REVIEW ARTICLE

Therapeutics Characteristics and Application of *Aloe vera*: A Review

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ABSTRACT

Aloe vera, a succulent perennial and drought resisting plant, is well known for its therapeutic potential. Different beneficial effects of *Aloe vera* have been reported such as anticancer, wound and burn healing, hypoglycemic, gastro-protective, antifungal, and anti-inflammatory properties. These beneficial therapeutic properties of *Aloe vera* have been employed for a number of commercial applications. Its gel has been used in variety of commercial products including skin care, cosmetics and medicinal. *Aloe vera* is being used as an edible coating for fruits or vegetables, which could be a good and safe option to postharvest chemical treatments. The current review focus on the therapeutics properties and various application of *Aloe vera*. Chemical characterization of *Aloe vera* is in progress through scientific developments in the area of analytical chemistry. It is expected that further information will be available at a faster rate in the near future, resulting in enhanced applications.

Keywords: Aloe Vera, Applications, Biological Activities, Edible Coating, Fruits.

1. INTRODUCTION

Aloe barbadense is Mill is fleshy (succulent xeropytes) cactus plant which used to be placed in family *Liliaceae* (Saleem *et al*., 2022) but recently it was classified as a member of *Aloaceae* (Maan *et al*., 2018) (Fig **1**). It has 400 species and cultivated in dry and warm countries like Asian countries including Indian, China and Japan (Baruah *et al*., 2016; Lee *et al*., 2021). Green leaves of *Aloe vera* (different color green or grey) are assembled in a rosette pattern at the stem of pulpy, perennial, as well as shrubby plant. The leaves are triangular as well as spongy with serrated edges and thick epidermis covered by cuticle. It reaches at height of 60–100 cm. Depending on the root condition, the plant can live at temperatures as low as 40°C and even below freezing (Baruah *et al*., 2016). Its leaves have strong water retention capacity, allowing the plant to thrive in difficult conditions such as longtime of aridity and dry, hot climate. One or more bicolor blooms are depending on variation of plant develop in tubular inflorescences at the middle of a bunch of leaves on this plant. It is the most effective, financially significant, and common plant in the scientific area among the different kinds of *Aloe* species. Leaves have thick epithelium which holds viscous mucilage gel (Terefe and Neges, 2017). Almost 75 nutrients and 200 active substances including carbohydrates, amino acids, saponins, enzymes, vitamins, minerals, anthraquinones, lignin, and salicylic acid, are found in various regions of the plant (Baruah *et al*., 2016). It contains various chemical compounds with different structures. Barbaloins and Nataloins are aloins found in *Aloe* vera. The blooms include variable elements and vitamin C, while the flesh contains polysaccharides, pectin, lignin, cellulose and hemicellulose (Quispe *et al*., 2018). The leaves include a variety of organic acids, phenolic compounds, enzymes, vitamins, and minerals. Outer layer, inner layer and latex/sap are layers of *Aloe* vera which are discussed below (Gao *et al*., 2019).

Outer layer/ Rind; it is the outer most layer of *Aloe vera* leaf and also synthesis carbohydrate sand proteins. It gives turgidity to the leaf as well as intersperses with chloroplast and also comprises different layers of cells. Vascular bundles like xylem and phloem also present in it. Pericyclic tubes also present in rind which are useful in transformation and storage of latex (Gao *et al*., 2019; Jose *et al*., 2021).

Sap/Latex; It is present between inner layer and outer layer. Its powder form used as therapeutic and laxative agent. Because of its pungent taste, it is used in the formation of various drinks. Anthraquinones, barbaloin, iso barbaloin *Aloe*rasin A, *Aloe*sin *Aloe*rasin B as well as derivatives of 1, 8-dihydroxy-anthraquinone and its glycosides are also found in yellow latex (Gao *et al*., 2019; Guo and Mei, 2016).

Gel (Inner layer): Parenchyma cell store clear and mucilaginous gel of *Aloe vera*. The gel is acidic (pH = 4.5-4.7). Water (99%), as well as other solid compounds (1.0%), like vitamins, enzymes, inorganic compounds and outer containing hydroxy anthracene, chromes, *etc*., are found in gel (Jangra *et al*., 2022; Riaz *et al*., 2021; Jose *et al*., 2021).

Aloe vera has been used in a number of industrial applications due to its beneficial properties such as drugs, cosmetics and food industries. The current research discusses the medicinal uses of *Aloe vera*, also its cosmetic and food applications (Sánchez-Machado, 2017; Lanka, 2018). It also known as medicinal plant due to its various useful applications including skin irritation, burns, and skin diseases (Shakib *et al*., 2019; Svitina *et al*., 2019; Lee *et al*., 2021).

Figure 1. *Aloe vera* plant and its gel

The industrial products which are drives from *Aloe vera* including products like (i) *Aloe* drinks, food supplements, milk, ice cream, gel preparations and ointments, (ii) skin care products like as soaps, creams, lotions facial cleaners, and shampoos, *etc*., commercially significant and growing. To enhancing *Aloe vera* processes including harvesting, handling, transportation, grinding, heating, dehydration, gel expulsion, gel extraction, gel stabilization is critical in order to obtain more active and effective products. While changes in composition is avoid that could alter the physiological and pharmaceutical properties of *Aloe vera* products (Sánchez-Machado *et al*., 2017).

Aloe vera gel is commonly used as an important constituent in several cosmetics and skin care products as show in Fig **1**. It is recognized for its various biological properties such as antifungal (Sarker and Grift, 2021), antibacterial (Riaz *et al*., 2021; Ahmad *et al*., 2018), antiviral (Subasree *et al*., 2016), antioxidant (Mondal *et al*., 2021), anti-diabetic (Arora *et al.,* 2019) ant-inflammatory activity (Heng, 2018), anti-ulcer (Sánchez-Machado *et al*., 2017; Shakib *et al*., 2019), anticancer (Hussain *et al*., 2015), wound healing (Komatsu, 2017; Saleem, 2022) and skin diseases (Svitina *et al*., 2019; Lee *et al*., 2021; Mikołajczak, 2018). Several anti-biotic and anti-fungal substances (polysaccharides, anthraquinone) are present in *Aloe vera* gel, which can stop the growth of microorganisms. Polysaccharides 10% (Acemamman, Glucomannan) are found in *Aloe vera* leaf, which shows broad range of pharmacological properties. *Aloe vera* gives you a feeling of freshness by improving blood circulation and making oxygen exchange between cells simpler (Dwivedi and Jhade, 2021). Its gel contains important compounds that are used in preparation of fragrance, cosmetics, juice, ice cream, alcoholic beverage and also used as food supplement (Sarker and Grift, 2021). It has been various applications in different fields such as sustainable packaging/coating fruits and use as preservative agent. It is being used as an edible coating for fruits, which could be a good and safe option to postharvest chemical treatments (Kumar *et al*., 2022).

1.1. Biological Activities of *Aloe vera*

Aloe vera has potential to use against different diseases because it is composed of several useful active components. The active compounds found in *Aloe* vera plant are sugar, amino acids, enzymes, methylchromones, flavonoids, vitamins, minerals, *Aloe*sin, *Aloe*emodin, lignin, aloin, *Aloe*mannan, acemannan *Aloe*ride, saponins, naftoquinones, sterols, anthraquinones and salicylic acid as well as other compounds such as fat-soluble and water-soluble vitamins, minerals, enzymes, organic acid, simple/complex, phenolic compounds and sugars (*Singh et al*., *2020)*.

Aloe vera exhibits various activities such as anti-bacterial, anti-viral, anti-cancer, anti-oxidant, anti-allergic, anti-inflammatory, anti-ulcer, anti-diabetic anti-aging, and wounds/burns healing and various skin infections (Sánchez-Machado *et al*., 2017; Arbab *et al*., 2021). Further, it has also been used in the treatment of constipation, gastrointestinal disorders, and for immune system deficiencies (Radha and Laxmipriya, 2015). Some of biological activities are discussed below in Fig **2**.

Figure 2. Biological activities of *Aloe vera*

1.2. Anti-Bacterial Activity

Some important polysaccharides are found in *Aloe vera* gel that has been evaluated anti-bacterial activity against *Gram* (*+Ve*) and *Gram* (*-Ve*) bacteria. Compounds saponins, anthraquinones present in *Aloe vera* used against bacterial infection (Sarker and Grift, 2021). *Aloe vera*gel exhibits activities against various bacterial strains such as *Shigella Flexneri*, *Streptoccocus pyogenes* and *Streptoccocus faecalisetc*. It isused as a disinfectant agent towards *Pseudomonas aeruginosa*, while acemannan inhibits it from binding to human lung epithelial cells (Riaz *et al*., 2021; Ahmad *et al*., 2018).

Aloe vera latex contains flavonoids, alkaloids, terpenoids and anthraquinone which are significantly correlated with anti-bacterial activity (Akinduti *et al*., 2021). Acemannan is a bactericidal compound found in *Aloe vera*, which prevent *Pseudomonas aeruginosa* from stick to epithelial cells of human lung. Bacterial species including *streptococcus pyogenes* and *streptococcus faecalis* are inhibited by *Aloe vera* (Kantam *et al*., 2016).

1.3. Anti-Fungal

Aloe vera and its various constituents use as anti-microbial agent. By decreasing the inhibition and development of fungal mycelia, *Aloe vera* gel has also shown anti-fungal action toward *Rhizoctonia solani, Fusarium oxysporum*, and *Collettotrichum coccodes*. *Aloe vera* elements like anthraquinone and aloine derivatives have also been demonstrated to have antifungal activity. It has been evaluated that *Aloe vera* gel helpful against different pathogens and fungal infection like *Penicillium expansum*, *Botrytis cinerea, Aspergillus niger Alternaria alternata* and *Penicillium digitatum* (Sarker and Grift, 2021). It inhibits the development of *Escherichia coli, Pseudomonas Candida albicans, Pseudomonas aeruginosa, Trichopyton mentagrophytes* and *Salmonella typhi*. Its maximum concentration inhibits the growth of *Staphylococcus aureus* (Kantam *et al*., 2016; Sharma *et al*., 2020).

1.4. Anti-Viral

Around the world, viral diseases have caused by serious threats to the health of people. The viral infection has ability to cause economic and pandemic loss. Several natural compounds have anti-viral properties. The *Aloe vera* plant has anti-viral activity against a variety of viruses, including the coronavirus SARS-CoV-1, Herpes simplex virus type 1, Herpes simplex virus type 2, Influenza virus, Varicella-Zoster virus, Human immunodeficiency virus, poliovirus, Human papillomavirus, Cytomegalovirus. *Aloe vera* can be eaten in a variety of ways and is completely safe. The compounds in *Aloe* are they have been demonstrated to be effective against other viruses through processes such as virus enzyme interaction, viral envelope destruction *etc*. Minerals like Zinc, which have been demonstrated to have an effect on SARS-CoV-1, could be implicated in *Aloe vera's* anti-viral activity (Mpiana *et al*., 2020).

Acemannan in *Aloe vera* is responsible for anti-viral action. It has been demonstrated to decrease herpes virus infection. *Aloe*-emodin is used as anti-viral agent against different viral infection including *herpes virus, influenza virus, pseudorabies virus* and *varicella zoster virus*. Anthraquinone derivatives reduce *influenza A. virus* growth as well as inhibit viral-induced cytopathic impact (Sharma *et al*., 2020). Acemannan is used against HIV infection and also used with combination of azido thymidine (AZT) and acyclovir to inhibit the virus of AIDS from replicating (Kumar *et al*., 2017).

7-*O*-methyl*Aloe*resinextracted exhibits reversible competitive inhibitory activity towards tyrosinase enzyme with minimum inhibitory concentration (IC^{50}= 9.8 ± 0.9 µM) which was extracted from *Aloe vera* gel (Kim *et al*., 2017).

Derivatives of anthraquinone including aloin, chrysophanol and emodin in found *Aloe vera* gel exhibited high anti-viral activity against different viral infections such as poliovirus, herpes simplex virus type-2, and human cyto megalovirus. Anti-viral compounds aloin and *Aloe*-emodin exhibits particularly high anti-viral potential. DNA- and RNA-containing enveloped viruses are directly affected by *Aloe* emodin, which prevent adsorption and replication of viruses. Except adenovirus and rhinovirus, *Aloe* emodin inactivated all enclosed viruses. *Aloe*-emodin exhibited maximum medicinal ratio in case of HL-CZ cells too, operating through IFN (Interferon) signaling responses towards encephalitis virus and enterovirus (Japanese) and also have potent virus inhibitory capacity (Lin *et al*., 2008; Gansukh *et al*., 2018).

1.5. Anti-Inflammatory

Inflammation is the body's natural response to an injury, which is revealed by pain, redness, swelling, and heat, that causes the process of healing to be slow. In aphthous stomatitis patients, *Aloe vera* gel has been shown to be beneficial in reducing severity of pain and wound growth (Radha and Laxmipriya, 2015). Due to anti-inflammatory property of *Aloe vera* is useful to reduce joint pain. Itsgel speeds up the healing process and also reduces pain. It also has anti-inflammatory properties that could be useful in the treatment of *H. Pylori* infection (Saleem *et al*., 2022). Sterols are useful inflammatory components which are found in *Aloe* vera gel. The use of *Aloe* polysaccharide has been shown to decrease reperfusion injury and cerebral ischemia as well as to improve the reticuloendothelial system's phagocytic and proliferative activities. Anthraquinones and chromone in *Aloe vera* gel has exhibit -inflammatory properties. The brady kinase and C-glucosyl chromone are enzymes present in *Aloe vera*, which shows anti-inflammatory activity. Because it includes the brady kinase enzyme found in *Aloe vera* gel, which is helpful to breaks down bradykinin and also lowers inflammation (Heng, 2018). *Aloe vera* gel is more potent against inflammation induced by prostaglandin formation and leukocyte infiltration, but less effective against allergic inflammation. Sterol in *Aloe vera* used as analgesic agent, also reduce pain and plays significant role in inflammatory action (Riaz *et al*., 2021). *Aloe vera* inhibits the cyclooxygenase action and decrease production of prostaglandin E2 from Arachidonic acid. C-glucosylchoromone obtained from *Aloe vera* gel, that exhibit anti-inflammatory activity (Sharma *et al*., 2020).

1.6. Anti-Ulcer Property

GERD (gastroesophageal reflux disease) is a digestive system disease characterized by symptoms such as chest pain, heartburn, acid reflux, ulcer, *etc*. Gastric ulcers caused by several factors including food ingredients, smoking, stress, NSAIDs, *Helicobacter pylori*, and drugs as shown in Fig **3**. *Aloe vera* constituents like polysaccharides, anthraquinones, and other useful components, can help to prevent peptic ulcers by regulating gastric secretion. In the ulcer groups, *Aloe vera* treatment resulted in decreased stomach inflammation, increased cellular growth, scratched gastric glands, and smaller ulcers (Rahmani *et al*., 2015; Sharma *et al*., 2020) as shown in Fig **3**.

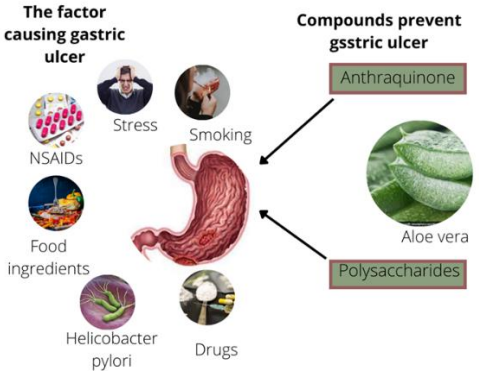

Figure 3. Factor causing gastric ulcer and compound prevent gastric ulcer

Ulcers are one of the most common oral diseases, and they can be very painful. It can also assist prevent dental diseases and oral mucosal illnesses, as well as protect oral habitats, in the cure of mouth diseases (Nair *et al*., 2016). Oral ulcer wound healing is a multi-step process that involves diverse cell types migrating, proliferating, differentiating, removing wounded tissue, and building extracellular matrices to protect the oral cavity (Davis *et al*., 2019). Acemannan (5%) reduced ulcer size and discomfort significantly, with no allergic reactions or side effects (Liu *et al*., 2019). It found in *Aloe* vera gel which useful in the treatment of ulcer as compared to steroid medications (Kantam *et al*., 2016).

Aloe vera gel has the capacity to treat or avoid the formation of gastric ulcers in animals and humans. The anti-ulcer properties of *Aloe vera* have been linked to a variety of processes, including its anti-inflammatory activity, healing benefits, mucus-stimulating action, stomach secretion regulation, and lectin synthesis. Antipyrine absorption by the parietal cells is blocked by lectins. *Aloe vera* gel

have ability to decrease stomach acid production could be due to direct effect on acid-producing cells and also maintain (Kumar *et al*., 2017).

1.7. Anti-Cancer/ Anti-Tumor

Anti-carcinogenic effects of *Aloe vera* gel have been discovered (Kim *et al*., 2016). *Aloe* vera extract's anti-hepatocarcinogenic action is mediated, at least in part, by apoptosis modulation (Shalabi *et al*., 2015). It contains anthraquinone and emodin, which can slow the progression of malignant cancer. In patients with head and neck cancer, prophylactic application of an *Aloe* vera-based cream has been shown to be effective in preventing radiation dermatitis (Riaz, 2021). Its gel contains a variety of glycoproteins that have anticancer properties and aid in the regulation of human cancerous cells. The polysaccharide fraction inhibits benzopyrene binding to primary rat hepatocytes, limiting the development of potentially cancer-causing benzopyrene-DNA adduct. Induction of glutathione S-transferase and reduction of the tumor-promoting effects of phorbol myristic acetate have also been documented, indicating that gel of *Aloe vera* could be effective in cancer chemoprevention (Fig **4**).

Colorectal cancer has been related to chronic overuse of anthropoid-containing laxatives. *Aloe vera* has been also known as cancer preventing. It promotes the body's ability to repair itself from cancer and the harm affected by radiotherapy and chemotherapy, which kills good immune cells that are necessary for recovery. Emodin, an anthraquinone found in *Aloe vera*, can decrease or prevent the growth of cancer cells, making it anti-neoplastic (Shadu, 2013). In *Aloe* vera gel polysaccharide avoids the formation of cancer causing benzopyrene DNA adducts. It is beneficial in cancer treatment (chemoprevention) (Sharma *et al*., 2020).

1.8. Laxative Effects

Significantly, a study has shown relationship between increased intestinal water content and peristalsis stimulation, confirming that *Aloe*-emodin-9-anthrone is the main agent responsible for barbaloin's cathartic activity (Rahmani *et al*., 2015). Commonly *Aloe* vera gel is use for the cure of constipation, which is one of the most effective laxative substances. Laxative actions start 6-12 hours after taking 0.25mg, resulting in loose bowel movements. It is beneficial to breastfeeding mothers because it has no laxative effects on their newborn (Maan *et al*., 2015). Anthraquinones are found in *Aloe vera* which shows laxative effect in intestine (Radha and Laxmipriya, 2015). The derivatives anthranoid glycosides (aloin) present in *Aloe vera* shows laxative effect (Sharma *et al*., 2020).

1.9. Antioxidant/ Anti-Septic

Aloe vera is a wide source of natural anti-oxidative phenolic compounds that can replace the synthetic anti-oxidant in cosmetics, pharmaceuticals and foods (Bendjedid *et al*., 2021). Phenolic compounds including flavonoids, polyphenols and tennis are found in *Aloe vera*, which exhibits radical scavenging activity in different products which are based on *Aloe vera* gel (Das and Srivastav, 2015). Anti-oxidants are molecules that protect other molecules from deteriorating. Oxidation is a chemical reaction that generates free radicals which can damage genetic material, increase ageing process, and enhance the chance of melanoma. Anti-oxidants are activated oxygen in the form of free radicals including superoxide anion radicals (O_2), hydroxyl radicals (OH-), and non-free radical species like H_2O_2 and singlet oxygen (O_2) (Mondal *et al*., 2021). Origin and side effects of Reactive Oxygen Species (ROS) are discussed.

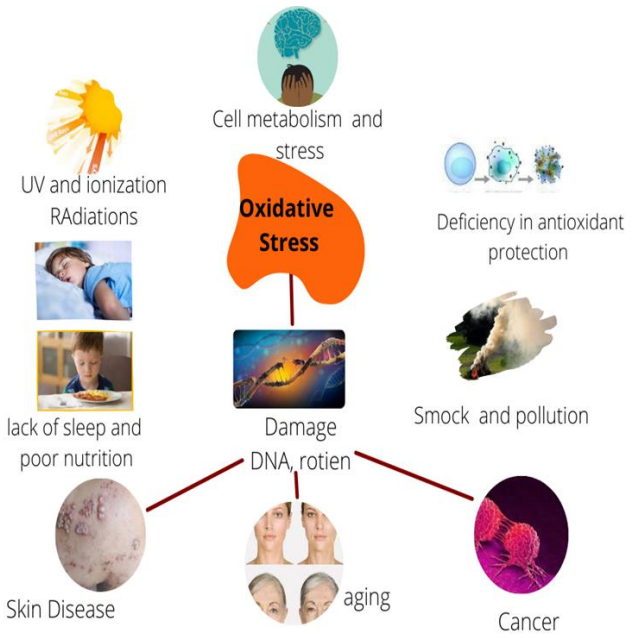

Figure 4. Origin and side effects of ROS

Phytochemicals have a variety of biological functions like anti-oxidant activity. Several anti-oxidant elements including phenolics, flavonoids, vitamin C, E, glutathione peroxidase, superoxide dismutase, carotenoids, tannins are found in *Aloe vera* which may be responsible for antioxidant benefits. It decreases biochemical and physiological changes as well as work to reduce oxidative stress of cell devastation. Due to an imbalance between the level of ROS and antioxidant status, excessive formation of free radicals causes oxidative stress, which leads to a number of degenerative disorders. *Aloe vera* gel can decrease AOM (Azoxymethane), which responsible for oxidative stress. Salicylic acid, lupeol, cinnamic acid, phenol, S, N_2 and urea are anti-septic compounds present in *Aloe vera*, which are used against bacterial, viral and fungal infection. Their assortments have adverse effect on several diseases, organisms and microorganisms (Pathak and Sharma, 2017; Yohannes, 2018). *Aloe vera* has broad range of anti-oxidant activities. Enzymes found in *Aloe vera* including glutathione peroxidase superoxide dismutase are exhibit anti-oxidant activities. *Aloe vera* improves blood quality by permitting the blood to transfer nutrients and oxygen more efficiently to the body's cells (Sharma *et al*., 2020).

1.10. Anti-Diabetic

Diabetes mellitus is a metabolic disorder which affects people all over the world. Diabetes mellitus is a common disease indicated by a reduction or complete cessation of secretion of insulin in response to physiological stimulation as well as a reduced insulin response in peripheral tissues. The blood sugar levels are maintained by use of *Aloe vera* gel. After 28 days of treatment of the five phytosterols from *Aloe vera*, including lophenol, 2,4-methyl-lophenol, 2,4-ethyl-lophenol, cycloartenol and 2,4-methylene-cycloartanol, were useful in treatment of diabetic mellitus (Rahmani *et al*., 2015; Hamza, 2022). The development of diabetes, as well as microvascular and cardiovascular problems, is heavily influenced by oxidative stress (Sharma *et al*., 2017; Sharma *et al*., 2018). *Aloe vera* phytosterols exhibited

hypoglycemic effect in diabetic patient as well as bind to cholesterol causing hypolipidemic effect (*Pothuraju et al*., 2016).

Blood sugar level is reduced by using *Aloe vera* juice/gel. Increasing glucose level in blood, herpetic transaminases, cholesterol level plasma and, triglycerides, free fatty acids, and phospholipids were all dramatically reduced by using *Aloe vera* gel. Polysaccharides in *Aloe vera* exhibit hypoglycemic action and also increase hormone (insulin) level (Riaz *et al*., 2021). However, because of changes in the separation of a mucilaginous layer from anthraquinones, the results may not be consistent. It decreases hepatic transaminases, plasma and tissue cholesterol, free fatty acids, triglycerides, and phospholipids (Afrin *et al*., 2021).

Diabetics appear to have decrease anti-oxidative ability, by minimize the levels of anti-oxidants like vitamin C and E, as well as reduced anti-oxidant enzyme activity. Polysaccharides in *Aloe vera* lower sterol regulate blood glucose and enhance body anti-oxidant production, which decrease tri-glycoside and aldohexose levels in patients of diabetic. *Aloe* juice balance the sugar level in blood by enhancing digestive system and increase the penetration of nutrients. It may be increasing the action of the medicine, that are used with insulin for a diabetic patient (Sharma *et al*., 2020).

1.11. Wound/ Burn Healing

Burns (combustion) are tissue damage produced by chemical exposure, high temperature, electric shocks and blasts. Saponins, *Aloe*sin B, anthraquinone and quinone are present in *Aloe vera* which function as anti-septic and speed the healing process on wounds or burn. Early 2100 BC, *Aloe vera* was firstly identified as wound healing plant. In 1930, it was used to treat burn injuries, skin abrasion as well as used as veterinary medicine (Hashemi *et al*., 2015). It is effective in the treatment of wound healing by different mechanisms like more production of collagen, balancing moist wound, decrease inflammation, and increasing cell migration (Komatsu, 2017; Saleem, 2022). Tannic acid as well as type of polysaccharide could be effective compounds for wound healing and tissue repair process. Glucomannan, a type of polysaccharide rich in mannose and gibberellin growth hormone interacts with fibroblast growth factor receptors, stimulating their development as well as proliferation, that important improves collagen synthesis by the use of *Aloe vera* such as orally and topically (Jamil *et al*., 2020). Because of its nutritional characteristics, *Aloe vera* is known for its great healing activity even at the epithelial level of the skin, providing a protective barrier on the skin that allows the skin to mend at a faster rate. Its gel improved the wound collagen's quality, changed its structure, as well as increased the degree of crosslinking. The healing process was assisted by increased dermatan sulphate and hyaluronic acid production in the granulation tissue of the healing wound (Liang *et al*., 2020).

Acemannan (sugar residue) has been significantly useful in wound healing as well as regenerate hard tissue regeneration and stimulating type collagen synthesis and VEGF (Vascular Endothelial Growth Factor) (Sánchez-Machado *et al*., 2017). It is the essential component of carbohydrate that stimulates healing process of wound (Kantam *et al*., 2016).

Aloe vera acts as modifiers. It also includes a stimulatory process that involves growth hormones including gibberellin, auxin, and mannose phosphate to increase production antibodies and prevent infection. Mannose is found in *Aloe vera* which is responsible for stronger activity of macrophage well as improved wound healing. Macrophages enhance tissue growth by causing fast fibroblast proliferation. *Aloe vera* mannose-6-phosphate is involved in wound healing either by directly or indirectly simulating collagen synthesis. Collagen is essential for the development of fiber in the wounds, as well as the repair of the wound through synthesis of protein and enzymatic activities. *Aloe vera* boosts oxygen levels in the wound, resulting in improved microcirculation and enhanced migration of epithelial cells, which are also engaged in the wound-healing process. It helps to promote skin regeneration at the deepest levels and also reduce wrinkles during skin injury by stimulating cell formation. Acemannan is component of *Aloe vera* which helpful to enhance growth of bone, increases bone density, bone volume and bone surface (Liu *et al*., 2019).

1.12. Food Applications

Aloe vera and its bioactive compounds are show applications in food packaging and preservation. It also has been used preservative in biopolymer-based edible films and coatings to increase shelf life of preserved food items as compared to synthetic chemicals (Kumar *et al*., 2022).

Functional foods with a long shelf life (Hassan *et al*., 2018) and no chemical preservatives are becoming increasingly popular around the world. Because of its applications in the food industry, *Aloe vera* gel production has recently become a large business. *Aloe vera* gel extract use in the preparation of functional foods started in the 1970s in Europe and United States. Food industry's shows interest in *Aloe vera* products due to its therapeutic properties, which stimulates the extract's use as a supplement in the production of functional foods. The *Aloe* vera gel have broad range of applications in food products such as milk, ice creams, confectionary, laxative drink, health drink, soft drink, sherbet, *Aloe* sports drink with electrolyte, *Aloe vera* lemon juice, diet drink with soluble fiber, healthy vegetable juice mix, hangover drink with vitamin B, amino acids and acetaminophen, tropical fruit juice with *Aloe vera*, *Aloe vera* buttermilk, yoghurts *Aloe vera* mix for whiskey and white bread cucumber juice with *Aloe vera*. Cellulose and pectic are present in *Aloe vera* that used as fat replacers in food industries (Sonawane *et al*., 2021). These products reported various health benefits including cancer, mitigative effect on rheumatoid arthritis, digestive diabetes, and disorder of intestines, or ulcers (Kumar *et al*., 2017).

Drinking *Aloe vera* juice has been shown several of health benefits, including strengthening cardiac contraction, lowering cholesterol and triglyceride levels, lowering cardiovascular disease risks, lowering blood glucose, and encouraging cell regeneration (Gao *et al*., 2019). *Aloe vera* gel contains mannose polymers as well as certain carbohydrates such as glucose and acemannan. By removing skim milk with *Aloe vera* gel formulated yogurt which have lower fat content, more phyto-nutrient and fibers. The quality of yogurt such as capacity to hold water, viscosity, whiteness index and total yield were enhanced as well as show nutritional and therapeutic activities. Other *Aloe vera*-based health foods include lassi, mango nectar and carbonated beverages *Aloe vera* gel enhanced beverages like sweetened *Aloe*

vera juice (ready-to-serve juices, and squashes) have also been described as potentially beneficial for health (Chen *et al*., 2020).

Aloe vera is used as a functional as well as nutritional constituent in a variety of confectionery goods, ice creams including jelly, chocolate, jams, and marmalade. Its juice (20%) can be used in the manufacturing of ice cream without damaging the ice cream's organoleptic qualities. In the manufacture of ice cream, *Aloe vera* gel concentration, *Aloe vera* gel powder, *Aloe vera* cubes, , and sugar coated *Aloe vera* cubes were used as functional. It has the ability to be act as a strategy for commercial development. *Aloe vera* gel or its powder also known as preservatives which inhibit the growth of microorganisms and pathogens such as *Staphylococcus aureus, Salmonella, Stroptococcus, Escherichia coli, Aspergillus niger, Candida etc. Aloe vera* gel to meals not only improves their safety but also protects them against microbial decay. A number of anti-microbial components are found in *Aloe vera* gel, which showed anti-microbial activity because of its synergistic effect. The 0.5%*Aloe vera* coating on the eggplant minimized vitamin C losses while reducing and preventing non-reducing sugar, pH, moisture loss, total sugar, and shrinking (Amanullah *et al*., 2016) During storage, the microorganisms load of bacteria, yeasts, and molds was significantly reduced. Mango, strawberry, persimmon, guava, green grape berries, and sweet cherries are antibacterial properties (Sonawane *et al*., 2021).

1.13. Edible Coating on Fresh Fruits and Vegetables

It is very useful applications of *Aloe vera* which shows safe and effective and alternative to postharvest chemical treatments. It is also being developed such as it is use as an edible coating of fruits. It is the best coating to increase the shelf life postharvest and balance maintain the sensory properties of the product with the storage period (Sánchez-Machado *et al*., 2017). *Aloe vera* gel is use as best edible coating material that is biodegradable, and safe. It keeps the texture, color, quality and flavor of the fruits by protecting the membrane from moisture and oxidation. It balances the biological and functional properties of fruits while its coating enhances anti-oxidant activity and minimizes microbial proliferation of fruits. It gives edible boundary for moisture as well as atmosphere gases, and also reduces transportation and respiration that improve preserve quality of fruits (Sarke and Grift, 2021).

Fruits are harvested and stored in different regions to make availability for everyone to eat. They are treated with different chemical to maintain quality and increase shelf life in storage. Lifespan increased for edible fruits for long time by the use of chemicals. Health risk can be reduced, if natural preservative used as compared to chemical preservative. Because of its anti-fungal characteristics, there has been an increase in the use of *Aloe vera* gel as a fruit wrapping material. Fruits such as berries, strawberry, guava, apples, pomegranates, and mangoes, *Aloe vera* gel as an edible coating had been considered to inhibit water and prevent respiration, firmness losing and maturation development, decrease berry decay, lower weight loss, maintain pH levels, maintain ascorbic acid level, highest anti-oxidant, and stem-end rot preservation. Its use gives customers with a long lasting, eco-friendly edible coating which is helpful to increase the shelf-life food, improve food safety and also provide health benefits. It is good preservative constituent as compared to other expensive and manufactured chemical preservative (Kankamol *et al*., 2021).

1.14. Berries

Aloe vera gel coating could be an effective process of managing berries fruit quality and increasing shelf life. The fruit covered with *Aloe vera* gel exhibited maximum anti-oxidant ability, total phenol content and total anthocyanin as compared to non-coated fruits. The shelf life of *Aloe vera* coated berries was increased and lesser the ability to decay in storage at 4 °C. It reduces natural decay process of fruits. The berries coated with *Aloe* gel manage antioxidant capacity level, total phenolic content, total anthocyanin content and anti-oxidative enzymes in storage process.

1.15. Strawberry

In the world, Strawberries are one of the most popular fruits. It is extremely sensitive microbial and fungal infection during storage. Due to fast softening and degradation, strawberry is not a climacteric fruit with a short post-harvest lifespan. *Aloe vera* gel coating can decrease fungal decay, increasing strawberries shelf life up to 15 day of storage and maintaining their physicochemical properties like color and quality (Jafari *et al*., 2018).

1.16. Guava

Guava is a tasty and aroma seasonal fruit which contains broad range of important nutrients such as vitamin C, minerals, carotenoids and polyphenols. It has a short shelf life in ambient conditions, which can make marketing and storage difficult. It is necessary to develop new mechanisms to maintain quality and increase shelf life of fruits. The *Aloe vera* gel-coated fruits had lower total sugar, total carotene and malondia aldehyde, levels as compared to chemical treated fruits. *Aloe vera*-coated fruits had higher amounts of flavonoid (quercetin and rutin), vitamin C and total phenolic than chemical control fruits. Furthermore, *Aloe vera*-covered fruits exhibited higher amounts of antioxidant and total soluble solids than uncovered fruits, as well as potent superoxide dismutase and catalase (Bornare 2015).

1.17. Persimmon

Persimmon fruit is highly farmed extensively from Japan to the Mediterranean Sea, as well as distant Brazil (Senica *et al*., 2016). Different beneficial component to humans including fibers, polyphenols, minerals, vitamins, carotenoids, flavonoids, steroids, and terpenoids found in persimmon fruit. These bioactive substances reduce oxidative stress and cholesterol accumulation in humans by regulating genes associated to cholesterol accumulation (Pérez-Burillo *et al*., 2018). It is coated with *Aloe vera* gel which shown significantly less weight loss, malondialdehyde, content electrolyte leakage and hydrogen peroxide level as well as had higher ascorbate peroxidase dismutase and catalase activities. By activating the enzymatic anti-oxidant system, generating bioactive chemicals, and reducing cell wall disintegration, *Aloe vera* gel coating prevented the development of decay. By inhibiting the activities of PME (pectin methylesterase), PG (polygalacturonate), and CEL (cellulase) enzymes as well as reducing the physical and chemical changes in sugars, tannic acids, and total carotenoids, *Aloe vera* gel coating also prolonged ripening and softening. *Aloe vera*-gel coating reduced senescence by activating the antioxidant system and inhibiting the degradation of cell walls. During ambient storage conditions, *Aloe vera*-gel coating can be used to

postpone ripening and softening of persimmon fruits (Saleem *et al*., 2022).

2. CONCLUSION

Aloe vera has beneficial therapeutic effects and its applications in a various products including foods, pharmaceuticals and cosmetics. Its consumption in various fields can be maximized by developing appropriate processing techniques. The international *Aloe* science council, as well as countries like the European Union, China, and Korea, are debating the establishment of criteria for its inclusion in various foods. It is expected that its application in functional foods and cosmetics will increase with time. However, there are some complications linked to the use of *Aloe vera* which need to be addressed. Precautions need to be considered while using *Aloe vera* in some specific conditions and with some specific compounds. It is recommended that its continuous use for extended period of time should be avoided in order to avoid any possible complications.

3. CONFLICT OF INTEREST

The authors declare no conflict of interest.

4. ACKNOWLEDGEMENT

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