

Aloe vera: A Multipurpose Plant, A review

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Abstract

Aloe vera is a widely recognized succulent plant, constitutes more than 75 physiologically active phytochemicals owing to its extensive range of advantages. The inner gel of the leaves contributes a variety of biological traits, including antibacterial and antimicrobial properties. It possesses a number of health benefits because of its antidiabetic, anticancer, and antioxidant features. It has also been recommended for gastrointestinal issues, immune system inadequacies, acne and rash treatment, and wound healing. It is also utilized as a waste adsorbent for the removal of contaminants. It is extremely popular in the cosmetic sector due to its numerous advantages. It is extensively used in cosmetic products like cleansers, shampoos, soaps, and moisturizing creams. It also has a variety of uses in the food business, including dietary supplements, food preservatives, beverages, confectionary and dairy. Because of its diverse applications, its global market is expanding day by day. Given the widespread interest that people from various nations have exhibited in aloe vera's therapeutic benefits and commercial applications, it is worthwhile to review the plant's active ingredients and clinical efficacy.

Keywords: Phytochemicals, medicinal plant, health benefits, biological activities, pollutant removal, food properties, cosmetics.

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1. Introduction

Medicinal plants have a number of useful applications worldwide [1-2]. Aloe vera, or *Aloe barbadensis* Miller, is one of the more than 400 species of aloe that are native to South Africa and are members of the Liliaceae family. Only a few kinds of aloe have recently been given economic consideration, aloe vera is thought to be the most potent of these species, making it the most well-liked plant in the scientific community. Aloe vera is used in the food industry and is also used as a waste adsorbent for the removal of pollutants such as fluoride and dyes. For over two centuries, aloe vera has been utilized in folk medicine [3]. It continues to play a significant role in the traditional medical practices of many modern countries. The plant aloe vera is succulent. The succulents are classified as xerophytes, which are defined by having a large water storage tissue and being designed to live in environments with limited water availability. The high water content of aloe vera plants, ranging from 99 to 99.5%, is its primary characteristic. Close up view of an aloe vera leaf is shown in Figure 1. It has been discovered that the remaining 0.5–1.0% solid material contains about 75 different potentially active substances, such as organic acids, minerals, enzymes, water and fat-soluble vitamins, and complex and simple polysaccharides. Research on compositional analysis of the structural components of

leaf sections from Aloe vera plants indicates that the pulp comprises 70–80% of the overall leaf weight, while the rind accounts for 20–30%. The percentages of the pulp and rind that were lipids were 2.7% and 4.2%, respectively and proteins only made up a small portion of the dry weight. The bulk of leaf fractions were made up of lignin and polysaccharides, which accounted for 62.3% and 57.6% of the dry weight of the pulp and rind, respectively [4]. The linear chains of glucose and mannose molecules that make up aloe vera gel are called polymannans because mannose is more abundant than glucose. These are linear chains with few a thousand molecules to several thousand molecules in length. One or more polymers with different chain lengths make up the main polysaccharide, acemannan.

Aloe vera has been farmed primarily for the pharmaceutical business in western cultures, particularly in the USA, where the latex component of the leaf is needed. But in the past ten years, a number of Aloe species have become more well-known as medicinal plants, and as a result, a sizable industry has sprung up around Aloe Vera's biological qualities. Numerous researchers have made an effort to determine the active ingredients in aloe vera gel. The polysaccharides present in the inner leaf and parenchymatous tissue have been linked to a number of the therapeutic

benefits of aloe vera leaf extracts. It is thought that rather than being attributed to a single chemical component, these biological activities should be attributed to the synergistic action of the chemicals included therein. Numerous Aloe species extracts have been traditionally applied to treat burns, eczema, psoriasis, arthritis, skin cancer, wound healing, bacterial infections, viral infections, digestive issues, high blood pressure, and diabetes. The polysaccharides in the pulp of this plant have been linked to numerous health benefits. The transparent pulp, commonly referred to as gel, finds extensive usage in diverse medicinal, cosmetic, and nutraceutical fields. Higher levels of antioxidant activity have been found in its rind, according to studies. Eczema, burns, and other skin problems have all been treated externally with aloe vera.

The two main substances among the anthraquinone compounds found naturally in the aloe vera plant are chrysophanol and aloe emodin. The three most significant secondary metabolites in Aloe vera gel are aloin, aloesin, and aloe-emodin, which are responsible for strong antioxidant, lipid-lowering, and anti-inflammatory properties [5]. Yet, there are no publications that fully explain all of the secondary metabolites that are found in plant species. Additionally, in the inner gel more than seventy five active ingredients have been found. There are various benefits of the aloe vera plant, as shown in Figure 2. The polysaccharides contained in aloe leaves have been linked to many health benefits and these health benefits are linked to the combined effects of multiple chemicals present in aloe vera rather than just one [5]. Due to its diverse applications, the global market share of aloe vera, aloe gel, and its products is increasing day by day, as shown in Figure 3.

2. Chemical Composition

There are three main layers to an aloe vera leaf. The 15–20 cells that make up the thick outer layer, or rind, are responsible for producing proteins and carbohydrates. Vascular bundles like phloem and xylem are found inside the rind. Xylem aids in the movement of water, but sucrose and other tiny organic molecules are transported by phloem. Bitter yellow sap with glycosides and anthraquinones can be found in the intermediate layer. The gel that makes up the innermost layer is 99% water, with the remaining layer consisting of lipids, sterols, amino acids, and other substances. Information about many chemicals found in Aloe vera with their biological activities is provided in table 1 [5].

3. Uses/applications

3.1. Healing effects of burn injuries

Aloe vera is referred to a plant that heals. In numerous cultures, traditional remedies have included using aloe vera as a medical treatment. The extracts of aloe vera are used in vitro to encourage the division of various types of cells. According to numerous studies, using complete Aloe vera gel extracts as a treatment speeds up the process of wound healing [6]. A faster rate of wound area shrinking

suggests that aloe vera may have a direct effect on the overall healing process. Aloe vera has also been demonstrated to support wound healing and collagen formation. Mannose-6-phosphate, which can be found in aloe vera gel, is assumed to be the cause of this healing characteristic [7]. Fibroblast synthesis of hydroxyproline and hyaluronic acid, which is crucial for reconstructing the extracellular matrix in the process of wound healing, is stimulated by polysaccharides that are present in aloe vera [8]. Aloe vera-treated patients healed their burn wounds remarkably sooner than other untreated patients [9]. The expression of the genes for metalloproteinase inhibitor-2 and matrix metalloproteinase (MMP)-3 is induced by Aloe vera polysaccharides during the repair of rat skin wounds, and this directly influences how well Aloe vera gel heals wounds [10].

3.2. Antidiabetic effect

Clinical research suggests that aloe vera gel can be used safely to treat type 2 diabetics without adversely impacting other normal blood lipid levels or the function of liver or kidney [11]. Studies done in vivo and in vitro demonstrate clearly that the water soluble fraction of aloe vera can lower blood sugar levels and that some of its components can change the expression of the glucose transporter mRNA [12]. Additionally, another trial found that two Aloe products used for eight weeks by prediabetic individuals tend to cure the prediabetes and improve glucose tolerance conditions. According to one study, aloemodin-8-O-glycoside, a compound found in the gel of aloe vera, can improve glucose transport and glycogen synthesis. When a diabetic mouse is given identical phytosterols from the gel of aloe vera over an extended period of time, glucose level decreases when comparing random and fasting blood glucose readings. Aloe vera gel has potent anti-diabetic and cardioprotective qualities because it greatly decreased oxidative stress in streptozocin-induced diabetic rats and enhanced antioxidant status [13]. According to a recent study, obese people can lower their body weight, body fat mass, fasting blood sugar, and fasting serum insulin levels with the help of aloe vera gel which improve metabolic parameters in obese prediabetes and early untreated diabetic patients. This help to improve carbohydrate metabolism. Aloe vera has also been demonstrated to enhance the Insulin levels in body [14].

3.3. Anti-aging effect

The synthesis of elastin fibers and collagen by aloe vera has been proven in a study to make much more elastic and wrinkle-free skin [15]. Aloe vera extract aids in the body's natural increase in collagen formation, which further aids in minimizing the appearance of wrinkles and other indications of aging. Collagen assists in skin tightening and wrinkle reduction. Additionally, it makes the skin more elastic. Aloe vera helps to lighten and get smooth skin. Its moisturizing qualities aid in skin hydration, while its antioxidants aid in preventing free radical damage. The end effect is skin that is younger-looking, more even in tone, and brighter [16].

3.4. Antioxidant effect

Many vitamins and amino acids are found in the mucilage, which is a viscous fluid found in aloe vera. Vitamins A, C, and E present in particular antioxidant substances also aid in removing harmful oxidizing agents and also carcinogens [17-18]. Some of the numerous antioxidants present in aloe vera include Carotenoids, ascorbic acid (vitamin C), flavonoids, tannins, and α -tocopherol (vitamin E). Aloe vera has antioxidant effects due to the antioxidants present in it. The free radicals 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2,20-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid), and nitric oxide may all be neutralized by aloe gel in a concentration-dependent manner, according to an in vitro investigation on the radioprotective characteristics of aloe vera gel [19].

The application of aloe vera gel to tissue results in a drop in blood sugar levels, resulting in the reduction of excessive production of free radicals through multiple biochemical pathways [20]. The ability of a polysaccharide to act as an antioxidant derived from the gel of aloe vera was studied in vitro and in vivo. Carbohydrases and proteases, among other digestive enzymes, were included in enzyme extract of aloe vera gel which reduces oxidative stress and cell death brought on by dihydrochloride and is protected by Aloe polysaccharides [21]. The phenolic content had antioxidant properties. The total phenolic content of leaf extracts of aloe vera was determined in a study [20]. Both the antioxidant and antimycoplasmic qualities of floral methanol extracts of aloe vera were examined. Both showed the antioxidant performance of aloe vera leaf extract in vitro tests [22].

3.5. Anti cancer activity

Aloe vera gel contains substances that stop malignant tumors from growing. According to research, Acemannan, a polysaccharide prevent production of DNA adducts from benzopyrene that cause cancer. Two polysaccharides from aloe vera, AVP and PAC-I, were discovered to exhibit antitumor action [5]. In order to counteract the effects of phorbol myristic acetate that cause tumors during chemotherapy, the gel of aloe vera aids in the activation of glutathione S-transferase. Clinical evidence shows that the plant's emodin has effect an on aggressive cancer cells [23]. Apoptosis eventually occurs as a result of aloin's alteration of a system relying on mitochondria to powers cell division, which also suppresses cancer cells. UVB radiation induces nuclear factor kappa B and nitric oxide synthase production in HaCat cells have been demonstrated to be protected by aloin, according to a study. By reducing UVB exposure causes the expression of nitric oxide synthase and mRNA, aloin suppresses the action of kappa B nuclear factor P65 [24]. Aloe emodin exhibits repeatable antitumor effects, which are more pronounced in cell lines that overexpress P-glycoprotein [25]. Acemannan has a potent anti-cancer effect. Acemannan induces macrophages to produce more TNF (Tumor Necrosis Factor), IgE antibodies, and Interleukin-1, which in turn renders cells of cancer inactive. Vascular Endothelial Growth Factor (VEGF) release in cells effected with cancer can be reduced

by aloin. VEGF is a proangiogenic cytokine that stimulates the neovascularization of tumors. By preventing endothelial cell proliferation and migration, aloin aids in the inhibition of the human endothelial cells' in vitro angiogenic response to VEGF [26].

3.6. Antihyperlipidemic activity

Aloe vera plant is renowned for its antihyperlipidemic activity, this aids in preventing the development of fatty streaks and also lessens the development of atherosclerosis by modifying risk factor [11]. In a clinical trial, the effectiveness of leaf gel of aloe vera was evaluated with type 2 diabetes patients with hyperlipidemia [11]. Total LDL(low-density lipoprotein) and cholesterol levels were markedly lowered. In high-fat diet and fructose-induced hyperlipidemic rats, the dried pulp of Aloe leaves markedly reduced total cholesterol levels in blood, total triglycerides, LDL cholesterol, very low-density lipoprotein cholesterol, and high-density lipoprotein cholesterol. [27]. Previous studies also suggested that Rats given aloe vera treatment for Polycystic Ovarian Syndrome (PCOS) showed a significant decrease in LDL cholesterol and plasma triglyceride levels increased along with HDL cholesterol levels. Hyperlipidemia is one among the major effects of PCOS. Additionally, the gel treatment led to return of abnormal Estrous cyclicity, glucose intolerance, and enzyme activity involved in fat metabolism. It contains phytochemicals that have antihyperlipidemic properties and has shown effective in managing PCOS as well as the related metabolic problems [28].

3.7. Antiviral activity

According to numerous investigations, aloe vera gel contains antiviral properties that stop viruses from adhering to surfaces or entering host cells. The type 2 strain of the herpes simplex virus has been demonstrated to be resistant to the crude extract of gel of aloe vera, according to an in vitro investigation. According to reports, Chrysophanol, emodin, and Aloe-emodin are examples of anthraquinone derivatives, have antiviral properties that include lowering the cytopathic effects of the influenza virus and preventing its replication [29]. Consuming aloe vera may benefit HIV-positive people since it boosts the immune system by raising CD4 counts [30]. Numerous techniques have been created to successfully alter and regenerate aloe vera, allowing Aloe vera to produce the IFN α 2 protein. Using A549 cells (adenocarcinomic human alveolar basal epithelial cells) that have been treated with rind and pulp extracts of portions of aloe vera shoot and then the lytic encephalomyocarditis virus, the success of this experiment against viruses was evaluated. The experiment showed that aloe vera is able to produce interferon alpha 2 (IFN α 2) protein, that is a biologically active human protein which shows antiviral effect [31].

3.8. Intestinal absorption

Aloe material is utilized to improve drug absorption for pharmaceuticals whose wide efflux results in low bioavailability [32]. The probiotics derived from aloe leaf strains of *Lactobacillus brevis* exhibit resistance to a variety

of antibiotics [21]. The majority of healthy commensals in the gut were not hindered by these strains, which were identified from organically fermented aloe vera gel, which prevented the formation of several hazardous enteropathogens. Five phytosterols found in aloe vera gel have been demonstrated to have the ability to lessen the buildup of visceral fat, alter the breakdown of lipids and glucose, diminish big intestinal polyps and improve plasma reduction in animal model trials. Animals on a high-fat diet with adenomatous polyposis coli gene deficiency and numerous intestinal neoplasia had high levels of adiponectin with a high molecular weight. Whole leaf extract with aloe vera gel were also capable to considerably lower the Caco-2 cell monolayers trans-epithelial electrical resistance, which demonstrated the capacity of neighboring cells to open tight junctions. This was demonstrated in an in vitro investigation. As a result, the transport of insulin across the monolayers of Caco-2 cells was greatly improved by the gel of aloe vera and all the solutions of leaf extract [33].

3.9. Aloe vera waste-adsorbents for elimination of other pollutants

a. Dyes removal

Researchers investigated the elimination of the dye methylene blue from aqueous media using activated carbon made from aloe vera. At pH 12, the best capacity for adsorption was observed which is 22.98 mg/g. The adsorbent dose rose with a reduction in adsorption capacity of 1 to 10 g/L, and the average was discovered at 1 g/L. The adsorption proceeded quickly and equilibrium reached after 40 minutes. Langmuir isotherm's q_{\max} was measured to be 129.87 mg/g. The result is reasonable, particularly when you consider the low activation temperature. However, carbons obtained from many additional agriculture waste sources (such as tea seeds, cashew nut shells, corncobs, nut shells of pecans, etc.) demonstrated more effective removal performance [34]. In order to separate Congo red dye, Khaniabadi explored the use of activated carbon made from the leaf shell of aloe vera [35]. Activated carbon SEM results revealed that the cavities in the adsorbent were irregularly connected by tiny open pores. After adsorption, larger pores, a normal surface and a smoother configuration was created. The pH increase (from 2 to 12) and the increase in adsorbent dosage (0.5 to 2 g/L) both had a detrimental effect on the dye uptake. Researchers investigated the ability of acid activated carbon made from Aloe barbadensis to bind to congo red, malachite green, rhodamine B, and rose Bengal. Batch equilibrium experiments were used in their research to examine the effects of the pH, temperature, starting dye concentration, and contact time. Estimates put the zero-charge point at 6.7. The adsorption mechanism appeared to be significantly influenced by pH. Acid (anion) dyes like congo red and rose Bengal, show most adsorption at pH 3, while basic (cationic) dyes such as malachite green and rhodamine B, show most adsorption at pH 10. The dye removal procedure involved both intra-particle diffusion and surface adsorption. Various desorption eluents (including water, nitric acid, sulfuric acid, and hydrochloric acid) were used in desorption tests, it is shown that 0.2 M HCl provided a desorption rate that is the greatest with more than 65% of adsorbed dyes, reactive blue

and reactive red were investigated to be adsorbable by aloe vera plant ash [36]. We went into great detail on the effects of pH (3-12), adsorbent dosage (0.1-1 g/L), contact period (10-60 min), starting dye concentration (10-160 mg/L), and temperature (25-55 °C). Both reactive blue and reactive red dyes demonstrate their maximum removal capability (50 mg/g) at pH 3, 20 min of contact time, 0.4 g/L of adsorbent dose, 60 mg/L of initial concentration, and 55 °C of temperature.

b. Fluoride removal

Researchers investigated the elimination of fluoride using a combination of CaCl₂ and the gel portion of Aloe vera leaves. The optimum removal was determined to be 88% at pH 7.4 using 40 g of juice obtained from aloe vera, 3 g of CaCl₂ in 1000 mL of sample, and 40 minutes of contact time. Additionally, it was investigated that if Aloe vera absorb fluoride ions. At pH 7, 10 mg/50 mL of adsorbent (examined range: 10 to 200 mg / 50 mL), one hour contact time (range: 10 min to one hour), also 120 revolution per min speed (study choice: 100 to 300 revolutions per min), greatest absorption efficiency (40 mg/g) was observed. The removal of fluoride was adversely affected by the presence of phosphate ions and was not adversely impacted by the existence of carbonate, chloride, or sulphate ions. On the other hand, the existence of the nitrate ion had a favorable effect on the adsorption of fluoride. Murugan and Subramanian also used aloe vera plant material to absorb fluoride. Maximum fluoride adsorption was seen at a pH about 7, and the pH of the adsorbent at its zero charge point was 7.43. The Adsorption equilibrium was reached in less than 60 minutes, and temperature had a detrimental impact on adsorption capacity. More specifically, a decline in removal ability was brought on by a temperature increase from 20 to 50 °C.

According to researchers, one possibility is that at high temperatures, the adsorbent biomass degraded and lost some of its surface activity, and bond rupture may have partially destroyed the active sites [37]. The elimination process was spontaneous and endothermic, respectively, according to negative values of H_0 and G_0 . The adsorbent's negative S_0 value suggested that there was less unpredictability where solids and liquids meet. The absorption of aniline and 4-chlorophenol was investigated by Khaniabadi in 2015 and showed the utilization of activated carbon made from discarded aloe vera that is to sequester an aqueous solution of 4-chlorophenol. In the analyzed pH range of 2 to 8, after the examined contact time range of 0 to 100 minutes, maximum adsorption was attained at pH 2, and equilibrium was established after 40 minutes. The adsorption capacity fell as the adsorbent dosage rose from 1 g/L to 9 g/L, making 1 g/L the ideal dose. To assess their capacity to remove aniline, activated carbon made from aloe vera leaves was treated with sulfuric acid. The material generated by using sulfuric acid as a modification agent has incredibly uniform holes, indicating a smoother surface and a larger surface area, according to SEM photographs. Results from SEM-EDX analysis on different samples revealed that sulfuric acid modified carbon (activated) resulted in a considerable drop in oxygen percentage (from 43.82% to 28.30%) and sulfur percentage (24.07%-17.9%), as well as an

increase in calcium percentage (27.98%-29.82%) and manganese percentage (3.66%-13.18%). At pH ranges of 3–11, 1 to 5 g/L of adsorbent to solution ratio and 0 to 90 minutes of contact time, investigated were the impact of contact duration, adsorbent dose, and pH on the adsorption process. The ideal conditions included a pH of 3.0, a dosage of equilibrium and 1 g/L of adsorbent being established after 60 minutes of contact. Sulfuric acid was discovered to enhance the ability to absorb substances.

3.10. Using Aloe Vera Gel for Electronic Devices

Electronic waste disposal is a serious issue in today's technological era. Electronic trash originates from the use of information technology, yet when we examine our houses, we will find a lot of electrical items. After their useful life, dumping them in landfills becomes an environmental and health problem because harmful waste of metals leach into the land, sea, and air. There were initiatives to repurpose, recycle, and resell outdated electronic devices. However, these actions alone cannot resolve the electronic waste issue. We need better solutions for the Earth and its people. The challenge is that electronic devices are mostly composed of inorganic components that are not biodegradable. They can remain in the environment for a long period. The inorganic raw ingredients are the primary cause of the electronic waste problem. They are increasing but the area available for their disposal is decreasing as available land is converted into houses and farmland. Thus, the organic electronics field has expanded, with organic materials being used to create organic light-emitting devices, field-effect transistors and organic field-effect transistors. Natural organic materials such as hibiscus leaf, potato tissues, apple leaf and aloe vera have been employed as layers of dielectric [38]. Since it has been shown to have exceptional insulating properties. Aloe vera layer has a dielectric constant of around 3.4 and it functions as an active layer in electrical devices and is affordable, easy to manufacture [39]. Researchers discovered that Aloe vera gel is made entirely of organic particles, regardless of whether it contains any foreign inorganic elements. The characteristics of aloe gel were calculated using the X-ray diffraction technique. The aluminum layer thickness was 9720 nm, whereas the thickness of the Aloe vera gel layer was about 33.2 nm. The study discovered that Aloe vera might be used in place of SiO₂. The aloe vera layer had a resistivity of 2.5 W, while the aluminum layer had a resistance of 2 W. It was discovered that the aloe vera layer's resistance was quite comparable to that of other dielectric materials. The findings revealed that Aloe vera has outstanding dielectric characteristics. Using SiO₂ nanoparticles and natural aloe vera paste as gate dielectrics, together with a 100 nm thick layer of aluminum for the gate electrodes, an n-type Organic Field Effect Transistors (OFETs) was produced on a glass substrate. OFETs are widely employed in flexible electronics. It has been proposed to employ OFETs on a textile substrate, with several configurations investigated. To create wearable OFETs, such devices are first fabricated on flexible substrates that may be readily removed, and then transferred to a textile substrate. The devices were then adapted to wearables (such as gloves and belts) and employed as sensors to measure physiological characteristics of body functioning [40].

3.11. Veterinary medicine

Aloe vera has been incorporated into pet food as a useful food item. In the context of a well-balanced diet, clinical investigations on dogs and cats demonstrated that using aloe vera and other bioactive substances had a number of health benefits. More precisely, Aloe vera consumption improved the health of the eyes by lowering tear and mucus production and corneal keratinization, as well as by reducing oxidative imbalance and improving biochemical markers that are closely related to a pet's wellbeing [41]. According to the study, Aloe vera that's been fermented has been suggested as an alternate method of feeding for livestock [42].

3.12. Anti-inflammatory properties

It has been discovered that the aloe vera plant possesses anti-inflammatory effects. According to research, it inhibits histamine and leukotriene released by mast cells and triggers macrophage nitric oxide and cytokine release. To reduce pain, Prostaglandin E2 (PGE2) is decreased via the cyclooxygenase pathway and metabolizes bradykinin, is likewise inhibited by aloe vera. Tumor Necrosis Factor (TNF) and leukocyte adherence are decreased, which prevents the inflammatory process from continuing. Each pathway interacts with the immune system and is ultimately responsible for Aloe vera's anti-inflammatory properties. The plant also includes inflammatory reduction fatty acids like LDL and HDL cholesterol, which help in the treatment of a number of immune system illnesses.

3.13. Wound Healing

The benefits of aloe vera are numerous, as was already noted. Wound healing is accelerated by the anti-inflammatory, antioxidant, and antibacterial qualities together. Aloe vera has long been valued for its capacity to repair skin exposed to ultraviolet and gamma rays. Aloe vera has been utilized for thousands of years by many different civilizations, but recently it has been demonstrated to be a therapeutic assistance in healing. Most significantly, aloe vera includes elements that support cell regeneration, as well as vitamins, carbohydrates, lignin, minerals, salicylic acids, saponins, amino acids, anthraquinones, enzymes, and minerals are present in it. Eczema, burns, acne, dermatitis, and psoriasis can all be treated with aloe vera when applied topically. This cell regeneration accelerates the body's natural healing processes. Aloe vera is advantageous and distinctive in the medical area because of its healing ability.

Oral injuries can cause discomfort or pain, which can interfere with activities of daily living like speaking, swallowing, and mastication. Oral dysesthesia and xerostomia may then develop. Oral lesions can arise from several sources, such as infections, trauma, neoplasia, immunological disorders and long-term habits [43]. To reduce the negative symptoms, oral wounds must be properly managed or treated. Aloe vera's ability to heal wounds has been proven in laboratory and clinical tests [44]. Finally, the research indicates that different aloe vera formulations, such as mouthwash, are effective in the management and treatment of wounds in oral cavity [44]. Aloe vera is a successful

assistance in treating Oral Lichen Planus (OLP) lesions. When it comes to treating OLP, aloe vera is very effective [45]. Aloe vera is a viable treatment for OLP, according to the meta-analysis, because it doesn't have negative side effects. In accordance with other research, aloe vera had a 74% achievement rate in decreasing the lesion brought on by OLP, compared to a 78% success rate with triamcinolone acetonide (0.1%). These results demonstrate that Aloe vera is useful in treating OLP as an oral wound, which is statistically significant [45].

3.14. Antiulcer activity

In both humans and animals, stomach ulcers can be reduced by the gel found in aloe vera. Due to their cytoprotective properties, aloe vera leaf extracts are also utilized to aid in digestion and treat peptic ulcers. By directly interacting with the cells that produce stomach acid or by interacting with the H₂-receptors of parietal cells, the aloe vera extracts demonstrated concentration dependent suppression of gastric acid discharges. According to research, aloe vera extract demonstrated cytoprotection efficacy at low concentrations. Another study showed that the combination of sucralfate and aloe vera treatment reduced stomach swelling, improved proliferation of epithelial cells, extended gastric glands, and reduced ulcer diameters [46].

3.15. Immunomodulatory activity

Acemannan present in aloe vera exhibits immunomodulatory properties. Acemannan activates the synthesis via macrophages and cytokines, including TNF, IFN, and IL-1 of nitric oxide, which in turn potentiates the lymphocyte response to alloantigen. It boosts circulating monocytes and macrophages as well as phagocytosis. Similar to bacterial endotoxin, the nuclear factor is activated by the polysaccharide aloeride which is composed of glucose, galactose, mannose, and arabinose in human macrophages. It causes the mRNAs for IL-1 and TNF to express at a level comparable to that seen in cells triggered by bacterial endotoxin. According to a clinical trial, the use of 2% aloe vera gel orally can shorten the time it takes for an aphthous wound to heal and can reduce discomfort and the size of the wound in individuals with repeated cases of aphthous stomatitis [46]. According to study, aloe vera increases the phagocytic activity and action of the reticuloendothelial system in proliferation.

3.16. Uses for acne and rash treatment

Aloe is used both topically (applied to the skin) and orally. Topically, aloe vera is recommended for conditions such as burns, lichen planus, acne, and radiation-induced skin damage. For more than 6,000 years, people have utilized the common plant aloe vera as a treatment at home for a variety of illnesses. A thick, transparent, watery gel found in aloe leaves can be applied directly to the skin. The thick and short-stemmed plant known as aloe vera has a number of advantages for skin care. Aloe vera is frequently used to treat rashes and other skin conditions. Aloe vera's essential nutrients, enzymes, and vitamins aid in the healing of your

skin from the itching and inflammation brought on by the rash.

Aloe vera can be used to treat itching rashes. Due to its anti-inflammatory characteristics, aloe vera is effective in curing rashes. As a result, it aids in reducing the rash's redness and irritation. Its moisturizing qualities not only cool the rash down but also soothe it. Due to the inclusion of a calming gel with renowned healing effects, it is one of the best natural treatments for skin irritation. As a result, it is a widely utilized component in herbal medicine. Aloe vera is also thought to be quite beneficial for a number of other skin conditions, such as dermatitis and sunburn. According to research, this is because it contains a number of different chemicals and micronutrients. Your skin develops a heat rash when the weather is hot and muggy. Because of its calming and anti-inflammatory qualities, aloe vera is suggested as a home treatment for heat rash. The majority of the evidence for utilizing aloe vera for heat rash is anecdotal. Another well-liked natural treatment for sunburn is aloe vera. Aloe vera benefits to skin is shown in figure 4.

3.17. Hepatoprotective activity

Dry aerial portions of aloe vera were extracted into an aqueous solution, which both dramatically decreased and reversed the harm that carbon tetrachloride did to mice's livers. Anthraquinones participate in free radical processes during the inflammatory response and have the ability to function as antioxidants [47]. Free radical reactions and the involvement of reactive oxygen species in the inflammatory response can lead to liver necrosis. In vivo investigations using rats administered aloe-emodin after they were intoxicated with CCl₄ were conducted to determine the hepatoprotective effect of the anthraquinone. Aloe-emodin was able to lessen the morphofunctional and molecular alterations that are typically brought about by CCl₄. It is possible that the anthraquinone will prevent hepatocyte apoptosis and the inflammatory reaction that follows lipid peroxidation. Aloe contains phytosterols, particularly thiophenol and cycloartanol, which can cause the liver to upregulate fatty acid oxidation and downregulate fatty acid synthesis, which lowers intra-abdominal fat and improves hyperlipidemia. A study showed [48] that fatty rats treated with aloe-sterol showed improvement in hepatic steatosis and diseases related to the metabolic syndrome. The findings also showed that aloe inhibits the inflammatory response brought on by fat by lowering cytokine levels. By reducing the liver's RNA expression of lipogenic genes, aloe vera gel can help stop ethanol-induced fatty liver. Additionally, aloe gel demonstrated a possible reduction in cholesterol and the risk of cardiovascular illnesses [49].

3.18. Intestinal drug absorption enhancement

The effects of whole leaf extract and aloe vera gel on the oral bioavailability of vitamins C and E in humans were investigated in a randomized clinical experiment. The rate of absorption of vitamin C was reduced by the gel and the leaf extract, however, aloe gel administered with the vitamin had a total vitamin C bioavailability that was three times higher, and the gel continued to maintain still after 24

hours, level of vitamin C was considerably greater. When vitamin C was given along using the whole leaf extract, its bioavailability was just 80% as compared to the control, and after 24 hours, the level went back to baseline. When vitamin E was given with aloe gel, its bioavailability increased by 3.7 times, and when aloe whole leaf extract was used, it increased by 2 times. The explanation for the aloe vera products ability to increase the bioavailability of vitamins was given as a potential defense against the vitamins' degradation in the digestive tract and as a result of the polysaccharide binding to the vitamins, which slowed down the rate of absorption.

Natural polysaccharides, like chitosan, are well known for their ability to temporarily open the narrow junctions between neighboring epithelial cells, facilitate the transfer of paracellular entities across the intestinal epithelium and improve the intestinal absorption of medications taken together. The resistance across the epithelium of intestinal epithelial cell monolayers was demonstrated to be lowered by Aloe vera gel and complete leaf extract in a recent *in vitro* study. This suggests that the tight junction between neighboring epithelial cells are opening. Additionally, the macromolecular peptide medication insulin was found to be substantially more transportable across the Caco-2 cell monolayers when administered in aloe vera gel and whole leaf extract.

Because of their limited membrane permeability, several prospective therapeutic drugs have low bioavailability following oral administration. Drug absorption enhancers are substances that can break down the body's outer layers resistance reversibly while causing the least amount of tissue damage. This enables the drug to be absorbed into the bloodstream in sufficient amounts. Many substances have been studied for their ability to improve drug absorption. However, some have been linked to harmful effects, while others have been ineffective. Aloe vera gel's ability to improve medication absorption is currently poorly understood, it turns out to function as a secure and efficient *in vivo* absorption enhancer, and it may find application in novel dosage forms for injectable drugs that are poorly absorbed when given orally.

3.19. Skin penetration enhancement

Transdermal drug delivery is a popular method of administering medication. However, its low permeation over the skin and poor penetration into the epidermis pose significant challenges to its usage. The utilization of enhancers of chemical penetration, as well as methods for physical improvement like sonophoresis and ultrasound, iontophoresis, micro-needles, velocity-based approaches, and electroporation are the foundations of methods for enhancing transdermal drug delivery. Depending on the molecular weights of the compounds, aloe vera gel enhanced their skin penetration *in vitro*. There was an apparent negative relationship between the enhancement ratio and the compound's molecular weight. The pull effect of potential complexes between the chemical and the boosting agent within the aloe gel was suggested as the explanation for the penetration augmentation effect of the gel. Aloe vera gel may also be utilized as a penetration enhancer for transdermal

medication administration, similar to the topic of improving intestinal drug absorption [50].

3.20. Gum and teeth protection

In dentistry, aloe vera is widely used to treat a variety of dental conditions, such as periodontal flap surgery, wound healing and pain management. Aloe vera reduces bleeding, reduces inflammation, and stops gum swelling to treat conditions like periodontitis and gingivitis [51].

3.21. Laxative effects

One of the strongest laxatives is aloe vera gel has been used for constipation relief for a long time. Within 6 to 12 hours after taking doses, laxative symptoms such as loose bowel motions begin. Nursing moms can safely use it because their babies don't experience any laxative effects from it [52].

3.22. Genital Herpes

One of the most prevalent sexually transmitted infections is genital herpes, which is brought on by the Herpes Simplex virus. Medication is used to treat this illness and fasten the healing of wounds and lesions in order to lessen or stop outbreaks. Men's genital herpes can be efficiently treated with 0.5 percent aloe vera extract as a hydrophilic cream by accelerating the healing process [51].

3.23. Asthma

Aloe vera extract that has been stored in the dark for three to ten days releases certain active substances called prostanooids throughout the fractions of polysaccharides and glycoproteins. These medicinal ingredients have demonstrated efficacy in treating long-term bronchial asthma sufferers. However, if the patient has already received steroid medication, the activity against asthma is rendered useless [51].

3.24. HIV Infection

The human immunodeficiency virus, which infects about 10 million people annually worldwide, is becoming a major danger to global health. For clinical use, a number of anti-HIV medications have been approved. These medications do have several drawbacks, though, like their expensive price, diminished sensitivity, and unfavorable side effects. Therefore, there is a need for less costly and harmless herbal remedies to treat HIV. Aloe vera's polysaccharides and acemannans have been shown to be effective against HIV [51].

3.25. Food applications

a. Food Supplements

In the United States, aloe vera is used as a "dietary supplement" without any risk, according to Food and Drug Administration (FDA). Aloe vera in the form of a highly concentrated powder is used as a food supplement to prepare functional foods. Because aloe vera gel is used in the food business, processing it has become a significant task in recent years.



Figure 1: Close-up view of aloe vera leaf, showcasing the gel-filled core (Left) and Multipurpose succulent Aloe vera plants (Right)

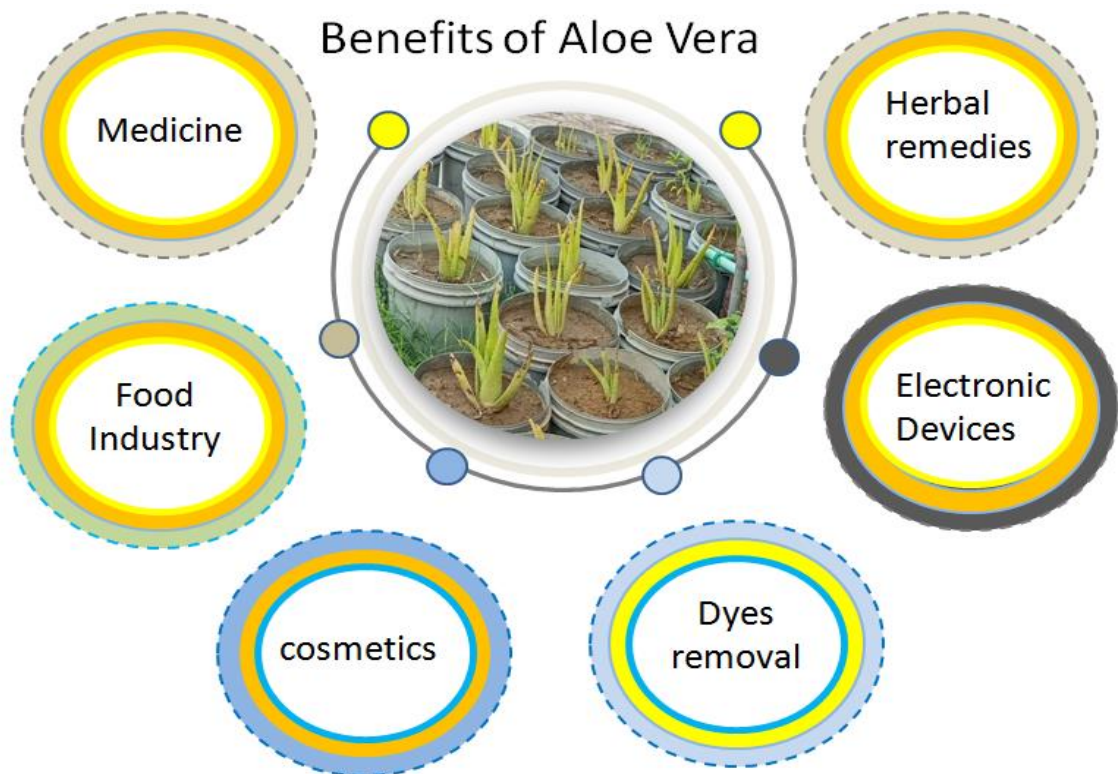


Figure 2: Benefits of Aloe Vera

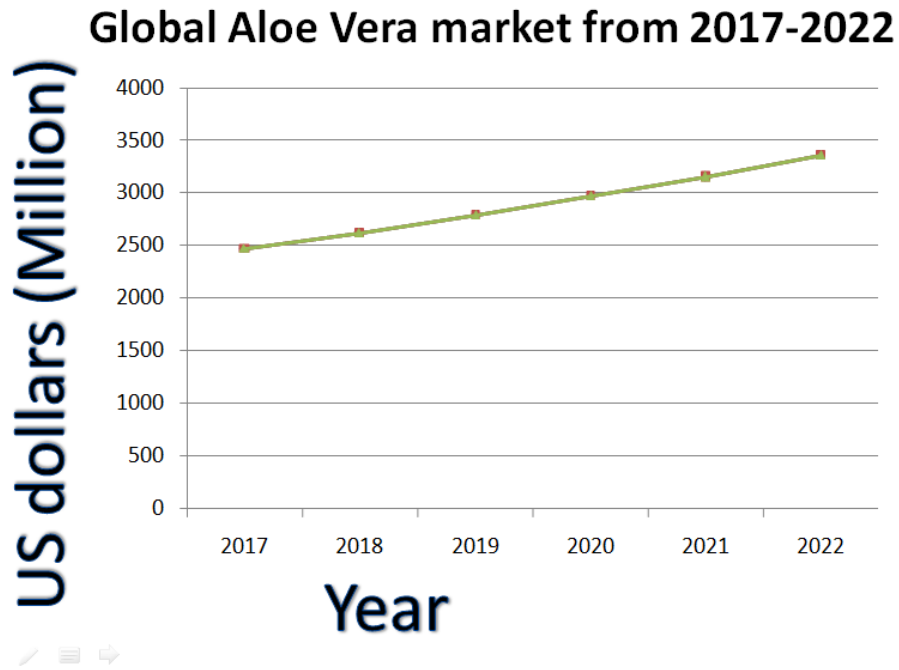


Figure 3: Global Market share of Aloe Vera from 2017-2022 in Us Dollars (Millions)



Figure 4: Benefits of Aloe Vera to Skin

Table 1: Compounds present in Aloe Vera gel with their biological activities.

Compound name	Biological Activity Reported
Saccharides	Provides glucose to body
Mannose-6-phosphate	treatment of AIDS , Wound healing
Acemannan	Wound healing, immunomodulatory, antibacterial, skin usage, anticancer, cell proliferation, hematopoiesis, and reticuloendothelial in dentistry
Emodin, AVP, PAC-I	Anti-cancer
HF1-Z, SL-1	Cough suppressing
Aloeferon	Growth stimulatory activity
CARN	Hematopoiesis, cell proliferation, antineoplastic, reticuloendothelial
Aloeride,	Immunomodulatory
polysaccharides A	Cough suppressing
Growth regulator Gibberellin, Acemannan, aloe genin	Wound healing
Aloe emodin	gastrointestinal absorption, anti-inflammatory, anti-cancer, and antibacterial properties; impacts on estrogen status
Emodin	Anticancer, effects on estrogen status
Chrysophanol , Phycion, Diethylhexylphthalate, N-terminal octapeptide	Cytotoxic
Chromone glycosides Aloin or Aloin A or Barbaloin	Laxative effects, anti-inflammatory, anti-cancer, anti-spermatogenic, cytotoxic, allergy
Aloin B, Anthraquinones, Aloe emodin-9-anthrone	Laxative effects
Aloeresin D	secretase inhibitory activity
8-C-β-d-[2-O-(E)-coumaroyl]glucopyranosyl-2-[2-hydroxy]propyl-7-methoxy-5-methylchromone	antioxidant and anti-inflammatory
C-2-decoumaroyl-aloesin G	β-secretase inhibitory activity
Aloesin	cytotoxic, anti-inflammatory, and tyrosinase inhibitory
Alactin A, Enzymes, β-sitosterol ,C-glucosyl chromone, Veracylglucan B, Miscellaneous	Anti-inflammatory
Veracylglucan C	cell proliferative , Anti-inflammatory
Lophenol	Antidiabetic, hepatoprotective
Sterols	Reduce wrinkles
24-methyl-lophenol, 24-ethyl-lophenol, 24-methylene cycloartanol, Lupeol	Antidiabetic
Cycloartanol	Antidiabetic, hepatoprotective
p- coumaric acid, Cinnamic acid, Ascorbic acid, Pyrocatechol, 2-vinyl crotonaldehyde	Antimicrobial
Aloe Polysaccharide(APS), β-carotene, Flavanoid, Phenol, Ascorbic acid, SAPS-1, GAPS-1 APS-1, Isoaloesin D, Aloe dihydroisocoumarin	Antioxidant
AVPI-12	Antifibrinolytic
Glycopeptide	Skin cell proliferating
Lectin	Hemagglutination, mitogenic
Glycoprotein	Cell proliferation activity
Bradykinase, Alkaline phosphatase, Amylase, Alkaline phosphatase, Carboxypeptidase, Catalase, Cellulase, Lipase, Peroxidase	Fats and sugars break down

Aloe vera is added to a variety of food items, such as drinks, yogurt, milk, ice creams, candies, and more, as a functional ingredient and dietary supplement [51]. In the 1970s, aloe vera gel extract was first used in the US and Europe to prepare functional meals. These days, its uses have expanded to include the creation of numerous nutraceuticals and functional foods. Mannose polymers are present in aloe vera along with some types of carbohydrates, like glucose and acemannan. These, together with vitamins, amino acids, enzymes, and glycoproteins, help foods function without compromising their acceptability or quality [53]. Aloe vera gel was used in place of skim milk to create a South Asian dairy product called dahi that has undergone fermentation [54]. Its quality indices (viscosity, whiteness index, total yield, whey syneresis, and water retaining capacity) were enhanced in addition to its nutritional and medicinal effectiveness. There have also been reports of drinks enhanced with aloe vera gel (squashes, ready-to-serve drinks, and sweetened aloe vera juice) having the ability to sustain excellent health [55]. Mango nectar [56], carbonated drinks, and ice cream [57] are products made from aloe vera. Based on their *in vitro* analysis, which verifies the presence of bioactive substances (e.g., flavonoids), the foods mentioned above are regarded as both functional and nutraceutical.

a. Food Preservative

Globally, there is a growing need for functional foods that have a longer shelf life and don't include chemical preservatives. The food sector has benefited from Aloe vera's antibacterial capabilities by using them to create herbal edible coatings. Such coatings increase product shelf life by preventing moisture loss in addition to their activity against microbes [58]. Peaches, papayas, sapotas, melons, and other fruits have been coated with aloe vera gel to protect them after harvest [42]. Aloe vera's capacity to form films and its biodegradability gel make it among the best palatable and non-toxic coverings for a variety of food applications. The primary causes of fruit and vegetable deterioration are moisture and oxygen, which are naturally blocked by the polysaccharides of aloe vera [59].

A material that has the power to stop or slow the growth of bacteria, fungus, and viruses is known as an antimicrobial agent. Pathogenic germs such as *Staphylococcus aureus* and food spoilage can be efficiently inhibited by aloe vera gel. Thus, adding aloe vera gel keeps food safe from microbiological deterioration in addition to improving its safety [51-60]. Aloe vera gel contains a range of antimicrobial chemicals, and because of their combined action, antimicrobial activity is demonstrated. Table grapes with an aloe vera gel treatment have increased safety. Researchers investigated the use of Aloe vera Gel Powder (AGP) to increase the shelf life of partially cooked and cold stored chicken nuggets. AGP reduces the load of microbial substances by increasing the shelf life of partially cooked and cold stored chicken nuggets for up to 6 days at refrigeration temperature. AGP contains 14 kDa protein, which has been shown to inhibit yeast growth [61]. AGP also contained organic acids such as citric acid and succinic acid, which reduce pH and inactivate microbial activity. Researchers proposed using a system of refrigeration instead of a freezer,

which increases shelf life by about 2 weeks with concentrations of 2.5-3.5% AGP in chicken nuggets. AGP also softened the chicken nuggets due to the presence of polysaccharides like cellulose and acemannan, which contribute to gel structure and hinder protein binding. As a result, AGP acts as a biopreservative and improves textural quality indices in meat-based products. Controlling deterioration and water loss in vegetables and fruits requires appropriate relative humidity (RH). Thus, high RH levels are generally used to preserve different vegetables and fruits throughout postharvest storage. As a result, in circumstances slightly above the threshold humidity contents and water activities, materials for coating will not be brittle or sticky, which may be accomplished by incorporating aloe vera. Because of their harmless nature, synthetic fungicides used in preserving fruits and vegetables can be substituted with aloe vera, which also serves as a natural preservative. Aloe vera can help increase the shelf life of fruits. Thus, it may be inferred that aloe vera can be employed as a possible biopreservative with antioxidant and antibacterial capabilities [62].

b. Bakery

Aloe vera gel (AG) is a good source of pectic compounds and cellulose, used in the food industry as alternatives to fat. According to research, AG can be used in place of fat when making cakes, especially for people who are obese or overweight [63]. They discovered that fat substitution with AG in cakes is a promising strategy for maintaining or lowering body weight in overweight and obese people, as well as providing essential nutrients from AG. Aloe vera fortification increased the rheological properties of Barbari dough, resulting in better shelf life and bread quality. Each aloe vera powder concentration resulted in an increase in the dough's water absorption and development time. The addition of 9% aloe vera powder to the dough formulation was more successful in terms of reducing dough extensibility. Thus, adding aloe vera to bread can help increase its shelf life [64]. As a result, using aloe vera to prepare beef burgers, bread, and cakes improves its textural properties, indicating its usefulness as a hydrocolloid.

c. Beverages

Aloe vera gel's potential as a functional component in a variety of health-focused food products, including yogurts and drinks, has been investigated for its nutraceutical properties [65]. Aloe Vera-based drinks have demonstrated potential to use as functional food, therefore their market availability will undoubtedly give health benefit to consumers. Although pure juice of aloe vera has beneficial nutritional, antioxidant, and antibacterial capabilities, its sensory qualities are not particularly appealing. Soft drinks formulated with juice of aloe vera and gel are a superior choice for more nutritional and health-conscious soft beverages. Researchers produced a ready-to-serve (RTS) mango beverage with various aloe vera blending proportions. The addition of 10% juice of aloe vera to a combination of sugar, citric acid and mango pulp improved both taste and the quality of the drinks. Because of the bitterness provided by aloe vera juice at concentrations above 20%, the taste were

unacceptable. Furthermore, the physicochemical and nutritional features of the finished goods were improved by allowing them to be stored for three months without compromising their organoleptic or chemical properties. Researchers investigated the effects of high-pressure processing (HPP) and Thermal processing on the preservation of blended aloe vera-litchi drinks. The authors discovered that HPP was more successful at keeping the beverage fresh than TP. HPP also enhanced shelf life for roughly 100 days at 4°C while sensory qualities were unaltered, and it was determined that HPP technology is useful at 60°C for maintaining a stable shelf life for fruit-based drinks [66]. Researchers sought to create a herbal wine using aloe vera. They discovered that the sensory properties and composition were identical to those of typical grape wine. Furthermore, herbal wine has demonstrated bactericidal efficacy against food-borne pathogens.

d. Confectionary

A variety of confections, including chocolate, jams, marmalade, ice cream, and jelly, are enhanced with aloe vera as a nutritional and functional element. Researchers investigated the use of pineapple juice and aloe vera gel in jelly production, which was made by boiling filtered fiber-free extract with citric acid, sugar and pectin. They discovered that mixing pineapple and aloe vera in a jelly shape is an effective way to use aloe vera. Researchers investigated the use of aloe vera in chocolate making. When substances like sugar, aloe vera juice, cocoa powder, and skim milk powder are mixed, whole new flavor and texture combinations are produced. Another jelly-like product is marmalade, which is often created from citrus fruit juice and peel mixed with sugar. Aloe vera powder was added to orange marmalade, resulting in notable modifications to the marmalade's sensory, physical and chemical characteristics. They discovered that increasing the percentage of aloe vera in orange marmalade reduces fat content while increasing protein and fiber content. The frightening scenario for dairy products is the rise in diabetes patients, creating a desire for natural and functional components. One of the earliest foods high in fat is ice cream. Researchers showed that aloe vera juice upto 20% may be used in the manufacture of ice cream without altering its organoleptic qualities. Aloe vera gel, aloe vera cubes and aloe vera gel powder were used as functional ingredients in the production of ice cream [67].

e. Dairy

Because of its health benefits, aloe vera is utilized in a range of dairy products, including yogurt and buttermilk. An excellent way to provide bioactives in a digestible manner is with yogurt that contains aloe vera gel. Researchers looked to develop an aloe vera enriched yogurt. When compared to the control, aloe vera enriched yogurt included less fat, more fiber and phytonutrients such as saponins, phlobatannin, anthraquinones and steroids. According to researchers, aloe vera gel enriched yogurt was superior and was shown to be a good probiotic as well as having a decent flavor. Enriched buttermilk with aloe vera juice, increases its viscosity (depending on the amount of aloe vera juice added) while improving its physicochemical,

nutritional, and sensory properties. The adding up of aloe vera juice to buttermilk improved vitamin C, dietary fiber, and iron levels [62].

3.26. Cosmetic applications

Aloe vera gel is a widely used ingredient in cosmetics and has gained significant attraction in this market. It serves as a foundation for a number of formulations, such as suntan lotions and moisturizers, which function as humectants in skin care products [68]. Because of its beneficial moisturizing and calming properties, aloe vera gel and powder are used in several cosmetic items, including cleansers, shampoos, soaps, and moisturizing creams. One benefit of aloe vera soap preparations is that they don't irritate skin or leave it feeling parched. In order to promote the process by which cuts from shaving heal, In the USA and Asia, aloe extracts are also used in a number of creams and lotions for shaving [69]. Aloe vera gel's mucilaginous properties enable it to function as a layer in shaving creams that separates the skin and beard. Many skin ailments, such as stretch marks, psoriasis, dandruff, sunburns, flaky or dry skin, and issues with the hair and scalp, can be treated with lotions and sunblocks. Aloe vera has lignin, vitamin A, steroids and 20 different types of amino acids that are beneficial for the growth of hair. Aloe vera has applications in preventing hair loss. Aloe vera has a strong healing effect that even reaches the skin's epithelium due to its high nutritional content and antioxidant properties. This results in the skin having a protective layer that speeds up healing. Aloe vera is applied before mineral-based makeup to prevent the skin from drying out. Because of its moisturizing qualities, it is perfect for oily skin without leaving a sticky residue behind. Aloe vera contains growth hormone, which encourages the development of new cells and promotes skin healing with little scarring. In Ayurvedic medicine, psoriasis, acne, and eczema are among the chronic skin disorders that aloe vera is used to treat. Antioxidants included in aloe vera leaves, like β -carotene, vitamin C and vitamin E improve the skin's inherent moisture and firmness. Aloe vera gel can be used in any product that has to be mild or moisturized. However, the gel's compatibility with the product system is essential to the successful creation of such items. Aloe vera gel generally works well with non-ionic, cationic, and anionic systems. Additionally, the product system may become neutral due to the gel's inherent pH (if applied at concentrations greater than 30%) [51].

4. Side effects

Use of aloe vera products is described as safe by the Cosmetic Ingredient Review Expert Panel. However, several studies have noted allergies as a side effect of aloe vera in some individuals. These allergic reactions are caused by anthraquinones, primarily the aloin found in aloe vera. Although, aloe vera is used as conventional medicine for treating a number of illnesses, some reports have also found that it can have negative side effects, including pains in the abdomen, diarrhea, crimson urine, hepatitis, loose stools, and others. Studies have shown that the anthraquinone in aloe promotes the laxative effect by causing looser stools and

other abnormalities, such as reducing potassium levels in patients. Aloe vera is also known to trigger uterine contractions in pregnant and nursing mothers and to raise the risk of colorectal cancer, according to reports [70].

5. Conclusions

This review article provides an in-depth analysis of the chemical constituents of aloe vera and their implications in different sectors, including health, cosmetics, food, and beyond. Aloe vera has long been used as a helpful herbal remedy. Numerous pharmacological properties are displayed by the plant, including wound healing, immune-boosting, anticancer, antioxidant, and antidiabetic properties. Through an exploration of its chemical composition and various applications, it becomes evident that aloe vera's versatility has no limits. In addition, it functions as a waste adsorbent for eliminating contaminants such as dyes and fluoride from water. Numerous applications, including burn injuries, eczema, cosmetics, and the treatment of fever and inflammation, have been documented. Because aloe vera is widely available and has only a few adverse effects, its use in disease prevention is growing globally, particularly in underdeveloped nations. To analyze aloe vera's medicinal potential, understand its mode of action, and evaluate the plant's efficacy under different circumstances, more thorough research is necessary.

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