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Therapeutic and Medicinal Uses of *Aloe vera*: A Review

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ABSTRACT

The plant *Aloe vera* is used in Ayurvedic, Homoeopathic and Allopathic streams of medicine**,** and not only tribal community but also most of the people for food and medicine. The plant leaves contains numerous vitamins, minerals, enzymes, amino acids, natural sugars and other bioactive compounds with emollient, purgative, antimicrobial, anti inflammatory, anti-oxidant, aphrodisiac, anti-helmenthic, antifungal, antiseptic and cosmetic values for health care. This plant has potential to cure sunburns, burns and minor cuts, and even skin cancer. The external use in cosmetic primarily acts as skin healer and prevents injury of epithelial tissues, cures acne and gives a youthful glow to skin, also acts as extremely powerful laxative.

Keywords: *Aloe vera*; Antimicrobial; Therapeutic; Medicinal Uses; Cosmetic Application

1. Introduction

Plant extracts represent a continuous effort to find new compound against pathogens. Approximately 20% of the plants found in the world have been submitted to pharmacological or biological test, and a substantial number of new antibiotics introduced on the market are obtained from natural or semi synthetic resources [1]. The genus Aloe belonging to family Alliaceae is a succulent herb of 80 - 100 cm in height which matures in 4 - 6 years and survives for nearly 50 years under favorable conditions. *Aloe vera* (L.) Burm. *f*. syn. *Aloe barbadensis* Miller, is most biologically active among 400 species [2-4]. According to World Health Organisation, medicinal plants would be the best source for obtaining a variety of drugs [5]. The plant is native to southern and eastern Africa along the upper Nile in the Sudan, and it was subsequently introduced into northern Africa and naturalized in the Mediterranean region and other countries across the globe. The plant is commercially cultivated in Aruba, Bonaire, Haiti, India, South Africa, the United States of America, and Venezuela [6,7] while the finest quality of Aloe is grown in desert of Southern California. The plant can survive in hot temperatures of 104˚F and with stand in below freezing temperatures until root is not damaged.

1.1. Synonym

Aloe barbadensis Miller, *Aloe chinensis* Bak., *Aloe elongata* Murray, *Aloe indica* Royle, *A. officinalis* Forsk., *A. perfoliata* L., *A. rubescens* DC, *A. vera* L. var. *littoralis* König ex Bak., *A. vera* L. var. *chinensis* Berger, *A. vulgaris* Lam. Most formularies and reference books regard *Aloe barbadensis* Mill. as the correct species name, and *Aloe vera* (L.) Burm. f. as a synonym. According to International Rules of Botanical Nomenclature (IRBN), *Aloe vera* (L.) Burm. *f*. is the legitimate name for this species [6].

1.2. Taxonomic Treatment

This succulent perennial herb has triangular, *sessile stem*, *shallow root system*, *fleshy serrated leaves arranged in rosette having* 30 - 50 cm length and 10 cm breadth at the base; colour pea-green. The bright yellow tubular flowers, length 25 - 35 cm, axillary spike and stamens are frequently projected beyond the perianth tube and fruits contain many seeds [7].

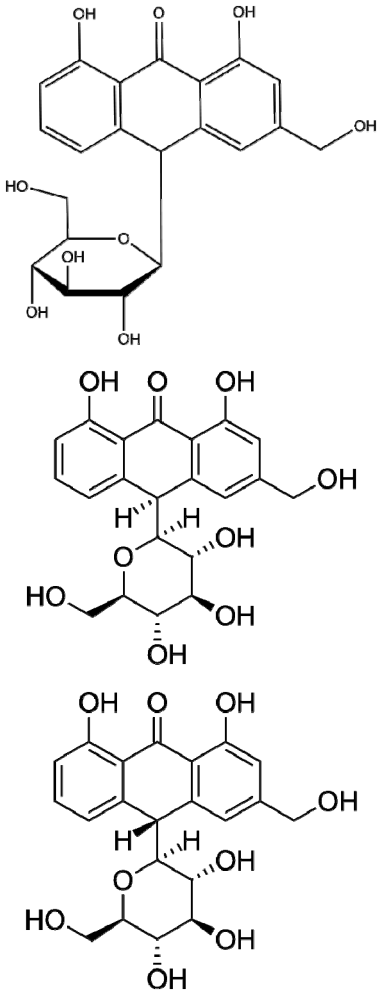
2. Active Ingredients

Leaves have three layers. The outer most layer consist of

15 - 20 cells thick protective layer synthesizing carbohydrates and proteins [8]. (**Figure 1**) The active components of aloe include anthraquinones, chromones, polysaccharides, and enzymes. The anthraquinones and chromones are responsible for the anti-cancer activity, anti-inflammatory, and evacuating [9]. The elements Al, B, Ba, Ca, Fe, Mg, Na, P, Si etc. has also been reported to be present in *Aloe vera* gel [9-11].

2.1. Outer Protective Layers of Leaf

The bitter yellow latex of pericyclic tubules in the outer layer of the leaves contain derivatives of hydroxyanthracene, anthraquinone and glycosides aloin A and B from 15% - 40% in different investigations [12-14]. The other active principles of *Aloe* include hydroxyanthrone, aloe-emodin-anthrone 10-C-glucoside and chrones.



Structure of Aloin, Aloin A, Aloin B

2.2. Middle Layer of Leaf

The bitter yellow latex containing anthraquinones and glycosides has been reported from the middle layers of

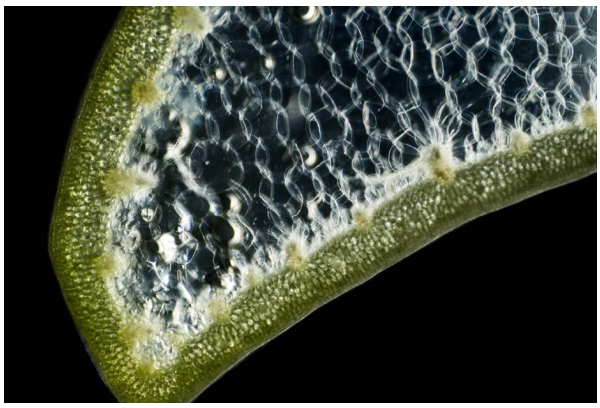
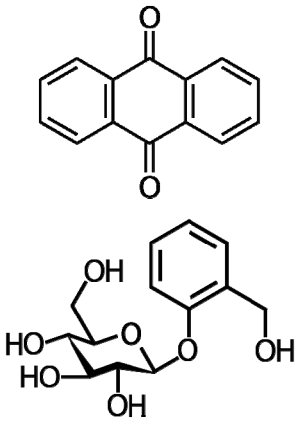


Figure 1. The transverse section of the leaf exhibiting three cells layers, the protective layer, middle layer and colourless inner layer.

leaf [8]. The juice that is originated from cells of the pericycle and adjacent leaf parenchyma, flowing spontaneously from the cut leaf get dried with or without the aid of heat and get solidified should not be confused with *Aloe vera* gel which is also the colourless mucilaginous gel that is obtained from the parenchymatous leaf cells [14]. The parenchymatous tissue or pulp shown to contain proteins, lipids, amino acids, vitamins, enzymes, inorganic compounds and small organic compounds in addition to the different carbohydrates. There is some evidence of chemotaxonomic variation in the polysaccharide composition [15-17] 16-different polysaccharides and 12 major polypeptides (mol wt 15 - 77 kD), and various glycoproteins (29 kD in leaf gel).

2.3. Inner Layers of Leaf

The innermost layer of leaf gel contains water upto 99%, with glucomannans, amino acids, lipids, sterols and vitamins [8,17].



Structure of Anthraquinone and structure of glycosides

The other potentially active ingredients include vitamins, enzymes, minerals, sugars, lignin, saponins, sali-

cylic acids, and amino acids [18-21]. It has numerous monosaccharide's and polysaccharides; vitamins B_1, B_2, B_6, and C; niacinamide and choline, several inorganic ingredients, enzymes (acid and alkaline phosphatase, amylase, lactate dehydrogenase, lipase) and organic compounds (aloin, barbaloin, and emodin) as described by [22]. The main functional component of *Aloe vera* is a long chain of acetylated mannose [11,23,24]. Aloe gel is often commercialized as powdered concentrate. The therapeutically, it is used to prevent progressive dermal ischemia due to burns, frostbite, electrical injury and intra arterial drug abuse. *In vivo* analysis of these injuries demonstrates that this gel acts as an inhibitor of thromboxane A_2, a mediator of progressive tissue damage [20].

The *Aloe vera* gel play chief role in stimulation of the complement linked to polysaccharides, hydration, insulation, and protection. Application of fresh gel to normal human cells *in vitro* promoted cell growth and attachment, whereas a stabilized gel preparation was cytotoxic to both normal and tumour cells. This cytotoxicity was attributed to additional substances added to gel during processing [25]. The wound healing powers were due to a high molecular weighted polypeptide in healing of rat's excision wounds [26]. This glycoprotein promotes cell proliferation, so gel improves wound healing by increasing blood supply and increased oxygenation [4,27]. Growth of new blood capillaries (angiogenesis) and tissue regeneration in the burn tissue for a guinea pig has been reported, however, no specific constituents were identified [26]. Further, a low molecular weight compound from freeze-dried gel stimulated angiogenesis in chick chorioallantoic membrane, and a methanol-soluble fraction of the gel stimulated proliferation of arteries in endothelial cells and induced them to invade a collage substrate [28]. **Table 1** representing the chemical composition and properties and activity of *Aloe vera*.

3. Therapeutic Use

3.1. Wound Healing

Wound healing is a dynamic process, occurring in 3 phases. The first phase is inflammation, hyperaemia and leukocyte infiltration. The second phase consists of removal of dead tissue. The third phase of proliferation consisting of epithelial regeneration and formation of fibrous tissue [30].

A more recent review concludes that the cumulative evidence supports the use of *Aloe vera* for the healing of first to second degree burns [31]. The wound healing property of *Aloe vera* gel has been attributed to Mannose-6-phosphate [25]. Actually, glucomannan and plant growth harmone gibberellins interacts with growth factor receptors of fibrobroblast and stimulate its activity and proliferation for increases collagen synthesis in topical and oral administration of Aloe according to Hayes [22]. The Aloe administration influence collagen composition (more type III) and increased collagen cross linking for wound contraction and improving breaking strength [17]. It also increases synthesis of hyaluronic acid and dermatan sulfate in the granulation tissue of a healing wound [32].

Acemannan is considered the main functional component of *Aloe vera*, is composed of a long chain of acetylated mannose [11,23,24]. This complex carbohydrate accelerates wound healing and reduces radiation induced skin reactions [33,34]. Macrophage-activating potential acermannan may stimulate the release of fibrogenic cytokines [34,35]. Direct binding of acemannan to growth

Table 1. Chemical composition and properties of *Aloe vera* [29].

Constituents	Number and identification	Properties and activity
Amino acids	Provides 20 of the 22 required amino acids and 7 of the 8 essential ones	Basic building blocks of proteins in the body and muscle tissues
Anthraquinones	Provides Aloe emodin, Aloetic acid, alovin, anthracine	Analgesic, antibacterial
Enzymes	Anthranol, barbaloin, chrysophanic acid, smodin, ethereal oil, ester of cinnamonic acid, isobarbaloin, resistannol	Antifungal and antiviral activity but toxic at high concentrations
Hormones	Auxins and gibberellins	Wound healing and anti-inflammatory
Minerals	Calcium, chromium, copper, iron, manganese, potassium, sodium and zinc	Essential for good health
Salicyclic acid	Aspirin like compounds	Analgesic
Saponins	Glycosides	Cleansing and antiseptic
Steroids	Cholesterol, campesterol, lupeol, sistosterol	Anti-inflammatory agents, lupeol has Antiseptic and analgesic properties
Sugars	Monosaccharides: Glucose and Fructose Polysaccharides: Glucomannans/polymannose	Anti-viral, immune modulating activity of acemannan
Vitamins	A, B, C, E, choline, B12, folic acid	Antioxidant (A, C, E), neutralises free radicals

factors and their stabilization may lead to promotion of prolong stimulation of granulation tissue [33].

The Aloe gel has been used for the treatment of radiation burns and radiation ulcers [36], and complete healing has been observed in two radiation burns patients [7]. The fresh gel was more effective than the cream [7,37] as Aloe gel-treated lesions healed faster (11.8 days) compared to burns treated with petroleum jelly gauze (18.2 days) by *Fulton* [38]. The 27 patients with partial thickness burns have been treated with Aloe gel in a placebo-controlled study [39].

3.2. Anti-Inflammatory Action

The anti-inflammatory activity of *Aloe vera* gel has been revealed by a number of *in vitro* and *in vivo* studies through bradykinase activity [40,41]. The peptidase bradykinase was isolated from aloe and shown to break down the bradykinin, an inflammatory substance that induces pain [42]. A novel anti-inflammatory compound, C-glucosyl chromone, was isolated from gel extracts [43]. *Aloe vera* inhibits the cyclo-oxygenase pathway and reduces prostaglandin E2 production from arachidonic acid. Fresh *Aloe vera* gel significantly reduced acute inflammation in rats (carrageenin-induced paw oedema), but not in chronic inflammation [41]. In croton oil-induced oedema in mice, three *Aloe vera* gel sterols were able to reduce inflammation by up to 37%. Lupeol, the most active antiinflamatory sterol, reduced inflammation in a dose dependent manner. The data suggest that specific plant sterols may also contribute to the anti-inflammatory activity of gel [43]. The aloe sterol includes campesterol, *β*-sitosterol, lupeol, and cholesterol which are anti-inflammatory in nature, helps in reducing the inflammation pain and act as a natural analgesic. Other aspirin-like compound present in Aloe is responsible for anti-inflammatory and antimicrobial properties [44]. Even, *Aloe vera* extract (5.0% leaf homogenate) decreased inflammation by 48% in a rat adjuvant-induced arthritic inflammatory model [45,46].

3.3. Effects on the Immune System

Alprogen inhibit calcium influx into mast cells, thereby inhibiting the antigen-antibody-mediated release of histamine and leukotriene from mast cells [47]. In a study on mice that had previously been implanted with murine sarcoma cells, acemannan stimulates the synthesis and release of interleukin-1 (IL-1) and tumor necrosis factor from macrophages in mice, which in turn initiated an immune attack that resulted in necrosis and regression of the cancerous cells [48]. Several low-molecular-weight compounds are also capable of inhibiting the release of reactive oxygen free radicals from activated human neutrophils [49].

3.4. Moisturizing and Anti-Aging Agent

Muco-polysaccharides help in binding moisture into the skin. The amino acids also soften hardened skin cells and zinc acts as an astringent to tighten pores. Its moisturizing effects have also been studied in treatment of dry skin associated with occupational exposure where *Aloe vera* gel gloves improved the skin integrity, decrease appearance of acne wrinkle and decrease erythema [50]. The Aloe gel gives cooling effect and also acts as a moisturizing agent. It also has role in gerontology and rejuvenation of aging skin. This property of Aloe is because it's biogenic material. *Aloe vera* is used as skin tonic in cosmetic industry.

3.5. Antitumor Activity

A number of glycoproteins present in *Aloe vera* gel have been reported to have antitumor and antiulcer effects and to increase proliferation of normal human dermal cells [51-53]. However, statistically significant clinical studies on the efficacy of *Aloe vera* gel on human health are very limited and often inconclusive [54]. In recent studies, a polysaccharide fraction has shown to inhibit the binding of benzopyrene to primary rat hepatocytes, thereby preventing the formation of potentially cancer-initiating benzopyrene-DNA adducts. An induction of glutathione S-transferase and an inhibition of the tumor-promoting effects of phorbol myristic acetate has also been reported which suggest a possible benefit of using aloe gel in cancer chemoprevention [55,56].

3.6. Laxative Effects

Anthraquinones present in latex are a potent laxative; it's stimulating mucus secretion, increase intestinal water content and intestinal peristalsis [35]. The Aloe are due primarily to the 1, 8-dihydroxyanthracene glycosides, aloin A and B (formerly designated barbaloin) [40,57]. After oral administration aloin A and B, which are not absorbed in the upper intestine, are hydrolysed in the colon by intestinal bacteria and then reduced to the active metabolites (the main active metabolite is aloe-emodin-9-anthrone) [41,58], which like senna acts as a stimulant and irritant to the gastrointestinal tract [59]. Aloe latex is known for its laxative properties. The laxative effect of Aloe is not generally observed before 6 hours after oral administration, and sometimes not until 24 or more hours after.

4. Medicinal Uses

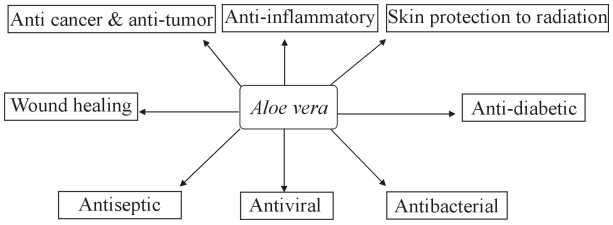
Aloe vera is anthelmintic, aperients, carminative, deobstruent, depurative, diuretic, stomachic and emmenagogue. Juice is used in skin care medicine, dyspepsia, amenorrhea, burns, colic, hyperadenosis, hepatopathy,

splenopathy, constipation, span menorrhea, abdominal tumors, dropsy carbuncles, sciatica, lumbago and flatulence. The elio, a product made by juice of this plant, is used for helminthiasis in children and is a purgative, anthelmintic & emmenagogue. A number of glycoprotein present in *Aloe vera* gel have been reported to have anti-tumor and antiulcer effects and to increase proliferation of normal human dermal cells [51-53]. Gel is useful in ulcerative colitis and pressure ulcers, respectively [60,61]. Traditionally, *Aloe vera* gel is used both, topically (treatment of wounds, minor burns, and skin irritations) and internally to treat constipation, coughs, ulcers, diabetes, headaches, arthritis, immune-system deficiencies [54,62].

Aloe vera has been used for medicinal purposes in several cultures for millennia: Greece, Egypt, India, Mexico, Japan, and China [63]. The Egyptians used the *Aloe vera* to make papyrus like scrolls as well as for treatment of tuberculosis [64]. Nadkerni [65] stated various preparations of *Aloe barbadensis* like confection, lotion and juice, useful remedies for curing various diseases. Aloe contains mixture of glucosides collectively called aloin which is the active constituent of various drugs. Traditionally Aloe is extensively used in treating urine related problems, pimples and ulcers etc. It is also used in gerontology and rejuvenation of aging skin. The juice of *Aloe vera* leaves is used as stomachic tonic and purgative. Scientific evidence for the cosmetic and therapeutic effectiveness of *Aloe vera* is limited and when present is frequently contradictory [66,67]. Despite this, the cosmetic and alternative medicine industries regularly make claims regarding the soothing, moisturizing, and healing properties of *Aloe vera*, especially *via* internet advertising [68,69]. The bioactive compounds are used as astringent, haemostatic, antidiabetic, antiulcer, antiseptic, antibacterial, anti inflammatory, antioxidant and anticancer agent also, effective in treating stomach ailments, gastrointestinal problems, skin diseases, constipation, radiation injury, wound healing, burns, dysentery, diarrhoea and in the treatment of skin diseases [70] (represents in **Graph 1**). It is used in ayurvedic formulations as appetite-stimulant, purgative, emmenogogue and antihelminthic, for treating cough, colds, piles, debility, dyspnoea, asthma and jaundice [71].

4.1. Cosmetic & Skin Protection Application

Aloin and its gel are used as skin tonic against pimples. *Aloe vera* is also used for soothing the skin, and keeping the skin moist to help avoid flaky scalp and skin in harsh and dry weather. The Aloe sugars are also used in moisturizing preparations [72]. Mixed with selected essential oils, it makes an excellent skin smoothening moisturizer, sun block lotion plus a whole range of beauty products. Due to its soothing and cooling qualities, Maharishi Ayurveda recommends *Aloe vera* for a number of skin



Graph 1. Representing the medicinal utilities of *Aloe vera*.

problems [71]. *Aloe vera* extracts have antibacterial and antifungal activities, which may help in the treatment of minor skin infections, such as boils and benign skin cysts and have been shown to inhibit the growth of fungi that cause tinea [73].

Currently, the plant is widely used in skin care, cosmetics and asnutraceuticals [74]. *Aloe vera* gel has been reported to have a protective effect against radiation damage to the skin [75,76]. Exact role is not known, but following the administration of *Aloe vera* gel, an antioxidant protein, metallothionein, is generated in the skin, which scavenges hydroxyl radicals and prevents suppression of superoxide dismutase and glutathione peroxidase in the skin. 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 [77]. Skin burns effect is reported and radiation dermatitis [78-80]. Some researcher has been reported the contact dermatitis and burning skin sensations following topical applications of *Aloe vera* gel to dermabraded skin. These reactions appeared to be associated with anthraquinone contaminants in this preparation [81,82].

4.2. Antiseptic

The antiseptic property of *Aloe vera* is due to presence of six antiseptic agents namely lupeol, salicylic acid, urea nitrogen, cinnamonic acid, phenols and sulphur. These compounds have inhibitory action on fungi, bacteria and viruses. Though most of these uses are interesting controlled trials are essential to determine its effectiveness in all diseases [83].

4.3. Anti Diabetic

The five phytosterols of *A. vera*, lophenol, 24-methyl-lophenol, 24-ethyl-lophenol, cycloartanol and 24-methylenecycloartanol showed anti-diabetic effects in type-2 diabetic mice [84]. *Aloe vera* contains polysaccharides which increase the insulin level and show hypoglycemic properties [85]. Noor *et al.*, [86] reviewed the beneficial effects of selective medicinal plant species such as *Allium cepa*, *Allium sativum*, *Aloe vera*, *Azadirachta indica*, *Gymnema sylvestre*, *Syzygium cumini* and *Pterocarpus marsupium*, and emphasize on the role of active bio-

molecules which possess anti-diabetic activity. The treatment of diabetes mellitus has been attempted with various indigenous plants and polyherbal formulations [87-89]. Encouraging results have been obtained from plant extracts with respect to antidiabetic activity, but still only a meager percentage of the plant world has been explored [90]. Medicinal plants like *Trigonella foenum graecum*, *Allium sativum*, *Gymnema slyvestre*, *Syzigium cumini* and *Aloe vera* have been studied for treatment of diabetes mellitus [91]. Extracts of Aloe gum increases glucose tolerance in both normal and diabetic rats [92] and *Aloe vera* sap taken for 4 - 14 weeks has shown a significant hypoglycaemic effect both clinically and experimentally [93]. *Aloe vera* gel is used in reducing sugar in diabetes [7]. The five phytosterols of *A. vera*, lophenol, 24-methyl-lophenol, 24-ethyl-lophenol, cycloartanol and 24-methylenecycloartanol showed anti-diabetic effects in type-2 diabetic mice [84]. Traditional anti-diabetic plants might provide new oral anti-diabetic compounds, which can counter the high cost and poor availability of the current medicines for many rural populations in developing countries [84].

4.4. Anticancer Properties

The role of Aloe in carcinogenicity has not been evaluated well. The chronic abuse of anthranoid-containing laxatives has been hypothesized to play a role in colorectal cancer, however, no causal relationship between anthranoid laxative abuse and colorectal cancer has been demonstrated and [81,82]. Report on cancer prevention is done by [94,95]. *Aloe vera* juice enables the body to heal itself from cancer and also from the damage caused by radio and chemotherapy that destroys healthy immune cells crucial for the recovery. *Aloe vera* emodin, an anthraquinone, has the ability to suppress or inhibit the growth of malignant cancer cells making it to have anti-neoplastic properties [96].

4.5. Stress

Aloe juice is helpful in smooth functioning of the body machinery [97]. It reduces cell-damaging process during stress condition and minimizes biochemical and physiological changes in the body [98]. Oxidative stress refers to chemical reactions in which compounds have their oxidative state changed. Some antioxidants are part of the body's natural regulating machinery while other dietary antioxidants are derived from diet sources. *Aloe vera* is an excellent example of a functional food that plays a significant role in protection from oxidative stress [71,72, 99].

4.6. Adverse Reactions

Abdominal spasms and pain may occur after even a single dose and overdose can lead to colicky abdominal spasms and pain, as well as the formation of thin, watery stools. Chronic abuse of anthraquinone stimulant laxatives can lead to hepatitis [100] and electrolyte disturbances (hypokalaemia, hypocalcaemia), metabolic acidosis, malabsorption, weight loss, albuminuria, and haematuria [101,102]. Weakness and orthostatic hypotension may be exacerbated in elderly patients when stimulant laxatives are repeatedly used [103]. Secondary aldosteronism may occur owing to renal tubular damage after aggravated use. Steatorrhoea and protein-losing gastroenteropathy with hypoalbuminaemia have also been observed, as have excessive excretion of calcium in the stools and osteomalacia of the vertebral column [104]. Melanotic pigmentation of the colonic mucosa (pseudomelanosis coli) has been observed in individuals taking anthraquinone laxatives for extended time periods. The pigmentation is clinically harmless and usually reversible within 4 to 12 months after the drug is discontinued [101].

Aloe vera contains polysaccharides which increase the insulin level and show hypoglycemic properties [85]. Noor *et al*., [86] reviewed the beneficial effects of selective medicinal plant species such as *Allium cepa*, *Allium sativum*, *Aloe vera*, *Azadirachta indica*, *Gymnema sylvestre*, *Syzygium cumini* and *Pterocarpus marsupium*, and emphasize on the role of active biomolecules which possess anti-diabetic activity. As with other stimulant laxatives, products containing Aloe should not be used in patients with intestinal obstruction or steno sis, stony severe dehydration with electrolyte depletion, or chronic constipation [105]. Chronic use may cause dependence and need for increased dosages, disturbances of water and electrolyte balance (e.g. hypokalaemia), and an atonic colon with impaired function [105]. The use of stimulant laxatives for more than 2 weeks requires medical supervision. Chronic abuse with diarrhoea and consequent fluid and electrolyte losses (mainly hypokalaemia) may cause albuminuria and haematuria, and may result in cardiac and neuromuscular dysfunction, the latter particularly in the case of concomitant use of cardiac glycosides (digoxin), diuretics, corticosteroids, or liquorices root. Aloe should not be administered to patients with inflammatory intestinal diseases, such as appendicitis, Crohn disease, ulcerative colitis, irritable bowel syndrome, or diverticulitis or to children less than 10 years of age. Aloe should not be used during pregnancy or lactation except under medical supervision after evaluating benefits and risks. Aloe is also contraindicated in patients with cramps, colic, hemorrhoids', nephritis, or any undiagnosed abdominal symptoms such as pain, nausea, or vomiting [105,106]. Leaf anti-hyperglycemic activity with protective effect on pancreas, liver and small Intestine in rabbits was studied [93,107-109].

5. Antimicrobial Activities

5.1. Antibacterial Activity

Aloe vera gel was bactericidal against *Pseudomonas aeruginosa* and acemannan prevented it from adhering to human lung epithelial cells in a monolayer culture [110, 111]. A processed *Aloe vera* gel preparation inhibited the growth of fungus *Candida albicans* [112]. The gel contains 99.3% of water, the remaining 0.7% is made up of solids with carbohydrates constituting for a large components [99]. Concentrated extracts of *Aloe* leaves are used as laxative and as a haemorrhoid treatment. *Aloe* gel can help to stimulate the body's immune system [113]. Glucomannan and acemannan have been proved to accelerate wound healing, activating macrophages, stimulating immune system as well antibacterial and antiviral effects [23,79,114-118]. *Streptoccocus pyogenes* and *Streptococcus faecalis* are two microorganisms that have been inhibited by *Aloe vera* gel [112,119]. Using a rat model, it was suggested that the antibacterial effect of the *Aloe vera* gel *in vivo* could enhance the wound healing process by eliminating the bacteria that contributed to inflammation [120]. The aloe extract was potent against three strains of Mycobacterium (*M. fortuitum*, *M. smegmatis* and *M. kansasii*) and a strong anti-mycobacterial activity against *M. tuberculosis* ss well as antibacterial activity against *P. aeruginosa*, *E. coli*, *S. aureus* and *S. typhi*. The preliminary phytochemistry revealed presence of terpenoids, flavonoids and tannins. Thus, *Aloe secundiflora* could be a rich source of antimicrobial agentsand it can give scientific backing to its use by the local people of Lake Victoria region of Kenyas [121].

5.2. Antiviral Activity

Several ingredients in *Aloe vera* jel have been shown to be effective antiviral agent. Acemannan reduced herpes simplex infection in two cultured target cell lines [122]. Lectins, fractions of *Aloe vera* gel, directly inhibited the cytomegalovirus proliferation in cell culture, perhaps by interfering with protein synthesis [123]. A purified sample of aloe emodin was effective against infectivity of herpes simplex virus Type I and Type II and it was capable of inactivating all of the viruses, including varicella-zoster virus, influenza virus, and pseudorabies virus [124]. Electron micrograph examination of anthroquinone treated herpes simplex virus demonstrated that the envelopes were partially disrupted. Such results indicate that anthraquinones extract from variety of plants are directly virucidal to enveloped viruses. These actions may be due to indirect effect due to stimulation of the immune system. The anthraquinone aloin also inactivates various enveloped viruses such as herpes simplex, varicella zoster and influenza [124].

5.3. Antifungal Activity

Aloe vera was evaluated on the mycellium development of *Rhizoctonia solani*, *Fusarium oxysporum*, and *Colletotrichum coccodes*, that showed an inhibitory effect of the pulp of *A. vera* on *F. oxysporum* at 10^4 µl L-1 and the liquid fraction reduced the rate of colony growth at a concentration of 10^5 µl L-1 in *R. solani*, *F. oxysporum*, and *C. coccodes* [125,126]. It is also reported that the Aloe juice have antiinflammatory, anti-arthritic activity, antibacterial and hypoglycaemic effects [127]. For bacteria, inner-leaf gel from *Aloe vera* was shown to inhibit growth of *Streptococcus* and *Shigella* species in vitro [128]. Agarry *et al*., [129] reported that the Aloe gel inhibited the growth of *Trichophyton mentagrophytes* (20.0 mm), while the leaf possesses inhibitory effects on both *Pseudomonas aeruginosa* and *Candida albicans*. In contrast, *Aloe vera* extracts failed to show antibiotic properties against *Xanthomonas species* [130]. Other uses for extracts of *Aloe vera* include the dilution of semen for the artificial fertilization of sheep, used as fresh food preservative [131] and used in water conservation in small farms [132]. Another constituent of *Aloe vera* includes saponins. These are soapy substances from the gel that are capable of cleansing and having antiseptic properties. The saponins perform strongly as anti-microbial against bacteria, viruses, fungi and yeasts [133].

6. Conclusion

The active ingredients hidden in its succulent leaves have the power to soothe human life and health in a myriad ways. The plant has importance in everyday life to soothe a variety of skin ailments such as mild cuts, antidote for insect stings, bruises, poison ivy and eczema along with skin moisturizing and anti ageing, digestive tract health, blood and lymphatic circulation and functioning of kidney, liver and gall bladder makes it a boon to human kind. *Aloe vera* as the "wonder plant" is multiple from being an antiseptic, anti-inflammatory agent, helps in relieving like cancer and diabetes, and being a cosmetic field. The plant is in need to a greater research emphasis for better utilization of this plant for humankind. *Aloe vera* is undoubtedly, the nature's gift to humanity for cosmetic, burn and medicinal application and it remains for us to introduce it to ourselves and thank the nature for its never-ending gift.

REFERENCES

[1] R. A. Mothana and V. Linclequist, "Antimicrobial Activity of Some Medicinal Plants of the Island Soqotra," *Journal of Ethnopharmacology*, Vol. 96, No. 1-2, 2005, pp. 177-181. http://dx.doi.org/10.1016/j.jep.2004.09.006

[2] S. P. Joshi, "Chemical Constituents and Biological Activity of *Aloe barbadensis*—A Review," *Journal of Medici-*

nal and Aromatic Plant Science, Vol. 20, 1997, pp. 768-773.

[3] D. P. West and Y. F. Zhu, "Evaluation of *Aloe vera* Gel Gloves in the Treatment of Dry Skin Associated with Occupational Exposure," *American Journal of Infection Control*, Vol. 31, No. 1, 2003, pp. 40-42. http://dx.doi.org/10.1067/mic.2003.12

[4] A. Yagi, A. Kabash, K. Mizuno, S. M. Moustafa, T. I. Khalifa and H. Tsuji, "Radical Scavenging Glycoprotein Inhibiting Cyclooxygenase-2 and Thromboxane A_2 Synthase from *Aloe vera* Gel," *Planta Medica*, Vol. 69, No. 3, 2003, pp. 269-271. http://dx.doi.org/10.1055/s-2003-38481

[5] P. R. V. Santos, A. C. X. Oliveria and T. C. B. Tomassini, "Controls Microbiological Products Fitoterapices," *Revista de Farmácia e Bioquímica*, Vol. 31, 1995, pp. 35-38.

[6] "African Pharmacopoeia," Vol. 1, Organization of African Unity, Scientific, Technical & Research Commission, Lagos, 1985.

[7] G. Y. Yeh, D. M. Eisenberg, T. J. Kaptchuk and R. S. Phillips, "Systematic Review of Herbs and Dietary Supplements for Glycemic Control in Diabetes," *Diabetes Care*, Vol. 26, No. 4, 2003, pp. 1277-1294. http://dx.doi.org/10.2337/diacare.26.4.1277

[8] J. P. Brown, "A Review of the Genetic Effects of Naturally Occurring Flavonoids, Anthraquinones and Related Compounds," *Mutation Research*, Vol. 75, No. 3, 1980, pp. 243-277. http://dx.doi.org/10.1016/0165-1110(80)90029-9

[9] S. W. Choi, B. W. Son, Y. S. Son, Y. I. Park, S. K. Lee and M. H. Chung, "The Wound-Healing Effect of a Glycoprotein Fraction Isolated from *Aloe vera*," *British Journal of Dermatology*, Vol. 145, No. 4, 2001, pp. 535-545. http://dx.doi.org/10.1046/j.1365-2133.2001.04410.x

[10] T. Yamaguchi, H. Takamura, T. Matoba and J. Terao, "HPLC Method for Evaluation of the Free Radical-Scavenging Activity of Foods by Using 1,1-Diphenyl-2-Picrylhydrazyl," *Bioscience, Biotechnology and Biochemistry*, Vol. 62, No. 6, 1998, pp. 1201-1204. http://dx.doi.org/10.1271/bbb.62.1201

[11] A. Femenia, E. S. Sanchez, S. Simal and C. Rossello, "Compositional Features of Polysaccharides from *Aloe vera* (*Aloe barbadensis* Miller) Plant Tissues," *Carbohydrate Polymers*, Vol. 39, No. 2, 1999, pp. 109-117. http://dx.doi.org/10.1016/S0144-8617(98)00163-5

[12] D. Saccu, P. Bogoni and G. Procida, "Aloe Exudate: Characterization by Reversed Phase HPLC and Headspace GC-MS," *Journal of Agricultural and Food Chemistry*, Vol. 49, No. 10, 2001, pp. 4526-4530. http://dx.doi.org/10.1021/jf010179c

[13] P. R. Bradley, "British Herbal Compendium," British Herbal Medicine Association, Bournemouth, 1992.

[14] J. Bruneton, "Pharmacognosy, Phytochemistry, Medicinal Plants," England, Intercept, Hampshire, 1995, pp. 434-436.

[15] Y. Ni and I. R. Tizard, "Analytical Methodology: The Gel-Analysis of Aloe Pulp and Its Derivatives," In: T. Reynolds, Ed., *Aloes the Genus Aloe*, CRC Press, Boca Raton, 2004, pp. 111-126.

[16] Anonymous, Cosmetic Ingredient Review Expert Panel, "Final Report on the Safety Assessment of *Aloe andongensis* 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," *International Journal of Toxicology*, Vol. 26, No. 2, 2007, pp. 1-50. http://dx.doi.org/10.1080/10915810701351186

[17] T. Reynolds and A. C. Dweck, "*Aloe vera* Leaf Gel: A Review Update," *Journal of Ethnopharmacology*, Vol. 68, No. 1-3, 1999, pp. 3-37. http://dx.doi.org/10.1016/S0378-8741(99)00085-9

[18] B. K. Vogler and E. Ernst, "*Aloe vera*: A Systematic Review of Its Clinical Effectiveness," *The British Journal of General Practice*, Vol. 49, No. 447, 1999, pp. 823-828.

[19] J. Townsend, "*Aloe vera*. The UK Reference Guide to Complimentary Medicine," Chartwell House Publishing, London, 1998.

[20] P. Antherton, "*Aloe vera*: Magic or Medicine?" *Nursing Standard*, Vol. 12, No. 41, 1998, pp. 49-54.

[21] M. S. Shelton, "*Aloe vera*, Its Chemical and Therapeutic Properties," *International Journal of Dermatology*, Vol. 30, No. 10, 1991, pp. 679-683. http://dx.doi.org/10.1111/j.1365-4362.1991.tb02607.x

[22] S. M. Hayes, "Lichen Planus: Report of Successful Treatment with *Aloe vera*," *General Dentistry*, Vol. 47, No. 3, 1999, pp. 268-272.

[23] A. Djeraba and P. Quere, "*In Vivo* Macrophage Activation in Chickens with Acemannan, a Complex Carbohydrate Extracted from *Aloe vera*," *International Journal of Immunopharmacology*, Vol. 22, No. 5, 2000, pp. 365-372. http://dx.doi.org/10.1016/S0192-0561(99)00091-0

[24] J. K. Lee, M. K. Lee, Y. P. Yun, Y. Kim, J. S. Kim, Y. S. Kim, K. Kim, S. S. Han and C. K. Lee, "Acemannan Purified from *Aloe vera* Induces Phenotypic and Functional Maturation of Immature Dendritic Cells," *International of Immunopharmacology*, Vol. 1, No. 7, 2001, pp. 1275-1284.

[25] R. H. Davis, J. J. Di Donato, G. M. Hartman and R. C. Hass, "Anti-Inflammatory and Wound Healing Activity of a Growth Substance in *Aloe vera*," *Journal of the American Podiatric Medical Association*, Vol. 84, No. 2, 1994, pp. 77-81.

[26] J. P. Heggers, "Beneficial Effect of *Aloe* on Wound Healing in an Excisional Wound Healing Model," *Journal of Alternative and Complementary Medicine*, Vol. 2, No. 2, 1996, pp. 271-277. http://dx.doi.org/10.1089/acm.1996.2.271

[27] R. H. Davis, M. G. Leitner, J. M. Russo and M. E. Byrne, "Wound Healing. Oral and Topical Activity of *Aloe vera*," *Journal of the American Paediatric Medical Association*, Vol. 79, No. 11, 1989, pp. 559-562.

[28] M. J. Lee, S. H. Yoon, S. K. Lee, M. H. Chung, Y. I. Park, C. K. Sung, J. S. Choi and K. W. Lim, "*In vivo* Angio-

genic Activity of Dichloromethane Extracts of *Aloe vera* Gel," *Archives of Pharmacal Research*, Vol. 18, No. 5, 1995, pp. 332-335. http://dx.doi.org/10.1007/BF02976327

[29] D. J. de Rodríguez, D. Hernández-Castillo, R. Rodríguez-García and J. L. Angulo-Sanchez, "Antifungal Activity *in Vitro* of *Aloe vera* Pulp and Liquid Fraction against Plant Pathogenic Fungi," *Industrial Crops and Products*, Vol. 21, No. 1, 2005, pp. 81-87. http://dx.doi.org/10.1016/j.indcrop.2004.01.002

[30] C. H. Reddy Uma, S. K. Reddy and J. Reddy, "*Aloe vera*—A Wound Healer," *Asian Journal of Oral Health and Allied Sciences*, Vol. 1, 2011, pp. 91-92.

[31] R. Maenthaisong, N. Chaiyakunapruk and S. Niruntraporn, "The Efficacy of *Aloe vera* for Burn Wound Healing: A Systematic Review," *Burns*, Vol. 33, No. 6, 2007, pp. 713-718. http://dx.doi.org/10.1016/j.burns.2006.10.384

[32] P. Chithra, G. B. Sajithal and G. Chandrakasan, "Influence of *Aloe vera* on Glycosaminoglycans in the Matrix of Healing Dermal Wounds in Rats," *Journal of Ethanopharmacology*, Vol. 59, No. 3, 1998, pp. 179-186. http://dx.doi.org/10.1016/S0378-8741(97)00112-8

[33] M. Castleman, "The Healing Herbs," Rodale Press, Emmaus, 1991, pp. 42-44.

[34] P. de Witte, "Metabolism and Pharmacokinetics of Anthranoids," *Pharmacology*, Vol. 47, Suppl. 1, 1993, pp. 86-97. http://dx.doi.org/10.1159/000139847

[35] Y. Ishii, H. Tanizawa and Y. Takino, "Studies of *Aloe*. V. Mechanism of Cathartic Effect. (4)," *Biological & Pharmaceutical Bulletin*, Vol. 17, No. 5, 1994, pp. 651-653. http://dx.doi.org/10.1248/bpb.17.651

[36] T. A. Syed, M. Afzal and A. S. Ashfaq, "Management of Genital Herpe in Men with 0.5% *Aloe vera* Extracts in a Hydrophilic Cream: A Placebo-Controlled Double-Blind Study," *Journal of Dermatological Treatment*, Vol. 8, No. 2, 1997, pp. 99-102. http://dx.doi.org/10.3109/09546639709160279

[37] V. Visuthikosol, Y. Sukwanarat and B. Chowchuen, "Effect of *Aloe vera* Gel to Healing of Burn Wound a Clinical and Histologic Study," *Journal of the Medical Association of Thailand*, Vol. 78, No. 8, 1995, pp. 403-409.

[38] J. E. Fulton, "The Stimulation of Postdermal Abarasion Wound Healing with Stabilised *Aloe vera* Gel-Polythylene Oxide Dressing," *Journal of Dermatologic Surgery & Oncology*, Vol. 16, No. 5, 1990, pp. 460-467. http://dx.doi.org/10.1111/j.1524-4725.1990.tb00065.x

[39] J. S. Montaner, J. Gill and J. Singer, "Double-Blind Placebo-Controlled Pilot Trial of Acemannan in Advanced Humanimmune-Deþciencyvirus Disease," *Journal of Acquired Immune Deficiency Syndromes and Human Retrovirology*, Vol. 12, No. 2, 1996, pp. 153-157.

[40] V. E. Tyler, "Herbs of Choice," Pharmaceutical Products Press, New York, 1994.

[41] Q. M. Che, T. Akao, M. Hattori, K. Kobashi and T. Namba, "Isolation of Human Intestinal Bacteria Capable of Transforming Barbaloin to Aloe-Emodin Anthrone," *Planta Medica*, Vol. 57, No. 1, 1991, pp. 15-19. http://dx.doi.org/10.1055/s-2006-960007

[42] S. Ito, R. Teradaira, H. Beppu, M. Obata, T. Nagatsu and K. Fujita, "Properties and Pharmacological Activity of Carboxypeptidase in *Aloe arborescens* Mill. var. Natalensis Berger," *Phytotherapy Research*, Vol. 7, No. 7, 1993, pp. S26-S29. http://dx.doi.org/10.1002/ptr.2650070710

[43] J. S. Haller, "A Drug for All Seasons, Medical and Pharmacological History of *Aloe*," *Bulletin of the New York Academy of Medicine*, Vol. 66, 1990, pp. 647-659.

[44] www.healingaloe.com, "Immunomodulatory Properties of *Aloe vera* Gel in Mice," *International Journal of Green Pharmacy*, Vol. 2, No. 3, 2008, pp. 152-154. http://dx.doi.org/10.4103/0973-8258.42732

[45] R. H. Davis, W. L. Parker, R. T. Samson and D. P. Murdoch, "Isolation of a Stimulatory System in an Aloe Extract," *Journal of the American Podiatric Medical Association*, Vol. 81, 1991, pp. 473-478.

[46] D. C. Hanley, W. A. Solomon, B. Saffran and R. H. Davis, "The Evaluation of Natural Substances in the Treatment of Adjuvant Arthritis," *Journal of the American Podiatric Medical Association*, Vol. 72, 1982, pp. 275-284.

[47] R. Hansel, K. Keller, H. Rimpler and G. Schneider, "Hagers Handbuch der Pharmazeutischen Praxis. Monograph: Valeriana," 5th Edition, Springer, Berlin, 1994. http://dx.doi.org/10.1007/978-3-642-57881-6

[48] S. Y. Peng, J. Norman, G. Curtin, D. Corrier, H. R. McDaniel and D. Busbee, "Decreased Mortality of Norman Murine Sarcoma in Mice Treated with the Immunomodulator, Acemannon," *Molecular Biotherapy*, Vol. 3: 1991, pp. 79-87.

[49] L. A. Hart, P. H. Nibbering, M. T. van den Barselaar, H. van Dijk, A. J. van den Burg and R. P. Labadie, "Effects of Low Molecular Constituents from *Aloe vera* Gel on Oxidative Metabolism and Cytotoxic and Bactericidal Activities of Human Neutrophils," *International Journal of Immunopharmacology*, Vol. 12, No. 4, 1990, pp. 427-434. http://dx.doi.org/10.1016/0192-0561(90)90026-J

[50] D. P. West and Y. F. Zhu, "Evaluation of *Aloe vera* Gel Gloves in the Treatment of Dry Skin Associated with Occupational Exposure," Vol. 31, No. 1, *American Journal of Infection Control*, 2003, pp. 40-42.

[51] S. W. Choi, B. W. Son, Y. S. Son, Y. I. Park, S. K. Lee, and M. H. Chung, "The Wound Healing Effect of a Glycoprotein Fraction Isolated from *Aloe vera*," *British Journal of Dermatology*, Vol. 145, No. 4, 2001, pp. 535-545. http://dx.doi.org/10.1046/j.1365-2133.2001.04410.x

[52] A. Yagi, T. Egusa, M. Arase, M. Tanabe and H. Tsuji, "Isolation and Characterization of the Glycoprotein Fraction with a Proliferationpromoting Activity on Human and Hamster Cells *in Vitro* from *Aloe vera* Gel," *Planta Medica*, Vol. 63, No. 1, 1997, pp. 18-21. http://dx.doi.org/10.1055/s-2006-957595

[53] A. Yagi, A. Kabash, K. Mizuno, S. M. Moustafa, T. I. Khalifa and H. Tsuji, "Radical Scavenging Glycoprotein Inhibiting Cyclooxygenase-2 and Thromboxane A2 Synthase from *Aloe vera* Gel," *Planta Medica*, Vol. 69, No. 3, 2003, pp. 269-271. http://dx.doi.org/10.1055/s-2003-38481

[54] K. Eshun and Q. He, "*Aloe vera*: A Valuable Ingredient for the Food, Pharmaceutical and Cosmetic Industries—A Review," *Critical Reviews in Food Science and Nutrition*, Vol. 44, No. 2, 2004, pp. 91-96. http://dx.doi.org/10.1080/10408690490424694

[55] H. S. Kim and B. M. Lee, "Inhibition of Benzopyren DNA Adduct Formation by Aloe Barbadensis Miller," *Carcinogenesis*, Vol. 18, No. 4, 1997, pp. 771-776. http://dx.doi.org/10.1093/carcin/18.4.771

[56] H. S. Kim, S. Kacew and B. M. Lee, "*In Vitro* Chemopreventive Effects of Plant Polysacchrides (*Aloe barbadensis* Miller, *Lentinus edodes*, *Ganoderma lucidum*, and *Coriolus vesicolor*)," *Carcinogenesis*, Vol. 20, No. 8, 1999, pp. 1637-1640. http://dx.doi.org/10.1093/carcin/20.8.1637

[57] V. E. Tyler, L. R. Bradley and J. E. Robbers, "Pharmacognosy," 9th Edition, Lea & Febiger, Philadelphia, 1988.

[58] European Council, "Council Directive (EEC) No. 88/388 on the Approximation of the Laws of the Member States relating to Flavourings for Use in Foodstuffs and to Source Materials for Their Production," *Official Journal of the European Communities*, Vol. 184, 1988, pp. 61-66.

[59] J. E. F. Reynolds, "Martindale, the Extra Pharmacopoeia," 30th Edition, Pharmaceutical Press, London, 1993.

[60] L. Langmead, R. M. Feakins and S. Goldthorpe, "Randomized, Doubleblind, Placebo-Controlled Trial of Oral *Aloe vera* Gel for Active Ulcerative Colitis," *Alimentary Pharmacology & Therapeutics*, Vol. 19, No. 7, 2004, pp. 739-747. http://dx.doi.org/10.1111/j.1365-2036.2004.01902.x

[61] D. R. Thomas, P. S. Goode, K. LaMaster and T. Tennyson, "Acemannan Hydrogel Dressing for Pressure Ulcers: A Randomized, Controlled Trial," *Advances in Wound Care*, Vol. 11, 1998, pp. 273-276.

[62] B. K. Vogler and E. Ernst, "*Aloe vera*: A Systematic Review of Its Clinical Effectiveness," *British Journal of General Practice*, Vol. 49, 1999, pp. 823-828.

[63] J. M. Marshall, "*Aloe vera* Gel: What Is the Evidence?" *The Pharmaceutical Journal*, Vol. 24, 1990, pp. 360-362.

[64] O.T. Baker, "The Amazing Ancient to Modern Useful Plant *Aloe vera*: Amazing Plant of the Magic Valley, R. Prevost, Lemon Grove, 1975,

[65] K. M. Nadkerni, "Indian Meteria Medica," 3rd Edition, Bombay Popular Prakashan Private Limited, Mumbai, 1976.

[66] E Ernst and A. FughBerman, "Methodological Considerations in Testing the Efficacy of Complementary/Alternative Treatments (CATs)," *The Journal of Alternative and Complementary Medicine*, Vol. 16, 1998, pp. 8-10.

[67] J. Marshall, "*Aloe vera* Gel: What Is the Evidence?" *The Pharmaceutical Journal*, Vol. 244, 2000, pp. 360-362.

[68] G. Kunkel, "Plants for Human Consumption," Koeltz Scientific Books, 1984.

[69] M. D. Boudreau and F. A. Beland, "An Evaluation of the Biological and Toxicological Properties of *Aloe barbadensis* (Miller), *Aloe vera*," *Journal of Environmental Science and Health*, Vol. 24, 2006, pp. 103-154.

[70] T. Rabe and J. Van Staden, "Antibacterial Activity of South African Plants Used for Medicinal Purposes," *Journal of Ethnopharmacology*, Vol. 56, No. 1, 1997, pp. 81-87. http://dx.doi.org/10.1016/S0378-8741(96)01515-2

[71] B. Joseph and S. J. Raj, "Pharmacognostic and Phytochemical Properties of *Aloe vera* Linn—An Overview," *International Journal of Pharmaceutical Sciences Review & Research*, Vol. 4, No. 2, 2010, pp. 106-110.

[72] Barcroft and Myskja, "*Aloe vera*: Nature's Silent Healer," BAAM, 2003.

[73] S. Sumbul, S. W. Ahmed and I. Azhar, "Anti Fungal Activity of *Allium*, *Aloe*, and *Solanum* Species," *Pharmaceutical Biology*, Vol. 42, No. 7, 2004, pp. 491-498. http://dx.doi.org/10.3109/13880200490891845

[74] M. C. Gordon and J. N. David, "Natural Product Drug Discovery in the Next Millennium," *Pharmaceutical Biology*, Vol. 39, 2001, pp. 8-17.

[75] D.B. Roberts and E. L. Travis, "Acemannan-Containing Wound Dressing Gels Reduce Radiation-Induced Skin Reactions in C_3H Mice," *International Journal of Radiation Oncology*, *Biology and Physiology*, Vol. 32, No. 4, 1995, pp. 1047-1052. http://dx.doi.org/10.1016/0360-3016(94)00467-Y

[76] Y. Sato, and S. Ohta, "Studies on Chemical Protectors against Radiation XXXI. Protective Effects of *Aloe arborescens* on Skin Injury Induced by X-Irradiation," *Yakugaku Zasshi*, Vol. 110, No. 11, 1990, pp. 876-884.

[77] S. Byeon, R. Pelley, S. E. Ullrich, T. A. Waller, C. D. Bucana and F. M. Strickland, "Aloe Barbadensis Extracts Reduce the Production of Interleukin-10 after Exposure to Ultraviolet Radiation," *Journal of Investigative Dermatology*, Vol. 110, 1988, pp. 811-817. http://dx.doi.org/10.1046/j.1523-1747.1998.00181.x

[78] M. S. Shelton, "*Aloe vera*, Its Chemical and Therapeutic Properties," *International Journal of Dermatology*, Vol. 30, No. 10, 1991, pp. 679-683. http://dx.doi.org/10.1111/j.1365-4362.1991.tb02607.x

[79] V. Visuthikosol, B. Chowchuen, Y. Sukwanarat, S. Sriurairatana and V. Boonpucknavig, "Effect of *Aloe vera* Gel to Healing of Burn Wound a Clinical and Histologic Study," *Journal of the medical Association of Thailand*, Vol. 78, No. 8, 1995, pp. 403-409.

[80] C. Bosley, J. Smith and P. Baratti, "A Phase III Trial Comparing an Anionic Phospholipidbased (APP) Cream and *Aloe vera*-Based Gel in the Prevention and Treatment of Radiation Dermatitis," *International Journal of Radiation Oncology Biology Physics*, Vol. 57, No. 2, 2003, pp. 34-38. http://dx.doi.org/10.1016/S0360-3016(03)01404-4

[81] C. P. Siegers, "Anthranoid Laxative Abuse—A Risk for Colorectal Cancer," *Gut*, Vol. 34, No. 8, 1993, pp. 1099-1101. http://dx.doi.org/10.1136/gut.34.8.1099

[82] C. P. Siegers, "Anthranoid Laxatives and Colorectal Cancer," *Trends in Pharmacological Sciences*, Vol. 13, 1992, pp. 229-231. http://dx.doi.org/10.1016/0165-6147(92)90070-M

[83] M. E. Zawahry, M. R. Hegazy and M. Helal, "Use of Aloe in Treating Leg Ulcers and Dermatoses," *International Journal of Dermatology*, Vol. 12, No. 1, 1973, pp. 68-73.

http://dx.doi.org/10.1111/j.1365-4362.1973.tb00215.x

[84] M. Tanaka, *et al*., "Identification of Five Phytosterols from *Aloe vera* Gel as Antidiabetic Compounds," *Biological and Pharmaceutical Bulletin*, Vol. 29, No. 7, 2006, pp. 1418-1422. http://dx.doi.org/10.1248/bpb.29.1418

[85] A. Yagi, Y. Sato, Y. Miwa, A. Kabbash, S. Moustafa, K. Shimomura and A. El-Bassuony, "Ribosomal DNA Sequence Analysis of Different Geographically Distributed *Aloe vera* Plants: Comparison with Clonally Regenerated Plants," *Saudi Pharmaceutical Journal*, Vol. 14, No. 3-4, 2006, pp. 208-211.

[86] A., Noor, S., Gunasekaran, A. S. Manickam and M. A. Vijayalakshmi, "Antidiabetic Activity of *Aloe vera* and Histology of Organs in Streptozotocin-Induced Diabetic Rats," *Current Science*, Vol. 94, No. 8, 2008, pp. 1070-1076.

[87] A. K. Chaurasia, S. O. Dubey and J. K. Ojha, "Role of Vijaysara and Jarul on Insulin Dependent Diabetes Mellitus," *Aryavaidyan*, Vol. 7, No. 3, 1994, pp. 147-152.

[88] S. K. Mitra, S. Gopumadhavan and T. S. Muralidhar, "Effect of D-400 an Ayurvedic Herbal Formulation on Experimentally Induced Diabetes Mellitus," *Phytotherapy Research*, Vol. 10, No. 5, 1996, pp. 433-435.

[89] O. P. Upadhyay, R. M. Singh and K. Dutta, "Studies on Antidiabetic Medicinal Plants Used in Indian Folklore," *Aryavaidyan*, Vol. 9, No. 3, 1996, pp. 159-167.

[90] S. Arokiyaraj, R. S. Radha, S. Martin and K. Perinbam, "Phytochemical Analysis and anti-diabetic Activity of Cadaba Fruticosa. R. Br.," *Indian Journal of Science and Technology*, Vol. 1, No. 6, 2008, pp. 1-4.

[91] K. M. Ramanathan and K. K. Krishnamoorthy, "Nutrient Uptake by Paddy during the Main Three Stages of Growth," *Plant Soil*, Vol. 39, No. 1, 1973, pp. 29-33. http://dx.doi.org/10.1007/BF00018042

[92] F. M. Al-Awadi and K. A. Gumaa, "Studies on the Activity of Individual Plants of an Antidiabetic Plant Mixture," *Acta Diabetologica Latina*, Vol. 24, No. 1, 1987, pp. 37-41. http://dx.doi.org/10.1007/BF02732051

[93] N. Ghannam, M. Kingston, I. A. Al-Meshaal, M. Tariq, N. S. Parman and N. Woodhouse, "The Antidiabetic Activity of Aloes: Preliminary Clinical and Experimental Observations," *Hormone Research*, Vol. 24, No. 4, 1986, pp. 286-294. http://dx.doi.org/10.1159/000180569

[94] F. Furukawa, A. Nishikawa, T. Chihara, K. Shimpo and H. Beppu, "Inactivation of Enveloped Viruses by Anthraquinones Extracted from Plants," *Antimicrobial Agents and Chemotherapy*, Vol. 35, No. 12, 1991, pp. 2463-2466. http://dx.doi.org/10.1128/AAC.35.12.2463

[95] E. Fenig, J. Nordenberg, E. Beery, J. Sulkes and L. Wasserman, "Combined Effect of Aloe-Emodin and Chemotherapeutic Agents on the Proliferation of an Adherent Variant Cell Line of Merkel Cell Carcinoma," *Oncology Reports*, Vol. 11, No. 1, 2004, pp. 213-217.

[96] R. H. Thomson, "Naturally Occurring Quinines," 2nd Edition, Academy Press, London, 1971.

[97] P. L. Saroj, D. G. Dhandar and R. S. Singh, "Indian Aloe," Central Institute for Arid Horticulture, Bikaner, 2004.

[98] S. Foster, "*Aloe vera:* The Succulent with Skin Soothing Cell Protecting Properties," *Herbs for Health Magazine*, 1999. http://www.healthy.net/library/articles/hfh/Aloe.htm

[99] H. A. El-Shemy, M. A. Aboul-Soud, A. A. Nassr-Allah, K. M. Aboul-Enein, A. Kabash and A. Yagi, "Antitumor Properties and Modulation of Antioxidant Enzymes' Activity by *Aloe vera* Leaf Active Principles Isolated via Supercritical Carbon Dioxide Extraction," *Current Medicinal Chemistry*, Vol. 17, No. 2, 2010, pp. 129-138. http://dx.doi.org/10.2174/092986710790112620

[100] U. Beuers, U. Spengler and G.R. Pape, "Hepatitis after Chronic Abuse of Senna," *Lancet*, Vol. 337, No. 8737, 1991, p. 472. http://dx.doi.org/10.1016/0140-6736(91)91012-J

[101] S. A. Muller-Lissner, "Adverse Effects of Laxatives: Facts and Fiction," *Pharmacology*, Vol. 47, Suppl. 1, 1993, pp. 138-145. http://dx.doi.org/10.1159/000139853

[102] E. W. Godding, "Therapeutics of Laxative Agents with Special Reference to the Anthraquinones," *Pharmacology*, Vol. 14, No. 1, 1976, pp. 78-101. http://dx.doi.org/10.1159/000136688

[103] M. D. Rockville, "United States Pharmacopeia, Drug Information," United States Pharmacopeial Convention, 1992.

[104] W. D. Heizer, *et al*., "Protein-Losing Gastroenteropathy and Malabsorption Associated with Factitious Diarrhea," *Annals of Internal Medicine*, 1968, Vol. 68, No. 4, pp. 839-852. http://dx.doi.org/10.7326/0003-4819-68-4-839

[105] A. G. Gilman, A. S. Nies and T. W. Rall, "Goodman and Gilman's the Pharmacological Basis of Therapeutics," 8th Edition, McGraw Hill, New York, 1990.

[106] N. G. Bisset, "*Sennae folium*. Max Wichtl's Herbal Drugs & Phytopharmaceuticals," CRC Press, Boca Raton, 1994.

[107] A. Noor, S. Gunasekaran, A. Manickam and M. A. Vijayalakshmi, "Antidiabetic Activity of *Aloe vera* and Histology of Organs in Streptozotocin Induced Diabetic Rats," *Current Science*, Vol. 94, 2008, pp. 1070-1076.

[108] S. Rajasekaran, K. Sivagnanam, K. Ravi, and S. Subramanian, "Hypoglycemic Effect of *Aloe vera* Gel on Streptozotocin-Induced Diabetes in Experimental Rats," *Journal of Medicinal Food*, Vol. 7, No. 1, 2004, pp. 61-66. http://dx.doi.org/10.1089/109662004322984725

[109] A. Gupta, J. Sethi, S. Sood, K. Dahiya, G. Singh, and R. Gupta, "Evaluation of Hypoglycemic and Anti-Atherogenic Effect of *Aloe vera* in Diabetes Mellitus," *Pharmacie Globale* (IJCP), Vol. 8, 2011, pp. 1-4.

[110] A. O. Azghani, I. Williams, D. B. Holiday and A. R. Johnson "A Beta-Linked Mannan Inhibits Adherence of *Pseudomonas aeruginosa* to Human Lung Epithelial Cells," *Glycobiology*, Vol. 5, No. 1, 1995, pp. 39-44. http://dx.doi.org/10.1093/glycob/5.1.39

[111] L. M. Cera, J. P. Heggers, M. C. Robson and W. J. Hagstrom, "The Therapeutic Efficacy of *Aloe vera* Cream (Dermaide Aloe) in Thermal Injuries. Two Case Reports," *Journal of the American Animal Hospital Association*, Vol. 16, 1980, pp. 768-772.

[112] J. P. Heggers, G. R. Pineless and M. C. Robson, "Der-

maide Aloe/*Aloe vera* Gel: Comparison of the Antimicrobial Effects," *The American Journal of Medical Technology*, Vol. 41, 1979, pp. 293-294.

[113] R. H. Davis, "*Aloe vera*: A Scientific Approach," Vantage Press Inc., New York, 1997.

[114] R. H. Davis, J. M. Kabbani and N. P. Maro, "*Aloe vera* and Wound Healing," *Journal of the American Podiatric Medical Association*, Vol. 77, No. 4, 1987, pp. 165-169.

[115] R. H. Davis, M. G. Leitner and J. M. Russo, "*Aloe vera*. A Natural Approach for Treating Wounds, Edema, and Pain in Diabetes," *Journal of the American Podiatric Medical Association*, Vol. 78, No. 2, 1988, pp. 60-68.

[116] T. Kaufman, A. R. Newman and M. R. Wexler, "*Aloe vera* and Burn Wound Healing," *Plastic and Reconstructive Surgery*, Vol. 83, No. 6, 1989, pp. 1075-1076. http://dx.doi.org/10.1097/00006534-198906000-00037

[117] N., Pugh, S. A. Ross, M. A. ElSohly and D. S. Pasco, "Characterization of Aloeride, a New High-Molecular-Weight Polysaccharide from *Aloe vera* with Potent Immunostimulatory Activity," *Journal of Agricultural and Food Chemistry*, Vol. 49, No. 2, 2001, pp. 1030-1034. http://dx.doi.org/10.1021/jf001036d

[118] B. K. Tan and J. Vanitha, "Immunomodulatory and Antimicrobial Effects of Some Traditional Chinese Medicinal Herbs: A Review," *Current Medicinal Chemistry*, Vol. 11, No. 11, 2004, pp. 1423-1430. http://dx.doi.org/10.2174/0929867043365161

[119] M. C. Robson, J. P. Heggers and W. J. Hagstrom, "Myth, Magic, Witchcraft or Fact? *Aloe vera* Revisited," *Journal of Burn Care & Research*, Vol. 3, No. 3, 1982, pp. 157-163. http://dx.doi.org/10.1097/00004630-198205000-00005

[120] J. P. Heggers, A. Kucukcelibi, C. J. Stabenou, F. Ko, L. D. Broemeling, M. C. Robson and W. D. Winters, "Wound Healing Effects of Aloe Gel and Other Topical Antibacterial Agents in Rat Skin," *Phytotherapy Research*, Vol. 9, No. 6, 1995, pp. 455-457. http://dx.doi.org/10.1002/ptr.2650090615

[121] R. M. Mariita, J. A. Orodho, P. O. Okemo, C. Kirimuhuzya, J. N. Otieno and J. J. Magadula, "Methanolic Extracts of Aloe Secundiflora Engl. Inhibits *in Vitro* Growth of Tuberculosis and Diarrhea-Causing Bacteria," *Pharmacognosy Research*, Vol. 3, No. 2, 2011, pp. 95-99.

[122] M. C. Kemp, J. B. Kahlon, A. D. Chinnah, R. H. Carpenter, B. H. McAnalley, H. R. McDaniel and W. M. Shannon, "*In Vitro* Evaluation of the Antiviral Effects of Acemannan on the Replication and Pathogenesis of HIV-1 and Other Enveloped Viruses: Modification of the Processing of Glycoprotein Glycoprotein Precursors," *Antiviral Res*, Vol. 13, Suppl. 1, 1990, p. 83. http://dx.doi.org/10.1016/0166-3542(90)90156-2

[123] K. Saoo, H. Miki, M. Ohmori and W. D. Winters, "Antiviral Activity of Aloe Extracts against Cytomegalovirus," *Phytotherapy Research*, Vol. 10, No. 4, 1990, pp. 348-350. http://dx.doi.org/10.1002/(SICI)1099-1573(199606)10:4<348::AID-PTR836>3.0.CO;2-2

[124] R. J. Sydiskis, D. G. Owen, J. L. Lohr, K. H. Rosler and R. N. Blomster, "Inactivation of Enveloped Viruses by Anthraquinones Extracted from Plants," *Antimicrobial Agents and Chemotherapy*, Vol. 35, No. 12, 1991, pp. 2463-2466. http://dx.doi.org/10.1128/AAC.35.12.2463

[125] M. Cheesbrough "Medical Laboratory Manual for Tropical Countries," The University Press, Cambridge, 1984.

[126] D. J. de Rodríguez, D. Hernández-Castillo, R. Rodríguez-García and J. L. Angulo-Sanchez, "Antifungal Activity *in Vitro* of *Aloe vera* Pulp and Liquid Fraction against Plant Pathogenic Fungi," *Industrial Crops and Products*, Vol. 21, No. 1, 2005, pp. 81-87. http://dx.doi.org/10.1016/j.indcrop.2004.01.002

[127] C. A. Newall, L. A. Anderson and J. D. Phillipson, "Herbal Medicines. A Guide for Health-Care Professionals," The Pharmaceutical Press, London, 1996.

[128] V.A. Ferro, F. Bradbury, P. Cameron, E. Shakir, S. R. Rahman and W. H. Stimson, "*In Vitro* Susceptibilities of *Shigella flexneri* and *Streptococcus pyogenes* to Inner Gel of *Aloe barbadensis* Miller," *Antimicrobial Agents and Chemotherapy*, Vol. 47, No. 3, 2003, pp. 1137-1139. http://dx.doi.org/10.1128/AAC.47.3.1137-1139.2003

[129] O. O. Agarry, M. T. Olaleye and C. O. Bello-Michael, "Comparative Antimicrobial Activities of *Aloe vera* Gel and Leaf," *African Journal of Biotechnology*, Vol. 4, No. 12, 2005, pp. 1413-1414.

[130] S. Satish, K. A. Raveesha and G. R. Janardhana, "Antibacterial Activity of Plant Extracts on Phytopathogenic Xanthomonas Campestris Pathovars," *Letters in Applied Microbiology*, Vol. 28, No. 2, 1999, pp. 145-147. http://dx.doi.org/10.1046/j.1365-2672.1999.00479.x

[131] M. Serrano, J. M. Valverde, F. Guillén, S. Castillo, D. Martínez-Romero and D. Valero, "Use of *Aloe vera* Gel Coating Preserves the Functional Properties of Table Grapes," *Journal of Agricultural and Food Chemistry*, Vol. 54, No. 11, 2006, pp. 3882-3886. http://dx.doi.org/10.1021/jf060168p

[132] Anonymous, "Taxon: *Aloe vera* (L) Burm," Germplasm Resources Information Network, United States Department of Agriculture, 2008. http://www.ars-grin.gov/cgibin

[133] A. Peter, "*Aloe vera* Myth or Medicine?" Positive Health Publications, 2002. http://www.positivehealth.com/permit/Articles/Aloe%20Vera/atherton.htm