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Review Article

Exploring the Diverse Applications of *Aloe vera*: A Review

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ABSTRACT

Aloe vera, a succulent plant that is well known for its medicinal properties, has been utilized for many centuries for its range of applications. Its rich composition of bioactive compounds such as minerals, vitamins, polysaccharides, and antioxidants contributes to its anti-inflammatory, antimicrobial, and immunomodulatory properties. In skincare, *A. vera* is extensively incorporated into cosmetics, moisturizers, and topical treatments due to its hydrating, soothing, and rejuvenating effects on the skin. Furthermore, *A. vera* has garnered attention in pharmaceutical research for its potential in drug delivery systems, the treatment of diabetes, cancer, and other chronic diseases. Its bioactive constituents exhibit promising pharmacological activities, opening avenues for the development of novel therapeutic agents. In agriculture, *A. vera* is valued for its role in enhancing crop yield, soil fertility, and plant resistance to environmental stressors. Its natural growth-promoting compounds facilitate sustainable agriculture practices, reducing reliance on synthetic inputs and promoting ecological balance. This review explores the multifaceted uses of *A. vera* in different fields, including traditional medicine, skincare, pharmaceuticals, and agriculture.

Key words: Agriculture, *Aloe vera*, Antimicrobial effect, Medicinal plant.

1. INTRODUCTION

Aloe vera (*Aloe barbadensis* Miller), a versatile plant with therapeutic properties that originated from the Arabian Peninsula, *A. vera* has traversed continents and cultures, earning a revered status in traditional medicine, skincare, and agriculture. Its fleshy leaves, with a gel-like substance, are rich in bioactive compounds [Figure 1]. *A. vera* is found in religious rituals, embalming practices, and medicinal preparations. The ancient Greeks and Romans also recognized its healing potential, employing it to treat wounds, burns, and various ailments. Over time, the knowledge of *A. vera*'s medicinal properties spread across diverse civilizations, including those of India, China, and the Americas, where indigenous communities revered it as a sacred plant with potent healing capacity. In today's modern scientific inquiry, *A. vera* continues to be a subject of intense study. The latest research is revealing an array of bioactive constituents that contribute to its pharmacological, cosmetic, and agricultural significance. Polysaccharides, vitamins, minerals, enzymes, and antioxidants are among the many compounds found within *A. vera* gel, having a diverse range of therapeutic and functional attributes [1]. In contemporary times, the applications of *A. vera* extend far beyond traditional medicine. The cosmetic industry has utilized its hydrating, soothing, an-d rejuvenating properties, incorporating it into skincare products ranging from moisturizers to sunscreens. Furthermore, ongoing research has revealed the potential of *A. vera* in pharmaceutical formulations, exploring its efficacy in treating conditions including diabetes, skin disorders, and even some types of cancer [2]. Moreover, in agriculture, *A. vera* stands as a sustainable cultivation practice, offering solutions for enhancing crop yield, soil fertility, and plant resistance to environmental stress. Its natural growth-promoting compounds have gained interest in eco-friendly agricultural approaches. The multiple benefits of *A. vera* are evident that this succulent harbors potential for addressing contemporary challenges in healthcare, skincare, and agriculture. The global market for different *A. vera* products and their utilization is increasing every year [Figure 2]. Continued research and innovation in its bioactive compounds hold promising prospects.

Compounds of *A. vera* have multiple applications with various properties [Table 1].

2. ANTIMICROBIAL PROPERTIES

A. vera possesses antimicrobial properties, which means that it can inhibit the growth of microorganisms such as bacteria, fungi, and viruses. The health benefits of *A. vera* include its use in skincare, wound healing, and oral care. Here's how *A. vera* exhibits its antimicrobial effects: Antimicrobial Properties**: *A. vera* contains compounds with antimicrobial properties, including certain polysaccharides and phenolic compounds. While more research is needed, these properties may potentially help inhibit the growth of bacteria responsible for urinary tract infections, although they may not be as effective as conventional antibiotics.

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Table 1: Components of *A. vera* and properties.

Chemical classification	Components	Property and activity
Amino acids	Gives twenty of the twenty-two necessary amino acids and seven of the eight necessary ones.	Fundamental components of body proteins
Enzymes	Resistannol, anthranol, isobarbaloin, chrysophanic acid, ethereal oil, and ester of cinnamon	Antiviral and antifungal properties, however at high doses, harmful
Steroids	Campesterol, sitosterol, lupeol, and cholesterol	Lupeol, an anti-inflammatory substance, possesses antibacterial, analgesic, and anticancer properties.
Anthraquinone	Gives aloe tic acid, aloe emodin, aloe alovin, and anthracene.	Painkilling and antimicrobial
Hormones	Gibberellins and auxins.	Healing of wounds and anti-inflammatory
Saponins	Glycosides.	Sanitizing and antiseptic
Salicylic acid	Substances similar to aspirin.	Painkiller
Sugars	Monosaccharides include fructose and glucose. Polysaccharides: polymnnose and glucomannan	Minerals and carbohydrates that are required for energy metabolism.
Vitamins	A, B12, C, E, folic acid, Choline, and B12.	Antioxidants (A, C, and E) counteract free radicals
Minerals	Zinc, potassium, sodium, iron, manganese, copper, chromium, and iron.	Necessary for optimal health.

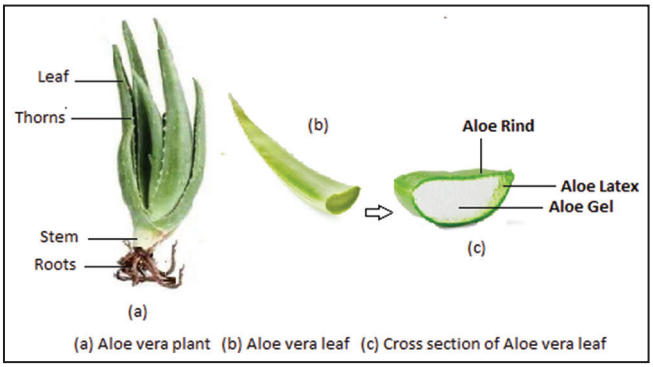

Figure 1: *Aloe vera*.

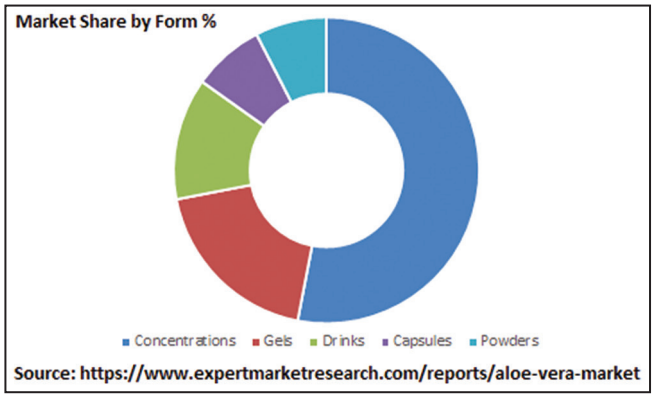

Figure 2: Global *Aloe vera* market.

3. BACTERIAL INHIBITION

A. vera contains anthraquinones, saponins, and phenolic compounds that act as antibacterials against *Pseudomonas aeruginosa*, *Staphylococcus aureus,* and *Escherichia coli*. These bacteria are common pathogens responsible for infections in wounds, burns, and skin conditions.

4. FUNGAL INHIBITION

A. vera has antifungal properties that make it effective against pathogenic fungi such as *Candida albicans* and *Aspergillus* species. These fungi can cause infections in the skin, nails, and mucous membranes, and *A. vera*'s antifungal activity helps prevent their growth and spread.

5. VIRAL INHIBITION

Some studies suggest that *A. vera* may exhibit the herpes simplex virus and influenza. *A. vera*'s antiviral properties hold promise for combating viral infections.

6. BIOFILM DISRUPTION

A. vera has been shown to disrupt bacterial biofilms. Biofilms contribute to the persistence of chronic infections and antibiotic resistance, and *A. vera*'s ability to disrupt biofilms can enhance the effectiveness of antimicrobial treatments.

7. ANTI-INFLAMMATORY PROPERTIES

Compounds found in the gel of *A. vera* leaves have anti-inflammatory properties.

8. POLYSACCHARIDES

A. vera contains various polysaccharides, including acemannan and glucomannan, known to exhibit anti-inflammatory properties by inhibiting the production of pro-inflammatory cytokines.

9. ENZYMES

A. vera gel contains enzymes such as bradykinase, which has anti-inflammatory effects. Bradykinase helps reduce inflammation by breaking down bradykinin, a pro-inflammatory mediator involved in the inflammatory response, along with cyclooxygenase and lipoxygenase.

10. ANTHRAQUINONES

A. vera contains anthraquinones, such as aloin and emodin, which have demonstrated anti-inflammatory properties. These compounds

inhibit the activity of enzymes, thereby reducing the production of inflammatory mediators, such as prostaglandins and leukotrienes.

11. ANTI-INFLAMMATORY EFFECTS

A. vera contains compounds with anti-inflammatory properties, such as polysaccharides and flavonoids, which can reduce inflammatory factors associated with heart disease. Oxidative stress may contribute to cardiovascular disease by promoting the oxidation of low-density lipoprotein (LDL) cholesterol and the formation of plaque in the arteries. *A. vera* contains antioxidants like vitamins C and E, as well as flavonoids and polyphenols, which can decrease oxidative damage [3]. *A. vera* contains compounds such as acemannan and various polysaccharides with known anti-inflammatory properties. Substances with anti-inflammatory effects may theoretically offer some benefits.

12. ANTIOXIDANTS

Chronic inflammation has been linked to obesity and metabolic disorders. *A. vera* supports weight loss by reducing inflammation. While these properties suggest that *A. vera* could have potential benefits for respiratory health, there is currently limited direct evidence to support its use for conditions, such as asthma, bronchitis, or chronic obstructive pulmonary disease. Some proponents suggest that *A. vera* may improve blood circulation, which may benefit nerve health by promoting the delivery of oxygen and nutrients to nerve cells and facilitating the removal of metabolic waste products. Oxidative stress is implicated in nerve damage and neurodegenerative diseases. By reducing oxidative stress, *A. vera* may help protect nerve cells and support nerve health. In addition, *A. vera* supplements or extracts intended for internal use may have side effects or interactions with medications, so it is essential to use them under the guidance of a health-care professional. *A. vera* has wound-healing properties that may benefit women recovering from gynecological surgeries or childbirth. Its soothing and anti-inflammatory effects can promote tissue repair and reduce discomfort during the healing process. Pregnant women often experience changes in their skin, such as stretch marks and skin dryness. *A. vera* gel is commonly used topically to hydrate the skin and may help alleviate some of these skin concerns during pregnancy. However, pregnant women should consult with their health-care providers before using any skincare products, including those containing *A. vera*, to ensure safety for themselves and their babies.

13. WOUND HEALING

Inflammation is a natural part of the wound healing process, but excessive inflammation can delay healing. *A. vera*'s ability to accelerate wound healing is partly attributed to its anti-inflammatory properties [4]. By reducing inflammation at the wound site, *A. vera* helps promote faster healing and tissue regeneration. *A. vera* gel contains compounds that can accelerate wound healing. By enhancing immune function, *A. vera* may help the body better defend against microbial infections and promote faster healing of wounds and injuries. It has antibacterial and antifungal properties that help prevent infection, while its soothing properties can reduce pain and inflammation [5]. *A. vera* has been traditionally used for wound healing. In diabetic individuals, chronic wounds are a common complication due to impaired wound healing [6]. *A. vera* gel may help accelerate wound healing by promoting collagen synthesis and tissue regeneration. It contains polysaccharides and growth factors that promote skin regeneration and accelerate the healing process of minor cuts, burns, abrasions, and wounds. Overall, *A. vera* is a versatile skincare ingredient that offers a wide range of benefits for the skin. Whether used alone or as part of skincare products, *A. vera* can help keep the skin hydrated, soothed, and healthy-looking.

14. SKIN CONDITIONS

A. vera gel is widely used in skincare products due to its soothing and moisturizing properties. *A. vera* is a common ingredient in various cosmetic products, such as moisturizers, creams, and lotions, due to its hydrating and skin-soothing properties. Applying *A. vera* gel topically can help hydrate the skin, reduce inflammation, promote healing, and reduce sunburns. Its cooling and anti-inflammatory properties can heal sunburned skin. *A. vera* contains compounds such as acemannan, which have anti-inflammatory effects. This makes it useful in alleviating inflammation associated with conditions like arthritis. *A. vera* has antibacterial and anti-inflammatory properties that make it effective in treating acne. It helps reduce inflammation, soothe redness, and prevent the growth of acne-causing bacteria, making it a valuable ingredient in acne skincare products. *A. vera* helps maintain the skin's natural moisture barrier, preventing dehydration and dryness. It penetrates the skin deeply, delivering hydration to the deeper layers. It helps reduce redness, inflammation, and discomfort caused by ultraviolet radiation exposure, promoting faster healing of sun-damaged skin. *A. vera* is a natural humectant. It can alleviate discomfort associated with sunburns, rashes, insect bites, and skin conditions such as eczema and psoriasis. It helps reduce inflammation, soothe redness, and prevent bacterial growth on the skin, making it a natural and gentle option for acne-prone skin. *A. vera* promotes the production of collagen, a protein that helps reduce scars. Applying *A. vera* gel regularly to scars can help fade them over time, resulting in smoother and more even-toned skin. *A. vera* is also beneficial for the scalp and hair. Its moisturizing properties help nourish and hydrate the scalp, reducing dandruff and promoting healthy hair growth. Overall, *A. vera* is a versatile and natural ingredient that offers numerous benefits for skin health. Whether used topically as a gel or incorporated into skincare products, *A. vera* can help maintain healthy, nourished, and radiant skin. *A. vera* gel is hydrating and can help moisturize dry and cracked skin on the feet. Regular application of *A. vera* gel can help soften rough areas and prevent dryness, keeping the skin on your feet smooth and supple. *A. vera* has natural anti-inflammatory properties, which can help soothe tired and achy feet. Massaging *A. vera* gel onto your feet can provide relief from discomfort and reduce swelling, making it especially beneficial after a long day of standing or walking. *A. vera* contains compounds that promote wound healing and skin regeneration. If you have minor cuts, scrapes, or blisters on your feet, applying *A. vera* gel can help speed up the healing process and prevent infection. *A. vera* has antimicrobial properties that can help control odor-causing bacteria on the feet. Applying *A. vera* gel to your feet regularly can help keep them clean and fresh, reducing the risk of foot odor. *A. vera* gel can help soften and reduce the appearance of calluses and corns on the feet. Regular application of *A. vera* gel to these areas can help gently exfoliate dead skin cells and promote smoother, healthier-looking feet. *A. vera* can offer several benefits for nail health due to its moisturizing, nourishing, and antimicrobial properties. Here's how *A. vera* can contribute to maintaining healthy nails. *A. vera* gel is hydrating and can help moisturize dry and brittle nails. Regular application of *A. vera* gel to the nails and cuticles can help prevent dryness and brittleness, keeping the nails flexible and less prone to breakage. *A. vera* contains vitamins, minerals, and amino acids that can nourish the nails and promote their overall health. These nutrients help strengthen the nails, improve their texture, and reduce the risk of infection from fungi and bacteria with their natural antimicrobial properties.

15. HAIR CARE

A. vera is used in various hair-care products, such as shampoos and conditioners. *A. vera* has soothing and moisturizing properties that can help alleviate scalp irritation, itching, and inflammation. A healthy scalp

environment is essential for promoting hair growth, as it supports the health of hair follicles and encourages optimal hair growth conditions. *A. vera* contains antioxidants, amino acids, vitamins, enzymes, and minerals that reduce oxidative stress and nourish the hair on the scalp and hair follicles. In addition, its anti-inflammatory properties may help soothe inflammation and irritation, which can hinder hair growth. Regulating excessive sebum production, *A. vera* can help maintain a healthy scalp environment. Scientific evidence supporting its specific efficacy against dandruff is somewhat limited, but several properties of *A. vera* may contribute to its ability to combat dandruff. By moisturizing the scalp, *A. vera* may help reduce dandruff flakes and alleviate associated symptoms. Anti-inflammatory compounds of *A. vera*, such as vitamins, enzymes, and polysaccharides, help soothe irritation and inflammation on the scalp. Some research suggests that *A. vera* may have antifungal properties, which could be beneficial in combating dandruff caused by fungal overgrowth. Dandruff is sometimes associated with the presence of a yeast-like fungus called Malassezia on the scalp. While more research is needed, *A. vera*'s potential antifungal properties may help address this underlying cause of dandruff. *A. vera* gel has cleansing properties that can help remove excess oil, dead skin cells, and product buildup from the scalp. These accumulations can contribute to dandruff by clogging hair follicles and creating an environment conducive to fungal growth. By gently cleansing the scalp, *A. vera* may help reduce dandruff and improve overall scalp health. By maintaining a healthy pH level, *A. vera* may support a dandruff-free scalp.

16. ORAL AND DIGESTIVE HEALTH

A. vera is used in oral care products such as toothpaste and mouthwash. It helps to reduce bacterial growth in the mouth, reducing the risk of dental plaque, gingivitis, and bad breath. It can alleviate discomfort caused by dryness, sunburn, cold sores, or other lip conditions. *A. vera* also promotes the healing of minor cuts, cracks, and wounds on the lips, helping them recover faster. *A. vera* contains enzymes that help gently exfoliate dead skin cells from the surface of the lips. *A. vera*, which has a role in oral health, is found in some toothpaste and mouthwash products due to its antibacterial properties. It can help reduce plaque buildup, gingivitis, and bad breath [7]. *A. vera* has nutritional and metabolic effects on the digestive system [8]. *A. vera* juice is sometimes consumed orally for its potential benefits to digestive health. Polysaccharides and enzymes aid in digestion, help in the breakdown of food molecules, and enhance nutrient absorption. Amylase, protease, and lipase break down carbohydrates, proteins, and fats. *A. vera* gel may have appetite-suppressing effects. It is thought that certain compounds in *A. vera* may interact with hunger-regulating hormones or receptors in the digestive system, leading to reduced appetite and food intake and resulting in weight loss. It can have laxative effects and may interact with certain medications [9]. A healthy digestive system is indirectly linked to heart health, as gut health influences inflammation and nutrient absorption. *A. vera* contains prebiotic fibers, such as mannans and polysaccharides. *A. vera* gel is hydrating and contains electrolytes like potassium, which supports fluid balance in the body. *A. vera* reduces inflammation and alleviates symptoms such as abdominal pain and discomfort [10]. *A. vera* latex, derived from the inner leaf lining, contains compounds called anthraquinones, which have laxative properties. Some research suggests that *A. vera* gel may help heal gastric ulcers by promoting the regeneration of damaged tissue and reducing inflammation in the stomach lining. *A. vera*'s anti-inflammatory and wound-healing properties may contribute to its effectiveness in treating ulcers. *A. vera*'s ability to promote bowel movements and support digestive function may help eliminate toxins and waste products from the body. Some studies suggest that *A. vera* may promote the regeneration of liver cells. *A. vera* supplementation can reduce elevated liver enzymes such as alanine transaminase and aspartate transaminase. Lowering these enzyme levels may indicate improved liver health. Research in animal models suggests that *A. vera* may offer protection against various forms of liver damage, including damage caused by alcohol, toxins, and certain medications.

17. IMMUNE-BOOSTING PROPERTIES

A. vera has immune-boosting properties, thanks to its high content of antioxidants, vitamins, and minerals. Compounds found in *A. vera*, such as polysaccharides, have been shown to modulate the immune system. In addition, *A. vera* polysaccharides may stimulate the production of certain immune cells, such as macrophages and lymphocytes, which play a role in cancer surveillance and defense [11]. *A. vera* contains polysaccharides and other bioactive compounds that modulate the immune response [12]. Some research suggests that *A. vera* polysaccharides may modulate the immune system, potentially enhancing immune function. While more research is needed in this area, maintaining overall health and hydration can indirectly support immune function.

18. DIABETES MANAGEMENT

The various medicinal properties of *A. vera* include potential antidiabetic effects. It contains compounds such as lectins and mannans, which may enhance insulin sensitivity and facilitate the uptake of glucose by cells, thereby lowering blood sugar levels. There is some evidence to suggest that *A. vera* may help lower blood sugar levels in people with type 2 diabetes [13]. Chronic inflammation a hallmark of type 2 diabetes, *A. vera* contains anti-inflammatory compounds like acemannan, which may help mitigate inflammation and improve insulin sensitivity. *A. vera* contains antioxidants such as vitamins C and E, flavonoids, and polyphenols. These antioxidants help neutralize free radicals, which can cause cellular damage and contribute to the development of diabetes complications. Lectins and mannans in *A. vera* may help in reducing blood sugar levels. By stabilizing blood sugar levels, *A. vera* may reduce cravings for sugary or high-calorie foods, thereby supporting weight management efforts. Some research suggests that *A. vera* supplementation may improve lipid profile parameters, including lowering levels of LDL cholesterol and triglycerides, which are often elevated in individuals with diabetes. While these properties suggest that *A. vera* may have potential benefits for individuals with diabetes, more research is needed to fully understand its mechanisms of action and determine optimal dosages and formulations. It is essential to consult with a health-care professional before using *A. vera* or any other herbal supplement, especially if you have diabetes or are taking medications, to avoid potential interactions or adverse effects. Cholesterol and Blood Sugar Regulation: Some animal studies have suggested that *A. vera* may have beneficial effects on cholesterol levels and blood sugar regulation. High cholesterol and blood sugar levels are risk factors for heart disease, and substances that help regulate these factors may contribute to heart health.

19. *A. VERA* ANTICANCER PROPERTIES

Research in this area is ongoing and will be carried out for evidence to fully understand its effectiveness. Here are some potential anticancer properties of *A. vera*. *A. vera* contains antioxidants that can neutralize free radicals and reduce oxidative stress. Oxidative stress contributes to DNA damage and the development of cancer. By reducing oxidative stress, *A. vera* may help prevent cancer initiation and progression. Chronic inflammation is associated with an increased risk of cancer development due to DNA damage [14]. *A. vera* has demonstrated anti-inflammatory properties, which may help reduce inflammation and lower the risk of cancer. By inhibiting inflammatory pathways and

reducing the production of pro-inflammatory mediators, *A. vera* may create an environment less conducive to cancer growth. Apoptosis, or programmed cell death, is a natural process that helps eliminate damaged or abnormal cells, including cancer cells [15]. Some studies suggest that *A. vera* extracts may induce apoptosis in cancer cells, which is a promising mechanism for cancer treatment. *A. vera* may inhibit tumor growth and metastasis in various types of cancer [16]. These compounds may interfere with signaling pathways involved in cancer cell proliferation. Few scientists have reported the adverse effects and carcinogenicity of *A. vera* [17].While these findings are promising, it is important to note that most of the evidence supporting the anticancer properties of *A. vera* comes from laboratory and animal studies. Clinical studies in humans are limited, and more research is needed to determine the effectiveness and safety of *A. vera* as a complementary or alternative therapy for cancer prevention and treatment [2]. In addition, *A. vera* should not be used as a replacement for conventional cancer treatments but rather as a complementary approach.

20. *A. VERA* IN AGRICULTURE PRACTICES

By incorporating *A. vera* into agricultural practices, farmers can achieve crop improvement through enhanced growth, stress tolerance, disease resistance, and nutrient uptake. Application timing, dosage, and compatibility with other inputs to maximize the benefits of *A. vera* in agriculture. In addition, conducting field trials and monitoring plant responses can help optimize its use for specific crops and growing conditions.

21. IMPROVING THE PLANT GROWTH

A. vera contains growth-promoting compounds such as auxins, gibberellins, and cytokinins, which can stimulate plant growth and development. Applying *A. vera* extracts as a foliar spray or soil drench can enhance root development, increase nutrient uptake, and promote overall plant vigor. Polysaccharides and antioxidants help plants tolerate environmental stresses. Treating crops with *A. vera* solutions during stress periods can mitigate the adverse effects and improve crop resilience. Its leaves, with gibberellins, amino acids, lignin, micro- and macro-nutrients, and vitamins, improve the vegetative growth of plants. Treating seeds with *A. vera* gel or extracts before planting can enhance germination rates, improve seedling establishment, and boost early-stage growth. One report indicates foliar sprays of *A. vera* at different concentrations increased plant growth and yielded therapeutic value for *Silybum marianum* [18]. *A. vera* provides essential nutrients and growth-promoting substances that support seed development and help plants overcome initial stressors. Adding *A. vera* to fertilizers or nutrient solutions can provide crops with additional vitamins, minerals, and bioactive compounds. *A. vera* supplements can enhance plant nutrition, optimize metabolic processes, and improve crop yield and quality.

22. PLANT DISEASE MANAGEMENT

A. vera possesses natural antimicrobial and insecticidal properties, making it effective in controlling plant diseases and pests. Spraying *A. vera* extracts on crops can inhibit the growth of pathogens and repel pests, minimizing crop damage. *A. vera* contains anthraquinones and saponins that exhibit antifungal activity against pathogens responsible for various plant diseases, including damping-off, root rot, leaf spot, and powdery mildew. *A. vera* gel contains substances such as aloin and emodin, which possess antibacterial properties. These compounds can help in controlling bacterial pathogens that cause diseases such as bacterial blight, bacterial spot, and soft rot in plants. *A. vera* extracts can be used as biopesticides to manage plant diseases. Spraying *A. vera* solutions on plants creates a protective barrier against pathogens, reducing their ability to infect plant tissues. This approach is environmentally friendly and reduces the reliance on synthetic chemical pesticides. *A. vera* extracts have been shown to induce systemic resistance in plants against pathogens. By activating plant defense mechanisms, *A. vera* enhances the plant's ability to resist infections and minimize disease development. This systemic resistance can provide long-lasting protection to crops. The wound-healing property of *A. vera* is beneficial in managing plant diseases caused by injuries or wounds. Applying *A. vera* gel to damaged plant tissues promotes rapid healing, preventing the entry of pathogens and reducing the risk of infection. Treating seeds with *A. vera* extracts before planting can help in controlling seed-borne pathogens and enhancing seedling vigor. A zone of fungal growth inhibition was reported for *A. niger* with *A. vera* leaf extract (ALE) [19].

A. vera provides a protective coating on seeds, inhibiting fungal and bacterial growth and promoting healthy seed germination and establishment. *A. vera* extracts as a post-harvest treatment to reduce the incidence of storage-related diseases in harvested crops. Applying *A. vera* solutions to fruits and vegetables helps in extending shelf life by inhibiting microbial spoilage and maintaining product quality.

23. IMPROVING THE SOIL FERTILITY

A. vera can improve soil fertility through several mechanisms: Incorporating *A. vera* into the soil as a natural amendment can improve soil structure, enhance water retention, and enrich soil fertility. *A. vera* contains organic matter, beneficial microbes, and nutrients that contribute to soil health, promoting better root growth and nutrient availability for crops. When incorporated into the soil, *A. vera* can contribute nutrients such as nitrogen, phosphorus, potassium, calcium, magnesium, and micronutrients, enriching the soil and supporting plant growth. *A. vera* contains organic compounds, including polysaccharides, enzymes, and amino acids, which can serve as a source of organic matter when applied to the soil. Organic matter improves soil structure, water retention, and nutrient availability, fostering a conductive environment for microbial activity and plant growth. *A. vera* extracts have been shown to stimulate microbial activity in the soil. Beneficial microorganisms play a crucial role in nutrient cycling, the decomposition of organic matter, and nutrient mineralization. By enhancing microbial populations, *A. vera* can contribute to soil health and fertility.

Foliar application of ALE, moringa leaf extract, to *Hibiscus sabdariffa* L. resulted in elevated levels of chlorophyll, carbohydrates, and protein [20]. *A. vera* has a neutral to slightly acidic pH, which can help regulate soil pH can be applied for maintenance.

A. vera has a neutral to slightly acidic pH, which can help regulate soil pH can be applied to maintain optimal soil pH. Soil Optimum pH is essential for nutrient availability and microbial activity, thus promoting soil fertility. *A. vera* extracts can improve soil structure and tilth, reducing compaction and increasing porosity.

Enhanced soil structure promotes root development, improves water infiltration and drainage, and facilitates nutrient uptake by plants, ultimately contributing to soil fertility.

24. CONCLUSION

Aloe vera have natural soothing and moisturizing gel is beneficial for skin care. It can provide relief from sunburn and irritation. It's having wound healing, antimicrobial and anti-inflammatory properties. It's used as home remedy and commercial skin care and hair care products. Research is in progress for its application as immune booster, anticancer, oral and digestive health. Agricultural applications such as

crop disease management, plant growth promotion and improving soil fertility using aloe vera are giving good results

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