

HEALTH BENEFITS OF THE GENUS ALOE, ITS PHYTOCHEMISTRY AND TOXICOLOGICAL PROFILE

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Abstract

Aloe vera a prominent member of the lily family, contains numerous bioactive compounds with therapeutic potential. Its Arabic name, "true bitter substance," reflects its bitter taste. *Aloe vera* is renowned for its antibacterial, anti-inflammatory properties, and skin benefits. With approximately 500 varieties, most cultivated in subtropical regions, *Aloe aborescens* and *Aloe barbadensis* are particularly significant for their medicinal applications. Commonly grown in Australia, Africa, Central America, the Caribbean, India, and Mexico, among other regions, *aloe vera* is a small plant (2 inches tall) with leaves that can reach 36 inches in length and weigh up to 3 pounds. Each leaf consists of three layers, with the inner gel comprising 99% water and 1% essential components, including vitamins, sterols, glucomannans, lipids, and amino acids.

INTRODUCTION

Aloe vera (True Aloe, genus *Aloe*) belongs to the *Asphodelaceae* family, *Asparagales* order, and *Plantae* kingdom. It is also known as *Aloe vulgaris* Lam., *Aloe barbadensis* Mill., and *Aloe flava* Pers. Regional names

include Mexico in French, Lu Hui in Chinese, and Bitter Aloes in English. A perennial, hardy herbaceous plant, *Aloe vera* thrives in hot, dry environments, including deserts and poor soils with

minimal watering. It is extensively cultivated in the Indian subcontinent, Asia, Africa, the Middle East, Australia, and Central America. Historical records indicate that the medicinal use of *Aloe* dates back to ancient civilizations, including those of **Egypt**, **China**, and **Greece**. In these cultures, *Aloe* was commonly employed for the treatment of wounds, burns, and various gastrointestinal disorders. Its therapeutic properties have been recognized for centuries, highlighting its significance in traditional medicine practices across different regions (Grace et al., 2015). The medicinal value of *Aloe* species is primarily attributed to their distinctive phytochemical constituents. Various parts of the plant—including the inner gel, latex, and rind—harbor a range of bioactive compounds such as polysaccharides, anthraquinones, flavonoids, saponins, vitamins, and enzymes. Notably, the inner gel of *Aloe vera* is particularly rich in acemannan, a polysaccharide recognized for its immunostimulatory and wound-healing properties (Eshun & He, 2004). These phytochemicals work synergistically to provide a broad spectrum of pharmacological benefits.

In addition to its historical applications, contemporary scientific research has substantiated numerous therapeutic properties of *Aloe* species. These properties encompass antioxidant, anti-inflammatory, antimicrobial, laxative, hepatoprotective, and even anticancer effects. For example, studies have demonstrated that *Aloe vera* gel can inhibit the production of pro-inflammatory cytokines, which makes it beneficial in the management of chronic inflammatory conditions. This validation of *Aloe*'s medicinal benefits underscores its relevance in both traditional and modern therapeutic contexts (Boudreau & Beland, 2006). Moreover, its antioxidant constituents, such as vitamins C and E, help neutralize free radicals and reduce oxidative stress.

Aloe vera is commonly used in dermatology and skincare due to its ability to soothe the skin, accelerate wound healing, and improve hydration. Topical applications of *Aloe vera* gel have demonstrated positive outcomes in the treatment of conditions such as burns, eczema, acne, and psoriasis. Its mucilaginous texture not only provides effective moisturization for the skin but also serves as a carrier for other medicinal agents, enhancing their absorption. Additionally,

Aloe's role in collagen synthesis and tissue regeneration further amplifies its significance in both cosmetic and therapeutic products, making it a valuable ingredient in skincare formulations aimed at promoting healing and improving skin health. (Surjushe et al., 2008).

Internally, *Aloe* extracts have been used as natural laxatives due to the presence of anthraquinones like aloin and emodin. These compounds stimulate bowel movements by increasing intestinal peristalsis and water secretion into the colon. However, prolonged or high-dose use can lead to adverse effects such as electrolyte imbalance, diarrhea, and dependency, which highlights the importance of proper dosage and formulation (National Toxicology Program, 2013). This dual nature—beneficial and potentially harmful—requires careful consideration.

The phytochemical composition of *Aloe* can vary considerably based on factors such as species, environmental conditions, plant maturity, and extraction methods. For example, while the inner gel is typically regarded as safe and is widely utilized, the latex—found as a yellowish sap beneath the skin—contains elevated levels of potentially toxic anthraquinones. Therefore, it is crucial to employ proper processing techniques, including decolorization and purification, to eliminate harmful substances and ensure the safety of *Aloe*-derived products. This careful processing is essential for maximizing the therapeutic benefits of *Aloe* while minimizing any associated risks (Eshun & He, 2004). Beyond its well-established dermatological and gastrointestinal applications, *Aloe* has demonstrated therapeutic potential in immune modulation, diabetes management, and hepatoprotection. Acemannan, one of its principal polysaccharides, enhances macrophage activity and stimulates cytokine production, thereby supporting immune responses. In experimental models of diabetes, *Aloe* extracts have exhibited hypoglycemic effects by improving insulin sensitivity and lowering blood glucose levels.

(Grace et al., 2015), positioning it as a candidate for integrative approaches in metabolic disorders.

Despite the therapeutic potential of *Aloe*, concerns about its toxicity have been raised, especially with unprocessed or whole-leaf preparations. The National Toxicology Program (2013) reported carcinogenic effects in animal studies involving non-decolorized

Aloe vera extracts. These findings have led regulatory bodies to limit or ban the use of certain *Aloe*-derived ingredients in food and supplements unless properly processed. Therefore, safety assessments and standardization are critical when incorporating *Aloe* into commercial products.

Recent advances in phytochemical research and analytical techniques have significantly enhanced the ability to identify, isolate, and characterize bioactive compounds in *Aloe*. These developments facilitate a deeper understanding of the complex chemical profile of *Aloe* species, enabling researchers to pinpoint specific compounds responsible for their therapeutic effects. Techniques such as high-performance liquid chromatography (HPLC), mass spectrometry (MS), and nuclear magnetic resonance (NMR) spectroscopy have proven invaluable in elucidating the structure and function of these bioactive constituents. As a result, this progress not only contributes to the scientific validation of *Aloe*'s medicinal properties but also supports the development of more effective and targeted applications in health and wellness (Boudreau & Beland, 2006).

The genus *Aloe* consists of succulent plants that have been traditionally utilized across various cultures for their medicinal properties, particularly in skin healing and anti-inflammatory applications. The bioactive compounds found in *Aloe vera* leaves, including polysaccharides and glycoproteins, play a crucial role in its therapeutic effects. These compounds contribute to the promotion of wound healing and the reduction of inflammation by stimulating fibroblast activity and enhancing collagen synthesis. This mechanism underscores *Aloe*'s effectiveness in supporting skin health and recovery from injuries, making it a valuable resource in both traditional and modern medicine (Hamman, 2008; Choi & Chung, 2003). These effects have been exploited in topical formulations for burns, abrasions, and other skin injuries.

The therapeutic applications of *Aloe* extend beyond dermatological uses, as research has shown its efficacy in managing digestive ailments and supporting immune function. Polysaccharides in *Aloe vera*, particularly acemannan, have immunomodulatory properties that enhance the body's defense against pathogens (Ahmad et al., 2017). Moreover, the plant contains various antioxidants that neutralize free

radicals, mitigating oxidative stress implicated in chronic diseases (Hamman, 2008).

While *Aloe vera* is generally considered safe for most uses, certain constituents—particularly anthraquinones present in the latex—possess potent laxative properties and may cause adverse effects or toxicity when consumed in excessive amounts (Baroni et al., 2012). Clinical studies emphasize the importance of controlled dosages to avoid adverse effects like electrolyte imbalance and gastrointestinal distress (Vogler & Ernst, 1999). This dual nature underscores the necessity for proper standardization of *Aloe*-based products.

Advances in phytochemical analysis have revealed a complex composition in *Aloe* species, including vitamins A, C, E, flavonoids, and sterols that contribute to its anti-inflammatory and antimicrobial activities (Balekar et al., 2012; Wani et al., 2010). These compounds not only promote skin repair but also inhibit the growth of various bacteria and fungi, supporting its use in traditional medicine for infections and inflammation (Lattouf et al., 2013).

The increasing demand for natural remedies has brought *Aloe* to the forefront of modern pharmacognosy and cosmetic research. Its inherent moisturizing and antioxidant properties have established *Aloe* as a favored ingredient in skincare products designed to prevent premature aging and soothe irritated skin. This trend reflects a broader shift towards incorporating natural ingredients in cosmetic formulations, as consumers seek effective and gentle solutions for maintaining skin health. The versatility of *Aloe* not only enhances the efficacy of these products but also aligns with the growing preference for sustainable and plant-based alternatives in the beauty industry (Eshun & He, 2004; West, 1996). Ongoing studies seek to optimize extraction methods to enhance bioavailability and therapeutic outcomes.

1. Phytochemical Composition

Aloe vera leaves contain over 200 bioactive components. The inner gel consists of 98% water and 0.66% solids, with 0.56% soluble. Dried gel contains 17% sugar and 53% polysaccharide. Vitamins A, C, B12, choline, and folic acid exhibit antioxidant properties (Sies et al. 1995). Alprogens, polysaccharides, auxin, and gibberellin support tissue

repair, wound healing, and anti-inflammatory effects. Minerals like calcium, potassium, manganese, selenium, chromium, and copper facilitate enzyme control, metabolism, and antioxidant defense. Salicylic acid exhibits anti-inflammatory and antibacterial properties (Sahu et al. 2013). Varieties such as *Aloe littoralis*, *Aloe arborescens*, *Aloe akaberi*, and *Aloe pirotta* are effective in treating sunburn, blood pressure control, wound healing, and diabetes. Aloe vera gel is also used for heartburn, irritable bowel syndrome, bleeding gums, menstrual pain, and otorhinolaryngological disorders. Liver secretion of anthraquinone supports liver function with anti-inflammatory and antioxidant properties. Phytosterols regulate cholesterol levels, reducing inflammatory cytokines and preventing hyperlipidaemia and cardiovascular disease (Shruthietal. 2023). Blat extract has been shown to improve conditions related to the yellow barrel and the uterus, as well as to reduce intestinal secretion in the stomach. This extract may possess properties that support digestive health and contribute to the regulation of gastrointestinal functions. Its potential benefits in managing uterine health further highlight its therapeutic applications in traditional and modern herbal medicine. Awadh et al. (2025) detected properties of actions against antibiotic-resistant *Pseudomonas aeruginosa* adding beneficial properties due to AmpC protein.

2. Classification of Phytochemicals

Phytochemicals are broadly classified into **primary** and **secondary metabolites**. Primary metabolites, such as carbohydrates, proteins, and lipids, play essential roles in plant growth and development. In contrast, secondary metabolites are primarily associated with the plant's medicinal and protective properties. These secondary compounds can be further categorized into major groups, including alkaloids, flavonoids, phenolics, saponins, tannins, terpenoids, glycosides, and steroids (Harborne, 1998). Each group of bioactive compounds found in plants exhibits distinct biological functions and therapeutic applications, positioning them as significant targets for phytochemical research (Li et al., 2023). Understanding the specific roles and effects of these compounds can lead to the development of novel therapeutic agents and enhance the efficacy of existing

treatments. By exploring the diverse properties of these compounds, researchers can uncover new insights into their potential uses in medicine, nutrition, and wellness, ultimately contributing to advancements in health care and disease management.³.

Alkaloids and Their Pharmacological Roles

Alkaloids are a group of nitrogen-containing compounds that contribute to the plant's medicinal properties. alkaloids are typically found in the **roots**, **bark**, and **seeds** of various plants and have been extensively studied for their analgesic, antimalarial, and anticancer properties. Notable examples of alkaloids include morphine derived from *Papaver somniferum*, quinine obtained from *Cinchona* species, and berberine sourced from *Berberis* species (Dewick, 2002). The mechanisms of action of these alkaloids are diverse and include: **enzyme inhibition**, **DNA intercalation** and **interference with Neurotransmission**. Alkaloids like morphine interact with neurotransmitter systems, providing pain relief and influencing various physiological responses.

Aloe vera is primarily known for its polysaccharides and glycoproteins, the presence of alkaloids adds to its pharmacological profile (Anzano et al. 2025). Some key points regarding alkaloids in *Aloe vera* include:

- **Types of Alkaloids:** *Aloe vera* contains various alkaloids, including **aloids**, which are derived from the latex of the plant. Aloin is known for its laxative effects and potential therapeutic benefits.
- **Biological Activities:** Alkaloids in *Aloe vera* exhibit a range of biological activities, including antimicrobial, anti-inflammatory, and antioxidant properties. These activities contribute to the overall health benefits associated with *Aloe vera*.
- **Therapeutic Applications:** The alkaloids found in *Aloe vera* may play a role in treating conditions such as digestive disorders, skin irritations, and inflammatory diseases. Their presence enhances the plant's utility in traditional and modern herbal medicine.
- **Safety Considerations:** While alkaloids can offer therapeutic benefits, some, like aloin, can be toxic in high doses. Therefore, proper processing and dosage are essential to ensure safety when using *Aloe vera* products.

4. Flavonoids and Phenolic Compounds

Flavonoids and phenolic acids are among the most abundant and studied phytochemicals. These compounds possess strong antioxidant properties, enabling them to scavenge free radicals and reduce oxidative stress. Flavonoids are categorized into flavonols, flavones, isoflavones, and anthocyanins, among others. Dietary sources of these compounds include fruits, vegetables, teas, and various herbs. Their potent antioxidant properties play a significant role in reducing the risk of chronic diseases, including cardiovascular disorders, diabetes, and certain types of cancer (Panche et al., 2016).

5. Tannins and Saponins

Tannins are polyphenolic compounds that bind to proteins and other organic compounds, forming stable complexes. They exhibit antimicrobial, antioxidant, and astringent properties. Saponins, on the other hand, are glycosidic compounds that produce foam in aqueous solutions and show a wide range of biological activities, including cholesterol-lowering, anti-inflammatory, and immune-boosting effects. Both tannins and saponins are frequently reported in ethnomedicinal plants and traditional herbal formulations (Gupta & Gupta, 2011).

6. Terpenoids and Essential Oils

Terpenoids, also known as isoprenoids, are the largest group of phytochemicals and are responsible for the aroma and flavor of many plants. These include monoterpenes, diterpenes, and triterpenes, which are often components of essential oils. Terpenoids have shown significant anti-inflammatory, antimicrobial, and anticancer activities, making them valuable compounds in medicinal research. For example, limonene, found in citrus oils, and pinene, derived from pine oils, is recognized for their biological efficacy and low toxicity (Bakkali et al., 2008).

7. Methods of Phytochemical Extraction and Analysis

The extraction and analysis of phytochemicals are crucial for understanding their pharmacological potential. Common extraction methods include maceration, Soxhlet extraction, and cold percolation using solvents like methanol, ethanol, chloroform, and water. Advanced analytical techniques such as High-Performance Liquid Chromatography (HPLC),

Gas Chromatography–Mass Spectrometry (GC-MS), and Fourier Transform Infrared Spectroscopy (FTIR) are employed to identify and quantify these compounds (Pérez-Jiménez et al., 2010). These techniques offer reproducibility and accuracy, essential for scientific validation.

8. Factors Affecting Phytochemical Content

Several intrinsic and extrinsic factors influence the phytochemical composition of plants. These include the plant's genetic makeup, age, part used (leaf, root, bark, etc.), season of harvest, soil type, altitude, and processing methods. For example, younger leaves may contain higher levels of flavonoids, while mature bark may have more alkaloids. Additionally, drying methods and storage conditions can lead to the degradation or transformation of certain compounds (Luthria, 2008).

9. Significance of Phytochemicals in Drug Discovery

Phytochemicals remain a cornerstone in drug discovery and development, playing a crucial role in the identification of new therapeutic agents. Many modern pharmaceutical compounds are either directly derived from or inspired by plant-based substances. Examples include aspirin (from salicin in *Salix alba*), paclitaxel (from *Taxus brevifolia*), and artemisinin (from *Artemisia annua*). The study of phytochemicals not only helps validate traditional medicine but also provides novel chemical scaffolds for synthetic modification and therapeutic innovation (Newman & Cragg, 2020). Phytochemicals in *Aloe vera* play a significant role in its therapeutic applications and continue to be a focal point in drug discovery and development. Many modern pharmaceutical agents are inspired by or derived from the bioactive compounds found in *Aloe vera* (Hirave et al., 2025). The presence of bioactive compounds, including polysaccharides, glycoproteins, anthraquinones, flavonoids, and terpenoids, is highly beneficial due to wound healing, anti-inflammatory effects, and antimicrobial properties.

Impact on the Central and Peripheral Nervous System

1. Introduction

Phytochemicals have demonstrated significant potential in modulating both the central nervous

system (CNS) and the peripheral nervous system (PNS). Many plant-derived compounds exhibit neuroprotective, anti-inflammatory, and antioxidant activities, which are crucial for preventing or alleviating neurological disorders. The CNS, composed of the brain and spinal cord, and the PNS, comprising nerves outside the CNS, are vulnerable to oxidative stress, inflammation, and neurodegeneration. Increasing evidence supports the role of phytochemicals in enhancing neuronal function, protecting neurons from damage, and potentially reversing neuropathological changes (García-Sánchez et al., 2020). *Aloe vera* extract has neuroprotective properties that support memory and cognitive function. They may be in the prevention and treatment of Alzheimer's disease (Gregory et al., 2021). An effect of *Aloe vera* extract helps prevent atherosclerosis, reduces cholesterol, lipoprotein (LDL), and improves cardiovascular health (demolition).

2. Antioxidant and Neuroprotective Actions

Oxidative stress is a key contributor to neurodegenerative diseases such as Alzheimer's, Parkinson's, and amyotrophic lateral sclerosis (ALS). Phytochemicals such as flavonoids, phenolic acids, and terpenoids act as antioxidants by scavenging free radicals and reducing lipid peroxidation. For instance, curcumin from *Curcuma longa* and resveratrol from grapes have exhibited potent antioxidant and neuroprotective effects in both in vitro and in vivomodelss (Mythri & Bharath, 2012). These compounds are known to modulate critical signaling pathways, such as the Nrf2/ARE (nuclear factor erythroid 2-related factor 2/antioxidant response element) pathway, which plays a vital role in cellular defense against oxidative stress. Additionally, they inhibit pro-oxidant enzymes, thereby helping to maintain redox balance in neuronal cells. This balance is crucial for protecting neurons from oxidative damage and supporting overall brain health. In comparison, *Aloe vera* also exhibits notable antioxidant and neuroprotective properties, primarily attributed to its rich phytochemical composition, including polysaccharides, flavonoids, and vitamins. Studies have demonstrated that *Aloe vera* can scavenge free radicals and reduce oxidative stress, similar to curcumin and resveratrol (Cordiano et al., 2025). The

presence of compounds like aloe-emodin, anthraquinone, and acemannan in *Aloe vera* contributes to its ability to protect neuronal cells from oxidative damage and inflammation.

3. Anti-inflammatory Effects on Nervous Tissue

Chronic inflammation in the CNS is implicated in the progression of multiple sclerosis, Alzheimer's disease, and spinal cord injuries. Phytochemicals such as quercetin, apigenin, and catechins have been shown to suppress the activation of microglia and astrocytes, which are key players in the inflammatory response within the central nervous system (Grabarczyk et al, 2024). By inhibiting the activation of these glial cells, these phytochemicals help reduce the release of pro-inflammatory cytokines, including TNF- α (tumor necrosis factor-alpha) and IL-6 (interleukin-6) (Spencer et al., 2012). These anti-inflammatory properties help protect neuronal integrity and enhance recovery following injury or disease. In *Aloe vera*, phytochemicals such as quercetin, apigenin, and catechins contribute to its anti-inflammatory properties by suppressing the activation of microglia and astrocytes (Hasbal-Celikok et al., 2025).

4. Cognitive Enhancement and Neurogenesis

Some phytochemicals have been reported to enhancememory, learning, and cognitive performance. *Bacopa monnieri*, commonly known as Brahmi, contains bacosides that enhance synaptic communication, increase dendritic branching, and promote neurogenesis in the hippocampus, a brain region critical for memory formation (Aguilar & Borowski, 2013). Similarly, ginsenosides from *Panax ginseng* have been shown to improve cognitive performance by modulating cholinergic transmission and increasing cerebral blood flow. *Aloe vera* has been studied for its potential health benefits, including its effects on cognitive function, although the evidence specifically linking *Aloe vera* to improvements in memory, learning, and cognitive performance is not as robust as that for some other phytochemicals (Khedraoui et al, 2025). Some studies suggest that the antioxidant and anti-inflammatory properties of *Aloe vera* may contribute to overall brain health, potentially supporting cognitive function indirectly by reducing oxidative stress and inflammation (Velázquez-López et

al. 2024). Furthermore, more research focused on it, is needed to establish a direct link between *Aloe vera* and cognitive enhancement.

5. Modulation of Neurotransmitters

Certain phytochemicals influence neurotransmitter systems, such as dopamine, serotonin, acetylcholine, and GABA. For example, alkaloids like caffeine and nicotine act as CNS stimulants by modulating dopamine and acetylcholine release. Meanwhile, compounds such as magnolol (from *Magnolia officinalis*) and kaempferol (a flavonoid) have GABAergic effects, making them potential anxiolytic and anticonvulsant agents (Zhang et al., 2019). These interactions with neurotransmitter systems underpin the use of medicinal plants in managing mood disorders, anxiety, and epilepsy.

6. Neuroprotective Potential in Peripheral Neuropathy

Peripheral nerve damage can result from diabetes, chemotherapy, infections, or trauma. Some phytochemicals help in the regeneration of peripheral nerves or alleviate neuropathic pain. For instance, capsaicin from chili peppers acts on TRPV1 receptors to reduce pain perception, while alpha-lipoic acid, a naturally occurring antioxidant, has shown benefits in diabetic neuropathy (Ziegler et al., 2006). Flavonoid-rich plant extracts such as those from *Ginkgo biloba* also support peripheral nerve function by improving microcirculation and reducing inflammation.

7. Alzheimer's Disease and Phytochemicals

Alzheimer's disease (AD) is characterized by amyloid- β plaque formation, tau hyperphosphorylation, synaptic loss, and neuronal death. Numerous phytochemicals have shown potential in preventing or slowing AD progression. Curcumin inhibits amyloid aggregation, resveratrol activates sirtuin-1 (SIRT1), and epigallocatechin gallate (EGCG) reduces tau phosphorylation (Rege et al., 2015). These compounds also influence cholinesterase activity, suggesting a multi-target approach to neurodegeneration.

8. Parkinson's Disease and Natural Compounds

In Parkinson's disease, degeneration of dopaminergic neurons in the substantia nigra leads to motor and

cognitive dysfunction. Phytochemicals such as baicalein, naringenin, and rosmarinic acid have shown neuroprotective effects by reducing mitochondrial dysfunction, oxidative stress, and neuroinflammation in PD models (Gao et al., 2013). These findings highlight the potential of plant-derived compounds as adjuncts to conventional Parkinson's therapies.

9. Future Prospects and Challenges

Despite their promising biological effects, many phytochemicals encounter significant challenges in clinical translation, primarily due to issues such as poor bioavailability, limited permeability across the blood-brain barrier, and metabolic instability. These factors can hinder the effective delivery and therapeutic potential of these compounds in treating central nervous system (CNS) and peripheral nervous system (PNS) disorders.

However, recent advancements in nanotechnology, formulation science, and drug delivery systems are making strides in overcoming these limitations. For instance, nanocarriers can enhance the solubility and stability of phytochemicals, facilitating their transport across the blood-brain barrier and improving their bioavailability. Continued research, including well-designed clinical trials, is crucial to validate the safety and efficacy of *Aloe vera* in human applications. Such studies will help clarify the mechanisms of action of its phytochemicals, determine optimal dosages, and assess potential interactions with other treatments. By overcoming the existing challenges and harnessing the full potential of *Aloe vera*, researchers aim to develop effective natural therapies for managing CNS and PNS disorders, ultimately improving health outcomes and quality of life for patient (Williams & Spencer, 2012).

Conclusion

The genus *Aloe*, particularly *Aloe vera*, provides a diverse array of health benefits attributed to its rich phytochemical composition, which includes anthraquinones, flavonoids, polysaccharides, and vitamins. These compounds contribute to *Aloe vera*'s notable antioxidant, anti-inflammatory, antimicrobial, and wound-healing properties, making it a valuable resource in both traditional and modern medicine.

However, it is important to note that certain components of *Aloe*, such as **aloin** and other anthraquinones, can exhibit toxic effects when consumed at high doses or with prolonged use. This potential for toxicity underscores the necessity for caution in the use of *Aloe vera* products.

Therefore, while *Aloe vera* holds significant therapeutic potential, its application should be guided by proper dosage, appropriate preparation methods, and an awareness of possible adverse effects. This careful approach ensures that the benefits of *Aloe vera* can be harnessed safely and effectively, maximizing its positive impact on health while minimizing risks.

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