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ALOE VERA: A REVIEW ON ITS PHYTOCHEMISTRY AND SKIN BENEFITS

Shosi Mari Larido[1]*, Kharie Shaine Timosa[1], Kezy Grave[1], Aira Silan[1], Jayvelita Baes, Michaela Sosas[1], Nursia Basso[1], Mylene Andal[2]

[1]College of Pharmacy, Medina College Ipil Incorporated, Ipil, Zamboanga Sibugay, Philippines.
[2]School of Pharmacy, Centro Escolar University, 9 Mendiola St., San Miguel, Manila, Philippines.

***Corresponding Author: Shosi Mari Larido**

College of Pharmacy, Medina College Ipil Incorporated, Ipil, Zamboanga Sibugay, Philippines.

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ABSTRACT

Aloe vera is a widely used medicinal plant known for its skin-related therapeutic properties. This review aims to summarize and evaluate existing literature on the phytochemical composition and dermatological benefits of *Aloe vera*. A narrative review design was used to collect and analyze related studies from databases such as Google Scholar and PubMed. The plant contains several bioactive compounds, including polysaccharides, vitamins, enzymes, phenolic compounds, and amino acids, which contribute to its pharmacological effects. Based on the reviewed literature, *Aloe vera* shows moisturizing, wound healing, anti-inflammatory, antimicrobial, and skin-repairing properties. These effects support its use in skincare formulations such as herbal soaps, including Castile soap. However, despite strong experimental evidence, further clinical studies are needed to fully establish its effectiveness in treating skin conditions such as hyperpigmentation and scarring.

KEYWORDS: Aloe vera, Phytochemistry, Skin benefits, Moisturizing, Wound healing.

1. INTRODUCTION

Aloe vera (L.) Burm. f. is a succulent plant belonging to the family Asphodelaceae and is widely distributed in tropical and subtropical regions. It has been traditionally used for its medicinal properties, especially in treating skin conditions such as burns, wounds, and dryness. According to Radha and Laxmipriya (2015), *Aloe vera* is one of the most extensively used medicinal plants due to its therapeutic and cosmetic applications.

In recent years, there has been an increasing demand for natural skincare products. This is mainly because plant-based ingredients are considered safer and more suitable for long-term use. In the Philippines, herbal-based products such as soaps and topical formulations are becoming more popular, particularly those containing *Aloe vera*.

The objective of this review is to summarize and evaluate existing literature on the phytochemistry and skin benefits of *Aloe vera*. It focuses on the plant's bioactive compounds and their role in moisturizing, wound healing, scar reduction, and improving overall skin condition.

1.1. Botanical and taxonomic description of *Aloe Vera*

Aloe vera (L.) Burm. f. is a perennial succulent plant belonging to the family Asphodelaceae. It is widely distributed in tropical and subtropical regions, including Africa, Asia, and parts of the Philippines (Hamman, 2018). The plant is commonly cultivated due to its medicinal and commercial value.

Taxonomically, *Aloe vera* belongs to the kingdom Plantae, division Tracheophyta, class Liliopsida, order Asparagales, family Asphodelaceae, genus *Aloe*, and species *Aloe vera* (Nalimu et al., 2021). It is also known by other names such as *Aloe barbadensis Miller*, which is often used interchangeably in scientific literature.

The plant is characterized by thick, fleshy, lance-shaped leaves that grow in a rosette pattern. These leaves are green to gray-green in color and may have serrated edges. The inner part of the leaf contains a clear gel,

which is the primary source of its medicinal properties. The plant can grow up to 60–100 cm in height and produces yellow tubular flowers arranged in spikes under favorable conditions (Hamman, 2018).

The gel inside the leaves is composed mainly of water (about 98–99%) along with bioactive compounds such as polysaccharides, vitamins, enzymes, and amino acids. These components are responsible for the plant's therapeutic effects, especially in skincare applications (Radha & Laxmipriya, 2015).

1.2. Traditional Neurocognitive Uses of *Aloe Vera*

Aloe vera has been widely used in traditional medicine systems such as Ayurveda, Traditional Chinese Medicine, and other herbal practices for its healing properties. It is commonly used to treat burns, wounds, skin irritation, and inflammation (Surjushe et al., 2015).

In traditional applications, the gel extracted from the leaves is applied directly to the skin to promote healing and reduce pain. According to Radha and Laxmipriya (2015), *Aloe vera* has been used as a natural remedy for cuts, minor wounds, and dry skin due to its soothing and moisturizing properties.

Aside from skin-related uses, *Aloe vera* has also been used for its antimicrobial and anti-inflammatory effects. Nalimu et al. (2021) reported that the plant has been traditionally used to manage infections and support overall skin health.

In some cultures, *Aloe vera* is also used for internal purposes, such as improving digestion and boosting immunity, although these uses require careful preparation and proper dosage (Hamman, 2018).

The traditional uses of *Aloe vera* support its current application in modern skincare formulations, including herbal soaps like Castile soap, where it is used for its moisturizing and skin-repairing properties.

Table 1: Traditional Neurocognitive Uses of *Aloe Vera.*

Plant Part	Traditional Use	References
Leaf Gel	Treatment for burns and wounds	Radha & Laxmipriya, 2015
Leaf Gel	Moisturizing dry skin	Surjushe et al., 2015
Whole Leaf	Anti-inflammatory use	Nalimu et al., 2021
Latex	Laxative	Hamman, 2018

2. METHODOLOGY

This study used a narrative review design to collect and analyze existing literature related to the phytochemistry and dermatological benefits of *Aloe vera*. Relevant articles were obtained primarily from Google Scholar, PubMed, and ScienceDirect.

The following keywords were used: *"Aloe vera," "phytochemistry," "skin benefits," "wound healing," "moisturizing," and "dermatological effects."*

Only peer-reviewed journal articles published from 2015 onwards were included to ensure updated and reliable data. Studies were selected if they discussed the phytochemical composition or skin-related effects of *Aloe vera*. Non-English articles, duplicate studies, and non-scholarly sources were excluded.

The collected data were analyzed by identifying common findings, mechanisms of action, and research gaps.

3. Phytochemistry of Aloe vera

Aloe vera contains a wide range of bioactive compounds that contribute to its medicinal properties. According to Radha and Laxmipriya (2015), the plant contains more than 75 active components, including vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids, and amino acids.

Nalimu et al. (2021) further reported that *Aloe vera* contains important phytochemicals such as flavonoids, tannins, alkaloids, and phenolic compounds, which contribute to its pharmacological activities.

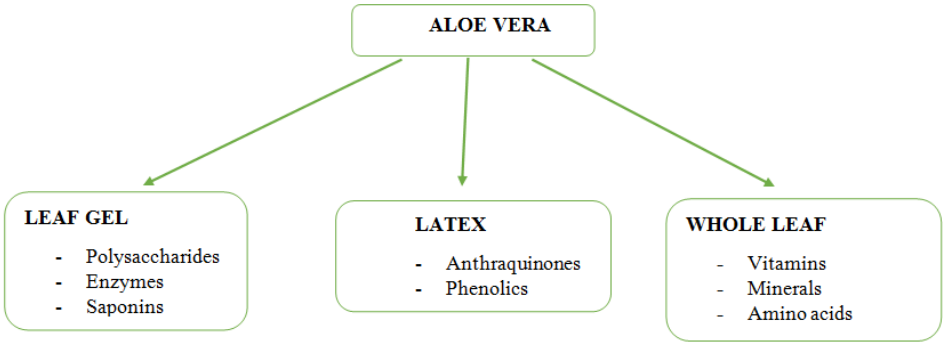


Figure 1: Distribution of Major Phytochemical Compounds in *Aloe Vera.*

Table 2: Major Phytochemical Compound Identified in Different Parts of *Aloe Vera.*

Compound Type	Examples	Reported Activity	References
Polysaccharides	Acemannan	Moisturizing, wound healing	Radha & Laxmipriya, 2015
Vitamins	Vitamin A, C, E	Antioxidant	Surjushe et al., 2015
Phenolic compounds	Anthraquinones	Antimicrobial, anti-inflammatory	Nalimu et al., 2021
Enzymes	Bradykinase	Anti-inflammatory	Radha & Laxmipriya, 2015
Amino acids	Essential amino acids	Tissue repair	Hamman, 2018

These compounds work together to produce the therapeutic effects of *Aloe vera*, especially in skin applications.

Leaf Gel

The leaf gel of *Aloe vera* is the clear, mucilaginous inner portion of the leaf parenchyma and is widely recognized as the primary source of its therapeutic properties. It contains a high concentration of polysaccharides, particularly acemannan, along with glucomannans, amino acids, vitamins (A, C, and E), enzymes, and minerals. According to National Center for Complementary and Integrative Health (2022), the gel is commonly used for topical applications due to its wound healing, moisturizing, and anti-inflammatory effects. Furthermore, Molecules reported that these polysaccharides contribute significantly to immunomodulatory and antimicrobial activities, enhancing fibroblast proliferation and collagen synthesis (Surjushe et al., 2008).

Additionally, Eshun and He (2004) emphasized that the hydrating properties of the gel are due to its ability to retain moisture and improve skin elasticity. These findings support the widespread use of aloe vera gel in dermatological and cosmetic formulations, particularly for treating burns, xerosis, and minor wounds.

Leaf Latex

The leaf latex of *Aloe vera* is a yellow, bitter exudate located beneath the outer rind of the leaf. It contains anthraquinones such as aloin (barbaloin) and emodin, which are responsible for its strong laxative effects. According to National Center for Complementary and Integrative Health (2022), aloe latex has been traditionally used as a stimulant laxative; however, its use is associated with potential adverse effects including abdominal cramping, diarrhea, and electrolyte imbalance.

Moreover, Encyclopaedia Britannica (2023) noted that anthraquinones act by increasing intestinal water content and stimulating peristalsis, thereby promoting bowel movement. Despite its pharmacological activity, prolonged use of aloe latex has raised safety concerns, including toxicity and possible carcinogenicity, leading to restrictions on its use in commercial products. These findings indicate that while the latex possesses therapeutic properties, its application requires caution and proper regulation.

Whole Leaf Extract

The whole leaf extract of *Aloe vera* is obtained by processing the entire leaf, including both the inner gel and outer latex. This extract contains a complex mixture of over 200 biologically active compounds, including polysaccharides, phenolic compounds, anthraquinones, vitamins, enzymes, and minerals. According to Boudreau and Beland (2006), whole leaf extracts exhibit a broad range of biological activities such as antioxidant, antimicrobial, and anti-inflammatory effects due to the synergistic interaction of these compounds.

However, the presence of anthraquinones from the latex component introduces potential safety concerns. The National Center for Complementary and Integrative Health (2022) reported that non-decolorized whole leaf extract has been classified as possibly carcinogenic in animal studies. As a result, modern processing techniques often involve decolorization to remove anthraquinones and improve safety for consumption and topical use. These findings suggest that while whole leaf extract offers a wider spectrum of bioactivity, its safety depends largely on proper processing and formulation.

4. Pharmacological Activities of Aloe vera

The pharmacological activities of *Aloe vera* are largely attributed to its rich and complex phytochemical composition, particularly polysaccharides, anthraquinones, vitamins, enzymes, and sterols. These bioactive constituents act synergistically to produce a wide range of therapeutic effects, especially in dermatological applications.

One of the most well-documented pharmacological activities of *Aloe vera* is its wound healing effect. According to Surjushe et al. (2008), the polysaccharide acemannan stimulates fibroblast proliferation and enhances collagen synthesis, which accelerates tissue repair and epithelial regeneration. In addition, the moist environment created by aloe gel promotes faster re-epithelialization and reduces scab formation, making it effective for burns, cuts, and minor abrasions.

Aloe vera also exhibits significant anti-inflammatory activity. Eshun and He (2004) reported that enzymes such as bradykinase help reduce excessive inflammation

by breaking down bradykinin, a compound responsible for pain and swelling. This mechanism supports the traditional use of aloe gel in soothing irritated or inflamed skin conditions such as dermatitis and sunburn.

In terms of antimicrobial activity, aloe vera contains anthraquinones, saponins, and phenolic compounds that inhibit the growth of bacteria, fungi, and certain viruses. The National Center for Complementary and Integrative Health (2022) noted that these compounds help prevent infection in damaged skin and support the healing process by reducing microbial colonization on wounds.

Another important pharmacological property is its antioxidant activity, which is primarily due to vitamins A, C, and E, as well as polyphenolic compounds. These antioxidants neutralize free radicals, thereby protecting skin cells from oxidative stress and delaying premature aging. This activity is particularly relevant in cosmetic formulations aimed at improving skin texture and reducing hyperpigmentation.

Furthermore, *Aloe vera* demonstrates moisturizing and skin barrier-enhancing effects. Its polysaccharide-rich gel has the ability to retain water within the skin, improving hydration and elasticity. According to Boudreau and Beland (2006), this property makes aloe vera highly suitable for treating xerosis (dry skin) and improving overall skin smoothness.

However, it is important to note that not all parts of the plant exhibit equal safety and efficacy. While the gel is considered safe for topical use, the latex portion contains anthraquinones such as aloin, which may exert strong laxative effects and potential toxicity when improperly processed. Thus, the pharmacological activity of aloe vera is highly dependent on the specific plant part used and its method of preparation.

Overall, the diverse pharmacological activities of *Aloe vera* support its wide application in pharmaceutical, cosmetic, and traditional medicinal systems, particularly in skin-related treatments involving hydration, healing, and protection.

Table 3: Summary of its Photochemistry and Skin Benefits of Aloe vera.

Phytochemical Class	Major Compounds	Reported Skin Benefits	Supporting Mechanisms
Polysaccharides	Acemannan, glucomannans	Wound healing, skin regeneration, hydration	Stimulates fibroblast activity, promotes collagen synthesis, enhances moisture retention
Vitamins	Vitamin A, C, E	Anti-aging, skin protection, brightening	Antioxidant activity reduces oxidative stress and UV-induced skin damage
Enzymes	Bradykinase, catalase, peroxidase	Anti-inflammatory, soothing effect on irritated skin	Reduces prostaglandin production and inflammatory responses
Anthraquinones	Aloin, emodin	Antimicrobial, exfoliating (low concentrations)	Inhibits microbial growth and promotes removal of dead skin cells
Amino Acids	Glycine, lysine, alanine	Skin repair, elasticity improvement	Supports protein synthesis and tissue repair processes
Saponins	Glycoside compounds	Cleansing, antimicrobial, antiseptic effects	Foaming action helps remove dirt and bacteria from skin surface
Sterols	β-sitosterol, campesterol	Anti-inflammatory, barrier repair	Strengthens skin barrier and reduces inflammation
Minerals	Zinc, magnesium, calcium	Skin healing, enzymatic support	Essential cofactors for cellular repair and enzymatic skin processes

Phytochemistry

Phytochemistry refers to the branch of science that deals with the study of chemical compounds naturally occurring in plants, including their structures, biosynthesis, and biological functions. These compounds, commonly known as phytochemicals, are secondary metabolites such as alkaloids, flavonoids, terpenoids, saponins, phenolics, and glycosides that are not directly involved in plant growth or reproduction but play significant roles in plant defense and physiological activity. According to Phytochemistry, phytochemicals are responsible for many of the therapeutic properties of medicinal plants and are widely studied for their pharmacological potential in drug development and natural product research. In medicinal species such as *Aloe vera*, phytochemistry explains the presence of bioactive constituents that contribute to its antioxidant, antimicrobial, anti-inflammatory, and wound-healing properties.

Skin Benefits

Skin benefits refer to the positive physiological and therapeutic effects that a substance exerts on the skin, particularly in terms of protection, hydration, repair, and overall skin health improvement. These benefits may include enhanced moisture retention, acceleration of

wound healing, reduction of inflammation, prevention of microbial infection, and protection against oxidative stress and environmental damage. In natural product research, skin benefits are commonly associated with plant-derived bioactive compounds that interact with skin cells and support dermal regeneration. In the case of *Aloe vera*, its skin benefits are attributed to its polysaccharides, vitamins, enzymes, and phenolic compounds, which collectively contribute to moisturizing, soothing, and regenerative effects on damaged or irritated skin, as supported by dermatological and cosmetic studies.

5. DISCUSSION AND LIMITATIONS

Most of the existing literature on *Aloe vera* is primarily based on laboratory-based experiments, in vitro analyses, and animal model studies. These preclinical investigations consistently demonstrate the plant's significant pharmacological potential, particularly in terms of wound healing, anti-inflammatory activity, antimicrobial effects, and skin hydration. However, despite these promising findings, there remains a limited number of well-controlled human clinical trials that can fully validate its efficacy and safety under real-world conditions, especially for long-term dermatological use.

Another important limitation identified in the reviewed literature is the lack of standardization in Aloe vera-based formulations. Variations in extraction methods, plant parts used (gel, latex, or whole leaf), concentration levels, and modes of application may lead to inconsistencies in reported outcomes. This variability makes it difficult to directly compare results across different studies and may influence the reproducibility of its pharmacological effects.

Furthermore, environmental factors such as soil composition, climate conditions, harvesting time, and plant maturity significantly affect the phytochemical profile of Aloe vera. These factors may alter the concentration of key bioactive compounds such as polysaccharides, anthraquinones, and phenolic constituents, thereby influencing its biological activity and therapeutic potential.

Given these limitations, the findings from the reviewed literature should be interpreted with caution. While Aloe vera demonstrates strong potential as a natural therapeutic agent for skin applications, further standardized and well-designed clinical studies are necessary to establish more definitive conclusions regarding its effectiveness and safety in human use.

6. Future Research

Future studies on *Aloe vera* should focus on conducting well-controlled human clinical trials to provide stronger evidence regarding its efficacy and safety in dermatological applications. Such studies may help bridge the gap between preclinical findings and real-world therapeutic use, particularly for skin conditions such as hyperpigmentation, scars, and chronic dryness.

In addition, future research should explore the standardization of Aloe vera extraction and formulation processes. Establishing consistent protocols for isolating gel, latex-free extracts, or whole-leaf preparations may improve reproducibility and ensure uniformity in pharmacological outcomes. This is especially important for commercial products such as soaps, gels, and cosmetic formulations.

Further investigations may also examine the synergistic effects of Aloe vera when combined with other natural ingredients, such as coconut oil or herbal extracts, to enhance its skin-beneficial properties. Studies focusing on optimal concentration levels and formulation stability are also recommended to improve product efficacy.

Moreover, future research may consider the influence of environmental and agricultural factors on the phytochemical composition of Aloe vera, as these variables significantly affect its bioactive content. Understanding these differences may lead to improved cultivation practices and higher-quality raw materials for medicinal and cosmetic use.

7. CONCLUSION

The reviewed literature confirms that *Aloe vera* contains a diverse range of bioactive compounds, including polysaccharides, vitamins, enzymes, sterols, and phenolic substances, which collectively contribute to its pharmacological activities. These phytochemical constituents are primarily responsible for its well-documented moisturizing, wound healing, anti-inflammatory, antioxidant, and antimicrobial properties, making it highly relevant in dermatological and cosmetic applications.

The findings further suggest that Aloe vera has strong potential as a natural ingredient in skincare formulations, particularly in products such as Castile soap, where mild cleansing and skin-conditioning properties are essential. Its ability to support skin hydration, promote tissue repair, and protect against microbial infection highlights its value in addressing common skin concerns such as dryness, irritation, and minor scarring.

However, despite these promising benefits, the current body of evidence is still insufficient to fully establish its clinical effectiveness in treating specific skin conditions such as hyperpigmentation, dark spots, and scars in human populations. Therefore, further clinical research and standardized formulation studies are recommended to validate its therapeutic claims and optimize its application in skincare and pharmaceutical products.

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