antidiabetic and antilipidemic agents on streptozotocin-induced Type 2 diabetic model rats. Molecules 2012;17:12851-67.
159. Shin S, Kim S, Oh HE, Kong H, Shin E, Do SG, *et al.* Dietary aloe QDM complex reduces obesity-induced insulin resistance and adipogenesis in obese mice fed a high-fat diet. Immune Netw 2012;12:96-103.
160. Radwan-Oczko M. Topical application of drugs used in treatment of oral lichen planus lesions. Adv Clin Exp Med 2013;22:893-8.
161. Ng SC, Lam YT, Tsoi KK, Chan FK, Sung JJ, Wu JC, *et al.* Systematic review: The efficacy of herbal therapy in inflammatory bowel disease. Aliment Pharmacol Ther 2013;38:854-63.
162. Coondoo A, Chattopadhyay C. Drug interactions in dermatology: What the dermatologist should know. Indian J Dermatol 2013;58:249-54.
163. Ferrara L, Naviglio D, Armone Caruso A. Cytological aspects on the effects of a nasal spray consisting of standardized extract of citrus lemon and essential oils in allergic rhinopathy. ISRN Pharm 2012;2012:404606.
164. Ke F, Yadav PK, Ju LZ. Herbal medicine in the treatment of ulcerative colitis. Saudi J Gastroenterol 2012;18:3-10.
165. Bruce S, Watson J. Evaluation of a prescription strength 4% hydroquinone/10% L-ascorbic acid treatment system for normal to oily skin. J Drugs Dermatol 2011;10:1455-61.
166. Djuv A, Nilsen OG. *Aloe vera* juice: IC_{50} and dual mechanistic inhibition of CYP3A4 and CYP2D6. Phytother Res 2012;26:445-51.
167. Skopiński P, Lewicki S, Bałan BJ, Kocik J, Zdanowski R, Skopińska-Rózewska E, *et al. In vivo* inhibitory effect of *Aloe vera* gel on the ability of mouse parental splenic lymphocytes to induce cutaneous angiogenesis in recipient F1 mice. Pol J Vet Sci 2014;17:131-6.
168. Karim B, Bhaskar DJ, Agali C, Gupta D, Gupta RK, Jain A, *et al.* Effect of *Aloe vera* mouthwash on periodontal health: Triple blind randomized control trial. Oral Health Dent Manag 2014;13:14-9.
169. Kriplani R, Thosar N, Baliga MS, Kulkarni P, Shah N, Yeluri R, *et al.* Comparative evaluation of antimicrobial efficacy of various root canal filling materials along with *Aloe vera* used in primary teeth: A microbiological study. J Clin Pediatr Dent 2013;37:257-62.
170. Cagetti MG, Federici A, Iannetti G, Gherlone E, Mazza C, Majorana A, *et al*. National guidelines for the prevention and clinical management of dental trauma in individuals during their developmental age. Ann Ig 2013;25:459-84.
171. Alam S, Ali I, Giri KY, Gokkulakrishnan S, Natu SS, Faisal M, *et al.* Efficacy of *Aloe vera* gel as an adjuvant treatment of oral submucous fibrosis. Oral Surg Oral Med Oral Pathol Oral Radiol 2013;116:717-24.
172. Mansour G, Ouda S, Shaker A, Abdallah HM. Clinical efficacy of new *Aloe vera*-and myrrh-based oral mucoadhesive gels in the management of minor recurrent aphthous stomatitis: A randomized, double-blind, vehicle-controlled study. J Oral Pathol Med 2014;43:405-9.
173. Liao J, Zhao L, Yoshioka M, Hinode D, Grenier D. Effects of Japanese traditional herbal medicines (Kampo) on growth and virulence properties of porphyromonas gingivalis and viability of oral epithelial cells. Pharm Biol 2013;51:1538-44.
174. Valera MC, Maekawa LE, de Oliveira LD, Jorge AO, Shygei É, Carvalho CA, *et al. In vitro* antimicrobial activity of auxiliary chemical substances and natural extracts on *Candida albicans* and *Enterococcus faecalis* in root canals. J Appl Oral Sci 2013;21:118-23.
175. Banu A, Sathyanarayana B, Chattannavar G. Efficacy of fresh *Aloe vera* gel against multi-drug resistant bacteria in infected leg ulcers. Australas Med J 2012;5:305-9.
176. Habeeb F, Shakir E, Bradbury F, Cameron P, Taravati MR, Drummond AJ, *et al.* Screening methods used to determine the anti-microbial properties of *Aloe vera* inner gel. Methods 2007;42:315-20.
177. Moody JO, Adebiyi OA, Adeniyi BA. Do *Aloe vera* and ageratum conyzoides enhance the anti-microbial activity of traditional medicinal soft soaps (Osedudu)? J Ethnopharmacol 2004;92:57-60.
178. 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.
179. Muller MJ, Hollyoak MA, Moaveni Z, Brown TL, Herndon DN, Heggers JP, *et al.* Retardation of wound healing by silver sulfadiazine is reversed by *Aloe vera* and nystatin. Burns 2003;29:834-6.
180. Gupta B, Agarwal R, Sarwar Alam M. Antimicrobial and release study of drug loaded PVA/PEO/CMC wound dressings. J Mater Sci Mater Med 2014;25:1613-22.
181. Kumar S, Yadav M, Yadav A, Rohilla P, Yadav JP. Antiplasmodial potential and quantification of aloin and aloe-emodin in *Aloe vera* collected from different climatic regions of India. BMC Complement Altern Med 2017;17:369.

182. Teka T, Bisrat D, Yeshak MY, Asres K. Antimalarial activity of the chemical constituents of the leaf latex of *Aloe pulcherrima* gilbert and sebsebe. Molecules 2016;21:pii: E1415.
183. Abdissa D, Geleta G, Bacha K, Abdissa N. Phytochemical investigation of *Aloe pulcherrima* roots and evaluation for its antibacterial and antiplasmodial activities. PLoS One 2017;12:e0173882.
184. Mukungu N, Abuga K, Okalebo F, Ingwela R, Mwangi J. Medicinal plants used for management of malaria among the luhya community of kakamega east sub-county, Kenya. J Ethnopharmacol 2016;194:98-107.
185. Kim JH, Yoon JY, Yang SY, Choi SK, Kwon SJ, Cho IS, *et al.* Tyrosinase inhibitory components from *Aloe vera* and their antiviral activity. J Enzyme Inhib Med Chem 2017;32:78-83.
186. Abdul Qadir M, Shahzadi SK, Bashir A, Munir A, Shahzad S. Evaluation of phenolic compounds and antioxidant and antimicrobial activities of some common herbs. Int J Anal Chem 2017;2017:3475738.
187. Bisi-Johnson MA, Obi CL, Samuel BB, Eloff JN, Okoh AI. Antibacterial activity of crude extracts of some South African medicinal plants against multidrug resistant etiological agents of diarrhoea. BMC Complement Altern Med 2017;17:321.
188. Abeje F, Bisrat D, Hailu A, Asres K. Phytochemistry and antileishmanial activity of the leaf latex of *Aloe calidophila* reynolds. Phytother Res 2014;28:1801-5.
189. Tewabe Y, Bisrat D, Terefe G, Asres K. Antitrypanosomal activity of aloin and its derivatives against trypanosoma congolense field isolate. BMC Vet Res 2014;10:61.
190. Chen R, Wang S, Zhang J, Chen M, Wang Y. Aloe-emodin loaded solid lipid nanoparticles: Formulation design and *in vitro* anti-cancer study. Drug Deliv 2015;22:666-74.
191. He ZH, Huang YQ, Weng SF, Tan YR, He TP, Qin YM, *et al.* Effect of aloe emodin on invasion and metastasis of high metastatic breast cancer MDA-MB-231 cells. Zhong Yao Cai 2013;36:1481-5.
192. Mulakayala C, Banaganapalli B, Mulakayala N, Pulaganti M, C M A, Chitta SK, *et al.* Design and evaluation of new chemotherapeutics of aloe-emodin (AE) against the deadly cancer disease: An *in silico* study. J Chem Biol 2013;6:141-53.
193. Akomolafe SF, Olanlokun JO, Adesina AJ, Olorunsogo OO. Protective effect of *Aloe vera* gel on the permeability transition pore in the inner membrane of rat liver mitochondria *in vitro*. Drug Chem Toxicol 2014;37:415-9.
194. Ochwang'i DO, Kimwele CN, Oduma JA, Gathumbi PK, Mbaria JM, Kiama SG, *et al.* Medicinal plants used in treatment and management of cancer in Kakamega county, Kenya. J Ethnopharmacol 2014;151:1040-55.
195. Capasso R, Laudato M, Borrelli F. Meeting report: First national meeting on aloe, april 20-21, 2013, Isernia, Italy. New perspectives in aloe research: From basic science to clinical application. Nat Prod Commun 2013;8:1333-4.
196. Chihara T, Shimpo K, Beppu H, Tomatsu A, Kaneko T, Tanaka M, *et al.* Reduction of intestinal polyp formation in min mice fed a high-fat diet with *Aloe vera* gel extract. Asian Pac J Cancer Prev 2013;14:4435-40.
197. Haddad P, Amouzgar-Hashemi F, Samsami S, Chinichian S, Oghabian MA. *Aloe vera* for prevention of radiation-induced dermatitis: A self-controlled clinical trial. Curr Oncol 2013;20:e345-8.
198. Ismail S, Haris K, Abdul Ghani AR, Abdullah JM, Johan MF, Mohamed Yusoff AA, *et al.* Enhanced induction of cell cycle arrest and apoptosis via the mitochondrial membrane potential disruption in human U87 malignant glioma cells by aloe emodin. J Asian Nat Prod Res 2013;15:1003-12.
199. Huang PH, Huang CY, Chen MC, Lee YT, Yue CH, Wang HY, *et al.* Emodin and aloe-emodin suppress breast cancer cell proliferation through ER α inhibition. Evid Based Complement Alternat Med 2013;2013:376123.
200. Botes L, van der Westhuizen FH, Loots du T. Phytochemical contents and antioxidant capacities of two *Aloe greatheadii* var. Davyana extracts. Molecules 2008;13:2169-80.
201. Ahmadi A. Potential prevention: *Aloe vera* mouthwash may reduce radiation-induced oral mucositis in head and neck cancer patients. Chin J Integr Med 2012;18:635-40.
202. Liu LY, Chen XD, Wu BY, Jiang Q. Influence of aloe polysaccharide on proliferation and hyaluronic acid and hydroxyproline secretion of human fibroblasts *in vitro*. Zhong Xi Yi Jie He Xue Bao 2010;8:256-62.
203. Chen R, Zhang J, Hu Y, Wang S, Chen M, Wang Y, *et al.* Potential antineoplastic effects of aloe-emodin: A comprehensive review. Am J Chin Med 2014;42:275-88.
204. Pan Q, Pan H, Lou H, Xu Y, Tian L. Inhibition of the angiogenesis and growth of aloin in human colorectal cancer *in vitro* and *in vivo*. Cancer Cell Int 2013;13:69.
205. Boudreau MD. "Nondecolorized" qualifier is a misnomer for the *Aloe vera* whole leaf extract test material. Toxicol Sci 2013;133:343.
206. Cox MC, Aloe-Spiriti MA, Cavalieri E, Alma E, Gigante E, Begini P, *et al.* HCV infection, B-cell non-hodgkin's lymphoma and immunochemotherapy: Evidence and open questions. World J Gastrointest Oncol 2012;4:46-53.
207. Sehgal I, Winters WD, Scott M, Kousoulas K. An *in vitro* and *in vivo* toxicologic evaluation of a stabilized *Aloe vera* gel supplement drink in mice. Food Chem Toxicol 2013;55:363-70.
208. Mapunya MB, Nikolova RV, Lall N. Melanogenesis and antityrosinase activity of selected South African plants. Evid Based Complement Alternat Med 2012;2012:374017.
209. Sydiskis RJ, Owen DG, Lohr JL, Rosler KH, Blomster RN. Inactivation of enveloped viruses by anthraquinones extracted from plants. Antimicrob Agents Chemother 1991;35:2463-6.
210. Kim HS, Lee BM. Inhibition of benzo[a]pyrene-DNA adduct formation by *Aloe barbadensis* miller.

Carcinogenesis 1997;18:771-6.
211. Kim HS, Kacew S, Lee BM. *In vitro* chemopreventive effects of plant polysaccharides (*Aloe barbadensis* miller, *Lentinus edodes*, *Ganoderma lucidum* and *Coriolus versicolor*). Carcinogenesis 1999;20:1637-40.
212. Ahlawat KS, Khatkar BS. Processing, food applications and safety of *Aloe vera* products: A review. J Food Sci Technol 2011;48:525-33.
213. Dunnick JK, Nyska A. The toxicity and pathology of selected dietary herbal medicines. Toxicol Pathol 2013;41:374-86.
214. Nema NK, Maity N, Sarkar BK, Mukherjee PK. Determination of trace and heavy metals in some commonly used medicinal herbs in Ayurveda. Toxicol Ind Health 2014;30:964-8.
215. Mwale M, Masika PJ. *In vivo* anthelmintic efficacy of *Aloe ferox*, *Agave sisalana*, and *Gunnera perpensa* in village chickens naturally infected with *Heterakis gallinarum*. Trop Anim Health Prod 2015;47:131-8.
216. Basyoni MM, El-Sabaa AA. Therapeutic potential of myrrh and ivermectin against experimental *Trichinella spiralis* infection in mice. Korean J Parasitol 2013;51:297-304.
217. Ahmed M, Laing MD, Nsahlai IV. *In vitro* anthelmintic activity of crude extracts of selected medicinal plants against *Haemonchus contortus* from sheep. J Helminthol 2013;87:174-9.
218. Maphosa V, Masika PJ, Bizimenyera ES, Eloff JN. *In-vitro* anthelminthic activity of crude aqueous extracts of *Aloe ferox*, *Leonotis leonurus* and *Elephantorrhiza elephantina* against *Haemonchus contortus*. Trop Anim Health Prod 2010;42:301-7.
219. Ajmera N, Chatterjee A, Goyal V. *Aloe vera*: It's effect on gingivitis. J Indian Soc Periodontol 2013;17:435-8.
220. Wintola OA, Afolayan AJ. Phytochemical constituents and antioxidant activities of the whole leaf extract of *Aloe ferox* mill. Pharmacogn Mag 2011;7:325-33.
221. Odes HS, Madar Z. A double-blind trial of a celandin, *Aloe vera* and psyllium laxative preparation in adult patients with constipation. Digestion 1991;49:65-71.
222. Pahor M, Mugelli A, Guralnik JM, Manto A, Carosella L, Sgadari A, *et al.* Age and laxative use in hospitalized patients. A report of the "Gruppo italiano di farmacovigilanza nell'anziano-GIFA". Aging (Milano) 1995;7:128-35.
223. Lee EJ, Warden S. A qualitative study of quality of life and the experience of complementary and alternative medicine in Korean women with constipation. Gastroenterol Nurs 2011;34:118-27.
224. Cellini L, Di Bartolomeo S, Di Campli E, Genovese S, Locatelli M, Di Giulio M, *et al. In vitro* activity of *Aloe vera* inner gel against helicobacter pylori strains. Lett Appl Microbiol 2014;59:43-8.
225. Wintola OA, Sunmonu TO, Afolayan AJ. The effect of *Aloe ferox* mill. In the treatment of loperamide-induced constipation in wistar rats. BMC Gastroenterol 2010;10:95.
226. Ishii Y, Tanizawa H, Takino Y. Studies of *Aloe. V*. Mechanism of cathartic effect. (4). Biol Pharm Bull 1994;17:651-3.
227. Robinson M. Medical therapy of inflammatory bowel disease for the 21st century. Eur J Surg Suppl 1998;582:90-8.
228. Fernández A, Barreiro-de Acosta M, Vallejo N, Iglesias M, Carmona A, González-Portela C, *et al.* Complementary and alternative medicine in inflammatory bowel disease patients: Frequency and risk factors. Dig Liver Dis 2012;44:904-8.
229. Langmead L, Rampton DS. Review article: Complementary and alternative therapies for inflammatory bowel disease. Aliment Pharmacol Ther 2006;23:341-9.
230. Langmead L, Feakins RM, Goldthorpe S, Holt H, Tsironi E, De Silva A, *et al.* Randomized, double-blind, placebo-controlled trial of oral *Aloe vera* gel for active ulcerative colitis. Aliment Pharmacol Ther 2004;19:739-47.
231. Park MY, Kwon HJ, Sung MK. Dietary aloin, aloesin, or aloe-gel exerts anti-inflammatory activity in a rat colitis model. Life Sci 2011;88:486-92.
232. Korkina L, Suprun M, Petrova A, Mikhal'chik E, Luci A, De Luca C, *et al.* The protective and healing effects of a natural antioxidant formulation based on ubiquinol and *Aloe vera* against dextran sulfate-induced ulcerative colitis in rats. Biofactors 2003;18:255-64.
233. Bjorå CS, Wabuyele E, Grace OM, Nordal I, Newton LE. The uses of Kenyan aloes: An analysis of implications for names, distribution and conservation. J Ethnobiol Ethnomed 2015;11:82.
234. Belayneh A, Bussa NF. Ethnomedicinal plants used to treat human ailments in the prehistoric place of Harla and Dengego valleys, Eastern Ethiopia. J Ethnobiol Ethnomed 2014;10:18.
235. Bieski IG, Leonti M, Arnason JT, Ferrier J, Rapinski M, Violante IM, *et al.* Ethnobotanical study of medicinal plants by population of valley of Juruena region, legal amazon, Mato Grosso, Brazil. J Ethnopharmacol 2015;173:383-423.
236. Grace OM, Simmonds MS, Smith GF, van Wyk AE. Therapeutic uses of *Aloe* L. (*Asphodelaceae*) in Southern Africa. J Ethnopharmacol 2008;119:604-14.
237. George D, Bhat SS, Antony B. Comparative evaluation of the antimicrobial efficacy of *Aloe vera* tooth gel and two popular commercial toothpastes: An *in vitro* study. Gen Dent 2009;57:238-41.
238. Jithendra P, Rajam AM, Kalaivani T, Mandal AB, Rose C. Preparation and characterization of *Aloe vera* blended collagen-chitosan composite scaffold for tissue engineering applications. ACS Appl Mater Interfaces 2013;5:7291-8.
239. Bhardwaj A, Velmurugan N, Sumitha, Ballal S. Efficacy of passive ultrasonic irrigation with natural irrigants (*Morinda citrifolia* juice, *Aloe vera* and propolis) in comparison with 1% sodium hypochlorite for removal

of E. Faecalis biofilm: An *in vitro* study. Indian J Dent Res 2013;24:35-41.
240. Ahmed M, Laing MD, Nsahlai IV. *In vivo* effect of selected medicinal plants against gastrointestinal nematodes of sheep. Trop Anim Health Prod 2014;46:411-7.
241. West DP, Zhu YF. Evaluation of *Aloe vera* gel gloves in the treatment of dry skin associated with occupational exposure. Am J Infect Control 2003;31:40-2.
242. Vardy AD, Cohen AD, Tchetov T. A double-blind, placebo-controlled trial of *Aloe vera* (*A. barbadensis*) emulsion in the treatment of seborrheic dermatitis. J Dermatol Treat 1999;10:7-11.
243. Syed TA, Afzal M, Ashfaq AS. Management of genital herpes in men with 0.5% *Aloe vera* extract in a hydrophilic cream: A placebo-controlled double-blind study. J Dermatol Treat 1997;8:99-102.
244. Syed TA, Cheema KM, Ahmad SA, Ashfaq A. *Aloe vera* extract 0.5% in hydrophilic cream versus *Aloe vera* gel for the measurement of genital herpes in males: A placebo-controlled, double-blind, comparative study. J Eur Acad Dermatol Venereol 1996;7:294-5.
245. Visuthikosol V, Chowchuen B, Sukwanarat Y, Sriurairatana S, Boonpucknavig V. Effect of *Aloe vera* gel to healing of burn wound a clinical and historic study. J Med Assoc Thai 1995;78:403-9.
246. Yeh GY, Eisenberg DM, Kaptchuk TJ, Phillips RS. Systematic review of herbs and dietary supplements for glycemic control in diabetes. Diabetes Care 2003;26:1277-94.
247. Montaner JS, Gill J, Singer J. Double-blind placebo-controlled pilot trial of acemannan in advanced human immunodeficiency virus disease. J Acquir Immune Defic Syn Hum Retrovirol 1996;12:153-7.
248. Furukawa F, Nishikawa A, Chihara T, Shimpo K, Beppu H, Kuzuya H, *et al.* Chemopreventive effects of *Aloe arborescens* on N-nitrosobis(2-oxopropyl)amine-induced pancreatic carcinogenesis in hamsters. Cancer Lett 2002;178:117-22.
249. Fenig E, Nordenberg J, Beery E, Sulkes J, Wasserman L. Combined effect of aloe-emodin and chemotherapeutic agents on the proliferation of an adherent variant cell line of merkel cell carcinoma. Oncol Rep 2004;11:213-7.
250. Fulton JE Jr., The stimulation of postdermabrasion wound healing with stabilized *Aloe vera* gel-polyethylene oxide dressing. J Dermatol Surg Oncol 1990;16:460-7.
251. Thomas DR, Goode PS, LaMaster K, Tennyson T. Acemannan hydrogel dressing for pressure ulcers: A randomized, controlled trial. Adv Wound Care 1998;11:273-6.
252. Hunter D, Frumkin A. Adverse reactions to vitamin E and *Aloe vera* preparations after dermabrasion and chemical peel. Cutis 1991;47:193-6.
253. Schmidt JM, Greenspoon JS. *Aloe vera* dermal wound gel is associated with a delay in wound healing. Obstet Gynecol 1991;78:115-7.
254. Su CK, Mehta V, Ravikumar L, Shah R, Pinto H, Halpern J, *et al.* Phase II double-blind randomized study comparing oral *Aloe vera* versus placebo to prevent radiation-related mucositis in patients with head-and-neck neoplasms. Int J Radiat Oncol Biol Phys 2004;60:171-7.
255. Bosley C, Smith J, Baratti P. A phase III trial comparing an anionic phospholipid-based (APP) cream and *Aloe vera*-based gel in the prevention and treatment of radiation dermatitis. Int J Radiat Oncol Biol Phys 2003;57:S4-38.
256. Hajheydari Z, Saeedi M, Morteza-Semnani K, Soltani A. Effect of *Aloe vera* topical gel combined with tretinoin in treatment of mild and moderate acne vulgaris: A randomized, double-blind, prospective trial. J Dermatol Treat 2014;25:123-9.
257. Hayes SM. Lichen planus: A report of successful treatment with aloe. Gen Dent 1999;47:268-72.
258. McCauley RL, Heggers JP, Robson MC. Frostbite. Methods to minimize tissue loss. Postgrad Med 1990;88:67-8, 73-7.
259. Garnick JJ, Singh B, Winkley G. Effectiveness of a medicament containing silicon dioxide, aloe, and allantoin on aphthous stomatitis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;86:550-6.
260. Erton P. *Aloe vera* revisited. Br J Phytother 1998;4:76-83.
261. Shelton M. *Aloe vera*, its chemical and therapeutic properties. Int J Dermatol 1991;30:679-83.
262. Atherton P. The Essential *Aloe vera*: The Actions and the Evidence. 2nd ed. Amazon.co.uk; 1997.
263. Ro JY, Lee BC, Kim JY, Chung YJ, Chung MH, Lee SK, *et al.* Inhibitory mechanism of aloe single component (alprogen) on mediator release in guinea pig lung mast cells activated with specific antigen-antibody reactions. J Pharmacol Exp Ther 2000;292:114-21.
264. Hutter JA, Salmon M, Stavinoha WB, Satsangi N, Williams RF, Streeper RT, *et al.* Anti-inflammatory C-glucosyl chromone from *Aloe barbadensis*. J Nat Prod 1996;59:541-3.

Source of Support: Nil. **Conflict of Interest:** None declared.