Aloe vera: Potential candidate in health management via modulation of biological activities

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ABSTRACT

Treatment based on natural products is rapidly increasing worldwide due to the affordability and fewer side effects of such treatment. Various plants and the products derived from them are commonly used in primary health treatment, and they play a pivotal role in the treatment of diseases via modulation of biochemical and molecular pathways. *Aloe vera*, a succulent species, produces gel and latex, plays a therapeutic role in health management through antioxidant, antitumor, and anti-inflammatory activities, and also offers a suitable alternative approach for the treatment of various types of diseases. In this review, we summarize the possible mechanism of action and the therapeutic implications of *Aloe vera* in health maintenance based on its modulation of various biological activities.

Key words: *Aloe vera*, antimicrobial activities, antioxidant activities, antitumor activities, Anti-inflammatotry effects biological activities

INTRODUCTION

Traditional medicine plays a critical role in the treatment of various types of diseases. Nowadays, the use of complementary medicine and natural products has been increasing rapidly worldwide because they are effective and inexpensive and have fewer side effects. Different types of medicinal plants and their constituents have been used to treat disease from ancient times. The significance of plants and their constituents in the curing of diseases has been discussed in Ayurveda, Unani, and Chinese medicine, and also in various religious books. In Islam, herbs are of significant value in health management, and Prophet Mohammad (PBUH) recommended various medicinal plants for curing diseases, such as *Nigella sativa* seeds and date fruits.[1] Earlier investigators reported that medicinal plants and their constituents, such as *Nigella sativa*, dates fruits and Curcumin, played a major part in the prevention of diseases, via modulation of several activities.[2-4] Only a few plants and their constituents have been properly investigated using animal models for their toxicity/lethal dose and mechanism of action in disease prevention. In this scenario, *Aloe vera*, the succulent species, plays a role in curing disease via modulation of various activities. The relevant chemical constituents are vitamins, minerals, enzymes, sugars, anthraquinones, lignins, alicylic acid, and saponins,[5-6] and most of the constituents appear to be of biological importance in curing diseases. In this study, we summarize the possible mechanism of action and the therapeutic implications of *Aloe vera* in health maintenance through the modulation of various biological activities.

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Active ingredients of *Aloe vera* and their functions

Aloe vera contains several biologically active constituents, including vitamins, minerals, saccharides, amino acids, anthraquinones, enzymes, lignins, saponins, and salicylic acids.[6-8] In addition, *Aloe vera* contains products of the isoprenoid pathway, such as carotenoids, steroids, terpenes, and phytosterols,[9] and some essential amino acids/nonessential amino acids and enzymes, such as bradykinase, carboxypeptidase, cyclooxygenase, and carboxypeptidase.

Mechanism of action in disease prevention

Aloe vera is a useful plant in alternative medicine and has a long history of use in traditional medicine for curing diseases due its ability to modulate various biological activities. Several active constituents have been identified in *Aloe vera*, and most of

them have therapeutic implications for disease prevention and treatment through the modulation of various biological and genetic activities. The possible mechanisms of actions of *Aloe vera* are described as follows:

1. *Aloe vera* and its constituents such as aloe emodin (AE), aloin (barbaloin), anthracene, and emodin are relevant to cancer prevention owing to the activation and inactivation of molecular pathways associated with them.
2. *Aloe vera* also appears to function as an antioxidant through free radical- and superoxide radical-scavenging activities and anti-inflammatory activities via inhibition of prostaglandin E2 production from arachidonic acid and also inhibition of various transcription factors and the activities of enzymes including lypoxygenase and cyclooxygenase.
3. *Aloe vera* shows antimicrobial activity by rupturing bacterial cell walls. Earlier studies have reported the anti-inflammatory and antibacterial properties of *Aloe vera* gel.[10-11]

Pharmalogical effects of *Aloe vera* and its constituents in curing diseases via modulation of biological activities

Antitumor effect

Tumor development and progressions constitute a multistep process including genetic and epigenetic changes.[12-13] *Aloe vera* and its constituents have a vital effect on the control of tumor development, through the modulation of genetic pathways. An important study was performed to investigate the antitumor activity of *Aloe vera* against stage-2 skin carcinogenesis induced by 7,12-Dimethylbenz[*a*] anthracene (DMBA) and *Croton tiglium* (croton) oil; the results revealed that, compared to 100% incidence of tumor development in group I (DMBA + croton oil only), the incidence of tumors decreased to 50%, 60%, and 40% in groups II (DMBA + croton oil + topical *Aloe vera* gel), III (DMBA + croton oil + oral *Aloe vera* extract), and IV (DMBA + croton oil + topical *Aloe vera* gel + oral *Aloe vera* extract) respectively.[14] Another study showed that *Aloe vera* decreased the levels of lipid peroxidation and increased the levels of reduced antioxidant enzymes, and the same study showed that 50% ethanol extract has an antitumor effect through the modulation of lipid peroxidation and augmentation of the antioxidant defense system.[15] Yet another experiment was performed to evaluate the anticancer properties and modulatory effects of *Aloe vera*, and it was found that *Aloe vera* active principles exerted significant inhibition of Ehrlich ascites carcinoma cell (EACC) number, when compared to the positive control group, in the order barbaloin > aloe emodin (AE) > octapeptide > aloesin.[16]

An important study was performed on human uterine carcinoma HeLa S3 cells to test the antiproliferative and cytotoxic potential of the anthracycline aloin, and the results confirmed that aloin showed a prominent antiproliferative effect on physiological concentration, caused cell cycle arrest in the S-phase, and noticeably increased HeLa S3 cell apoptosis.[17] In another study of a hepatocellular carcinoma cell line, it was observed that AE induced apoptosis and was accompanied by the induction of p53 and p21 expression.[18] Other investigators confirmed the efficacy of extracts derived from *Aloe arborescens* in the palliative therapy of patients with untreatable metastatic cancer, either to improve their quality of life or to prolong their survival time.[19] Moreover, another study revealed that emodin and AE are capable of inhibiting breast cancer cell proliferation by downregulating estrogen receptor (ER)α protein levels and suppressing ERα transcriptional activation.[20] AE plays a role in the inhibition of cell growth in several types of tumor cells, such as lung carcinoma,[21] hepatoma,[18] and leukemia cell lines,[22] and shows a high specificity for neuroectodermal tumor cells.[23] A study demonstrated that the activation of caspase-3, caspase-8, and caspase-9 is induced by AE, and suggested that AE induces CH27 cell death by the Bax and Fas death pathway.[21] Another important study concluded that AE-induced apoptosis in T24 cells is mediated by the activation of p53, p21, Fas/APO-1, Bax, and caspase-3.[24] One study has shown that AE plays a role in the induction of apoptosis via activation of caspase-6 in human colon cancer cells.[25] The findings of other study suggest that the decrease in the expression of protein kinase C-δ and protein kinase C-ε isoforms plays a critical role in AE-induced apoptosis,[26] while those from yet another study show that AE exhibits anticancer activity in two human colon carcinoma cell lines, DLD-1 and WiDr, and that the cytotoxic mechanism involves the induction of apoptosis.[27]

Antimicrobial activity

The incidence of drug resistance is increasing day by day worldwide and it causes major health problems in terms of treatment failure. Numerous studies have shown that *Aloe vera* and its constituents act as antimicrobial agents [Table 1]. An important study was performed to investigate *Aloe vera* phytochemical compounds and the antimicrobial activities of its different extracts, and it was found that the maximum antibacterial activities and antifungal activities were observed in acetone extracts compared to aqueous and ethanol extracts.[28] In another study on *Aloe vera*, the serial dilution method revealed that a high concentration (1/10) inhibited the growth of *Staphylococcus aureus* at, while moderate concentrations were required to inhibit the growth of *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhi*.[29] Another study was conducted to determine the antimicrobial activity of *Aloe vera* juice against Gram-positive bacteria and Gram-negative bacteria, and the results showed that the antibacterial activity of the tested plant juice was effective mainly against the Gram-positive bacteria.[30] An experiment was performed to analyze antimicrobial activities against *S. aureus*, *S. pyogenes*, *P. aeruginosa*, and *E. coli*, and it was observed that the maximum antibacterial activities were noticed in the acetone extract other than the aqueous extract or the ethanol extract.[31] An analysis was carried out using pathogens isolated from patients with dental caries and periodontal diseases; the inhibitory activities of *Aloe vera* gel on some cariogenic and periodontopathic pathogens, and an opportunistic periodontal pathogen were investigated, and the results showed that *S. mutans* was the most sensitive

Table 1: Biological activities of *Aloe vera* and its constituents in disease management

Authors/years	Findings/outcomes	Biological activity
Saini *et al*. 2010[14]	*Aloe vera* protected mice against DMBA/croton oil-induced skin papillomagenesis	Antitumor activity
Naveena *et al.* 2011[15]	Ethanol extract (50%) showed antitumor effect by modulation of lipid peroxidation and antioxidant defense system	Antitumor activity
El-Shemy *et al.* 2010[16]	*Aloe vera* active principles exerted significant inhibition on EACC number	Antitumor activity
Niciforovic *et al*. 2007[17]	Showed pronounced antiproliferative and cytotoxic effects	Antiproliferati-ve activity
Kuo *et al.* 2007[18]	AE inhibited cell proliferation and induced apoptosis	Antiproliferati-ve activity
Lissoni *et al.* 2009[19]	Aloe was successfully associated with chemotherapy to increase its efficacy in terms of both tumor regression rate and survival time	Antitumor activity
Lee *et al*. 2001[21]	AE-induced apoptosis of CH27 cells involved modulation of the expression of Bcl-2 family proteins	Cell death by the Bax and Fas death pathway
Chen *et al.* 2004[22]	AE showed its anticarcinogenetic properties by inhibiting proliferation and inducing cell cycle arrest and apoptosis	Anticarcinogen-etic activity
Suboi *et al.* 2012[25]	AE inhibited cell proliferation by arresting the cell cycle at the G2/M phase and inhibiting cyclin B1	Antitumor activity
Lee 2001[26]	AE- and emodin-induced apoptosis	Antitumor activity
Lin and Uen 2010[27]	Inhibition of casein kinase II activity, the release of apoptosis-inducing factor and cytochrome c, and the caspase-3 activation are involved in AE-mediated apoptosis	Anticancer activity
Arunkumar and Muthuselvam 2009[28]	Acetone extract can be used as an antimicrobial agent	Antimicrobial activity
Philip *et al.* 2012[29]	*Staphylococcus aureus* was inhibited at high concentration (1/10), and moderate concentration of *Aloe vera* extract was needed to inhibit the growth of *Escherichia coli, Pseudomonas aeruginosa*, and *Salmonella typhi*	Antimicrobial activity
Alemdar and Agaoglu *et al.* 2009[30]	*Aloe vera* juice showed antimicrobial activity against *M. smegmatis, K. pneumoniae, E. faecalis, M. luteus, C. albicans*, and *B. sphericus*	Antimicrobial activity
Nejatzadeh-Barandozi 2013[31]	The maximum of antibacterial activities were observed in acetone extracts rather than aqueous and ethanol extracts	Antimicrobial activity
Fani and Kohanteb 2012[32]	*S. mutans* was the species most sensitive to *Aloe vera* gel, with a MIC of 12.5 μg/mL, while *A. actinomycetemcomitans, P*. gingivalis, and *B. fragilis* were less sensitive, with a MIC of 25-50 μg/mL	Antimicrobial activity
Pandey and Mishra 2010[33]	Ethanolic extract shows great inhibitory activity for Gram-positive bacteria such as *E. bovis*, and highest inhibitory effect for Gram-negative bacteria was observed with *P. aeruginosa*	Antimicrobial activity
Anilakumar 2010[44]	Restoration of hepatic GSH and uric acid to normal levels	Antioxidant activity
Saritha *et al.* 2010[45]	MEAG and AEAG showed the maximum DPPH free radical- and superoxide radical-scavenging activities	Antioxidant activity
Vázquez *et al.* 1996[47]	Inhibitory action on the arachidonic acid pathway via cyclooxygenase	Anti-inflammatory activity
Davis and Maro 1989[48]	Both *Aloe vera* and gibberillin inhibited inflammation in a dose-response manner	Anti-inflammatory activity
Davids *et al.* 1994[51]	Mice receiving 300 mg/kg of mannose-6-phosphate exhibited more improved wound healing than saline controls	Anti-inflammatory activity
Rajasekaran and Sathishsekar 2007[58]	Oral administration of ethanolic extract of Aloe vera leaf gel extract for 21 days significantly restored the levels of hexose, hexosamine, and sialic acid to near-normalcy	Preventing glycoprotein-mediated secondary diabetic complications
Chandan *et al.* 2007[59]	Aquous and methanol extracts showed significant hepatoprotective activity against CCl4-induced hepatotoxicity	Hepatoprotectiv effect
Nayak *et al.* 2011[61]	*Aloe vera* significantly reduced the levels of AST, ALT, and ALP and restored the depleted liver thiol levels significantly	Hepatoprotective effect
Halder *et al.* 2012[62]	*Aloe vera* (400 mg/kg, orally) significantly enhanced the secondary humoral immune response	Immunomodulatory effect
Chandu *et al.* 2011[64]	*Aloe vera* extract at the dose of 100 mg/kg was found to suppress delayed-type hypersensitivity reactions	Immunomodulatory effect
Borra *et al.* 2011[65]	Antiulcer effect of *Aloe vera* in indomethacin-induced peptic ulcer was observed. The mean ulcer index of the test (*A. vera*) group was 20±1.79.	Antiulcer activity
Eamlamnam *et al.* 2006[66]	*Aloe vera* treatment can reduce leukocyte adherence and tumor necrosis factor (TNF)-alpha level, elevate interleukin (IL)-10 levels, and promote gastric ulcer healing	Gastric ulcer-healing effect

species, with a minimum inhibitory concentration (MIC) of 12.5 μg/mL, whereas *A. actinomycetemcomitans*, *P. gingivalis*, and *B. fragilis* showed less sensitivity, with a MIC of 25-50 μg/mL.[32] Another study demonstrated that the ethanolic extract of *Aloe vera* leaves showed a wider zone of growth inhibition with 29-30 mm than did the aqueous extract with 3-4 mm against *Enterococcus bovis* and *Staphylococcus aureus*.[33] The antimicrobial activity of *Aloe vera* juice was investigated using agar disk

diffusion against bacteria, fungi, and yeast, and it was observed that *Aloe vera* juice showed antibacterial activity against the Gram-negative bacteria *A. hydrophilia and E. coli* only.[34] Other studies have confirmed that *Aloe* juice has been found to be bacteriostatic against *Staphylococcus aureus*, *Streptococcus pyogenes*, and *Salmonella paratyphi*.[35,36] One important study focused on the antimicrobial activities of different types of aloe preparations, such as fresh, preserved, cooling gel, and acne cream, against various microorganisms; it was observed that the fresh and preserved gel preparations showed maximum zones of inhibition against *Bacillus subtilis*, and the cooling gel and acne cream against *Staphylococcus aureus*.[37] An experiment was performed to evaluate the antibacterial activity of *Aloe vera* extracts, such as ethanol, methanol, and distilled water extracts, and the methanol extract showed the maximum antibacterial activity among the solvent extracts.[38]

Antioxidant activity

Free radical production is balanced through the antioxidative defense system of our body,[39] and any alteration occurring between the generation of reactive oxygen species (ROS) and its neutralization by antioxidant defenses[40,41] causes oxidative stress, which plays a role in the pathogenesis of diseases. Medicinal plants contain various types of constituents, such as vitamins, amino acids, carbohydrates, and phenolic compounds, and these compounds are active in controlling or neutralizing the ROS. Earlier studies supported the role of ROS in cancer development, and dietary antioxidants and endogenous antioxidants appear to be vital as cancer-preventive agents through the neutralization of ROS.[42,43] In this context, *Aloe vera* with its potent antioxidant activities can be used for disease management [Table 1]. Azoxymethane (AOM)-induced oxidative stress in rats was tested to study the effects of oral feeding with *Aloe vera* gel extract (AGE), and the results showed that the hepatic glutathione (GSH) and uric acid levels reduced by AOM were restored to normal levels with AGE feeding.[44]

The antioxidative properties of AGE prepared in methanol (methanol extract of *Aloe vera* gel or MEAG), 95% ethanol (ethanol extract of *Aloe vera* gel or EEAG), hexane (hexane extract of *Aloe vera* gel or HEAG), acetone (AEAG), and chloroform (chloroform extract of *Aloe vera* gel or CEAG) were tested, and it was revealed that MEAG and AEAG possessed maximum 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical- and superoxide radical-scavenging activities.[45] Further, a study was performed on the polysaccharide and flavonoid concentrations of two-, three-, and four-year-old *Aloe vera* to evaluate the antioxidant activities; the three-year-old extract exhibited the strongest radical-scavenging activity, which is significantly higher than that of butylated hydroxytoluene (BHT) and alpha-tocopherol.[46]

Anti-inflammatory activity

Inflammation is the body's natural response to wounds and infections. Medicinal plants and their constituents serve as anti-inflammatory agents without any adverse complications. *Aloe vera* aloe is one of the best-known natural remedies and can reduce swelling/redness [Table 1]. An important study was performed to evaluate the effects of different types of extract on carrageenan-induced edema in rat paws; the results showed that the aqueous and chloroform extracts reduced the edema in the hind paw and that the aqueous extract inhibited prostaglandin E2 production from [14C] arachidonic acid.[47] Another study was performed on streptozotocin (STZ)-induced diabetic mice, in which the anti-inflammatory activities of both *A. vera* and gibberellin were measured, and it was found that both equally inhibited inflammation in a dose-response manner.[48] A supportive report showed that the *Aloe vera* extract decreased inflammation by 48% in a rat adjuvant-induced arthritic inflammatory model,[49] and *in vitro* study based on human colorectal mucosa confirmed that aloe vera gel inhibited the production of prostaglandin E2 and secretion of IL-8 secretion.[50] Lupeol, a sterol present in a variety of plants including *Aloe vera*, has antimicrobial, antitumor, and anti-inflammatory properties.[51]

Antidiabetic activity

Diabetes mellitus is a major endocrine/metabolic disorder and also a major problem worldwide. Several plants and their constituents, such as ginger and gingerol, have proved to be therapeutically useful in the management of diabetes.[52] *Aloe vera* shows role in the management of diabetes and its associated symptoms [Table 1]. Studies in support of the potency of *Aloe vera* have reported that the use of *Aloe* gum increases glucose tolerance in diabetic rats and normal rats,[53] and another study concluded that *Aloe* contains a hypoglycemic agent that lowers the blood glucose, but the exact mechanism is not known yet.[54]

A study results showed that after administration of the five phytosterols from Aloe vera such as lophenol , 24-methyl-lophenol, 24-ethyl-lophenol, cycloartanol and 24-methylene-cycloartanol for 28 days fasting blood glucose levels decreased to approximately 64%, 28%, 47%, 51%, and 55% of control levels, respectively.[55] A key study showed significant reduction in fasting blood glucose, hepatic transaminases, plasma and tissue cholesterol, triglycerides, free fatty acids, and phospholipids, and also showed significant improvement in plasma insulin when AGE was administered orally at a dose of 300 mg/kg.[56] The administration of *Aloe vera* high molecular weight fractions (AHM) for 12 weeks three times per day concurrently with the oral hypoglycemic drugs significantly decreased the fasting blood glucose level, and a significant decrease in blood glucose level was also evident that was sustained after 6 weeks from the start of the study.[57] One study has shown a significant increase in the blood glucose level and food and water intake in STZ-induced diabetic rats compared to control group rats, and the administration of *Aloe vera* juice extract to diabetic rats showed a tendency to bring these changes back to the normal level.[58]

Hepatoprotective effect

Liver diseases are major health problem worldwide. Allopathic medicines such as paracetamol and ibuprofen belong to a class of drugs called nonsteroidal anti-inflammatory drugs (NSAIDs),

which are used for the management of pain; fever and inflammation are among the major culprits in liver damage/cirrhosis. Studies have demonstrated the hepatoprotective activity of *Aloe vera* against carbon tetrachloride;[59] one study of the protective effects of fresh *Aloe vera* (AV) leaf extract on lindane (LD)-induced hepatoxicity and genotoxicity was performed, and the results showed that pretreatment with *Aloe vera* leaf extract at a concentration of 1.0 mL/kg body weight significantly decreased the serum levels of glutamate pyruvate transaminase (GPT), glutamate oxaloacetate transaminase (GOT), gamma-glutamyl transferase (GGT), and alkaline phosphatase (ALP) raised by 100 mg/kg body weight of LD.[60] Another important study tested the hepatoprotective activity of the aqueous extract of *Aloe vera* against paracetamol-induced hepatotoxicity in albino rats; it was observed that single-day treatment of aqueous extract of *Aloe vera* (doses of 250 mg/kg and 500 mg/kg) reduced aspartate transaminase (AST) and alanine transaminase (ALT) levels and that the 500 mg/kg dose in particular reduced the ALP levels and restored the depleted liver thiol levels.[61]

Immounomodulatory effect

Aloe vera, used therapeutically, plays a vital role in the immune system, as shown by the increased cell viability of macrophages, and also functions effectively in the first line of defense against pathogens. A study of the mouse macrophage cell line RAW 264.7 was made to explore the effects of acemannan and it was noticed that acemannan stimulates macrophage cytokine production, nitric oxide release, surface molecule expression, and cell morphologic changes.[62] An important study was performed to explore the effect of the aqueous extract of *Aloe vera* on parameters of humoral and cell-mediated immunity, and it was found that *Aloe vera* (400 mg/kg, orally) significantly enhanced the secondary humoral immune response.[63] Another study showed that the pyrogallol-induced suppression of humoral and cell-mediated immune response were significantly attenuated by oral treatment with *Aloe vera* extract, and furthermore, the 100-mg/kg dose was found to suppress delayed-type hypersensitivity reactions in a mouse model study.[64]

Antiulcer effect

Various factors such as food ingredients, stress, *Helicobacter pylori*, smoking, NSAIDs, and drugs are responsible for gastric ulcers. *Aloe vera* and its constituents including polysaccharides, anthraquinones, and other valuable components can act significantly toward the inhibition of peptic ulcers by controlling gastric secretion. An important study in support of the antiulcer activity of *Aloe vera* has shown that the mean ulcer index of the control group was 50 ± 3.5, whereas the mean ulcer index of the *Aloe vera* treated group was 20 ± 1.79 and the mean ulcer index of the standard omeprazole-treated group was 10 ± 1.96.[65] Another study in support of *Aloe vera* reported that sucralfate and *Aloe vera* treatment in the ulcer groups showed reduced gastric inflammation, enhanced epithelial cell proliferation, elongated gastric glands, and reduced ulcer sizes.[66]

Skin protection and hydration activity

Natural products from plants are effective in skin protection [Table 1] as they are rich sources of antioxidants. Dietary supplementation with vitamins, minerals, or essential fatty acids, improves skin conditions.[67] In this context, various plants such as *Nigella sativa*, turmeric, and *Aloe vera* are effective in skin protection as they are rich sources of antioxidants and vitamins, which are essential health-maintaining components and can also neutralize the effects of ultraviolet (UV) radiation.

The results of a key study confirmed that *Aloe vera* gel contains small-molecular-weight immunomodulators, such as G1C2F1, that prevent ultraviolet B (UVB)-induced immune suppression in the skin by repairing UVB-induced damage on epidermal Langerhans cells (LC).[68]

The photoprotective effect of *Aloe vera* on different types of hair was investigated, and it was concluded that the selected *Aloe vera* juice as a photoprotective agent was satisfactory for all types of hair, but the degree of protection varied with each type of hair.[69] One study concluded that *Aloe vera* gloves improved the skin integrity, decreased the appearance of fine wrinkling, and decreased erythema for the management of occupational dry skin and irritant contact dermatitis.[70] Yet another study summarized the herbal cosmeceuticals that offer photoprotection from UVB radiation.[71]

Anti-aging effect

Medicinal plants including *Aloe vera* have shown significant anti-aging effects [Table 1]. However, the exact mechanism behind such effects is not fully understood. An earlier study showed the anti-aging effect of *Aloe vera* to be tied to the production of collagen and elastin fibers, which make the skin more elastic and less wrinkled.[72]

Laxative effects

An important study has shown the relationship between increase in the intestinal water content and the stimulation of peristalsis, which confirms that aloe-emodin-9-anthrone is the chief agent responsible for the cathartic effect of barbaloin.[73]

Role of Aloe vera in dentistry

Medicinal plants and its constituents are applied in dental management due to their antibacterial and wound-healing activities. *Aloe vera* is very useful in the treatment of gum diseases including gingivitis and periodontitis.[74] A study was performed to evaluate the efficacy of *Aloe vera* mouth rinse on plaque accumulation and gingivitis (in the experimental setting), and it was observed that mouth wash containing *Aloe vera* products led to significant reduction of plaque and gingivitis; however, the effect was less than that of chlorhexidine.[75]

CONCLUSION

Treatment based on synthetic/allopathic drugs is effective in the prevention and treatment of diseases, but such a type of

treatment is expensive and also shows adverse effects. The implications of natural products in the prevention of diseases and treatment are in increasing evidence worldwide, especially in the developing countries, due to their affordability and fewer side effects. However, a few studies have confirmed the safe dose level and mechanism of action of *Aloe vera* in the prevention and treatment of diseases. However, further, detailed studies are urgently needed to check the therapeutic potentiality, safety, and mechanism of action of *Aloe vera* in the management of diseases.

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