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Aloe Vera in Dentistry: A Review

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Abstract

Aloe Vera is a tender and succulent type of plant belonging to the *Liliaceae* family and genus Aloe. It has been used as a medicinal plant for its healing and soothing properties for more than 2000 years. Properties of the Aloe Vera are not only specie dependent but also on how it is handled after being collected. Due to the adverse effects associated with conventional drugs, researchers are again interested in pursuing plant-based therapies for diseases. Aloe Vera possesses number of beneficial ingredients whilst some studies have also reported its potentially harmful effects. Presence of Aloe Vera in the scaffold material increases viability of the regenerating cells. It is crucial to understand how Aloe Vera interacts with the human body and its physiology when used for dental diseases and discomforts. Components like anthraquinones, aloe-emodin, and aloin present in the Aloe Vera leaves are responsible for their strong anti-bacterial and anti-viral properties. Therefore, this article reviews the current literature related to Aloe Vera use as a replacement or adjunctive therapy in dental diseases.

Introduction

Man has tried to seek a cure for his illnesses from Mother Nature since ancient times. Many herbs and plants have been known to have anti-inflammatory and soothing effects along with reducing the bleeding. The main disadvantages of conventional drugs in dentistry are allergic reactions, toxicity, drug interactions, and drug resistance. There have also been reports of cytotoxicity and protein synthesis inhibition of PDL by conventional chemical agents having injurious effects on vital tissues of the oral cavity [1, 2]. Therefore, alternative medicine in the form of herbal agents is being sought to treat diseases [3]. For this reason, dentistry has also begun to look for alternatives to chemical agents for the treatment of pain, sores, and inflammation of the oral cavity. Endodontics has recently started using several plants extracts like Aloe Vera, neem and propolis, etc. for intra-canal medication with excellent results [4]. However, it is very crucial to understand how these herbs and plants interact with the human body and its physiology before they can be seriously considered for administration for dental diseases and discomforts.

Herb is derived from the Latin word “herba” which means grass. It is a broad term that is used for any plant that has stem, leaves, and fruit and has been used for its scent, flavor, or as food or medicine. The practice of herbal medicine is global and was the predominant type of medicine practiced in the West till the late twentieth century [5]. Among these herbs is Aloe Vera which has been known for its medicinal properties for thousands of years [6]. The word “alloe” belongs to Arabic, meaning “bitter and shining substance” and “Vera” is a Latin word that means “true”[7]. Aloe Vera belongs to the Liliaceae family and has more than three hundred species worldwide [8]. An Aloe Vera leaf has two parts; the outer part helps to transport the Aloe Vera latex and the inner part contains the gel, the bioactive material [9]. Aloe Vera leaves contain approximately 98.5% water and have system for storage of water in their leaves [10] and the rest of the part is solid which is packed with a wide range of components like carbohydrates, minerals, enzymes, organic acids, amino acids, phenolic compounds, and vitamins [11]. Aloe Vera specie like *Barbadensis* which is commonly available and contain around seventy-five components [12].

Global distribution

Aloe Vera is a perennial monoecious plant having superficial roots. Its habitat is diverse but certain species may be specific to certain regions. It readily grows in the arid climates of Asia and Africa but can also survive in subtropical regions [13].

Components of Aloe Vera

The gel of Aloe Vera is composed of plant cell wall material (insoluble), carbohydrates (soluble), calcium malate and protein [14]. Photochemical constituents of medicinal plants are extremely complex; they are a blend of ingredients with a range of different degrees of polarity and volatility. Functional groups present in most of these species are –COOH, -OH, =NH, -SH -NH_2 with the carboxylic group being the most abundant functional group present [15].Some studies also reported the functional groups present in Aloe Vera as–OH, COO-, =CO-CH_3 and –COC [16]. However, further studies are needed to fully understand the types of functional groups present in different species of Aloe Vera [17]. The major ingredients of Aloe Vera gel are given in **Table 1**.

Polysaccharides

Polysaccharides make the most abundant component in Aloe Vera gel[18]. Acemannan is a natural storage polysaccharide consisting of β- [1, 4] -linked highly acetylated mannoses, α- [1, 6] -linked galactose, and β- [1, 4] -linked glucose and is found in the pulp/gel of the Aloe Vera leaves. It is the major bioactive component of Aloe Vera and it’s breakdown increases bioactivity of the Aloe Vera [19]. It has an abundance of beneficial properties like anti-oxidation, anti-cancer, wound healing, bone healing, immune-regulation, and others [20].

Amino acids

The human body can only synthesize 12 types of amino acids while the rest of 8 types known as essential amino acids need to be taken from outside sources like food. Aloe Vera contains 7 types of these essential amino acids though there have been claims that all 8 types of the essential amino acids are present in the plant [7].

Enzymes

Two types of enzymes are identified in the Aloe Vera plant; anti-inflammatory ones and the type that helps in digestion, for example, amylase [7].

Minerals

Minerals like calcium, magnesium, copper, manganese, potassium, sodium, and zinc are present in the Aloe Vera gel[21].

Phenolic compounds

Different parts of the Aloe Vera plant possess different types of phenolic compounds. Epidermis of the Aloe Vera leaves contains more phenolic compounds than the flowers [22].

Extraction and purification

Properties of the Aloe Vera are not only specie dependent but also on how it is handled after being collected [24]. The chemical composition of the gel is also altered by the extraction and purification methods [25]. The gel can be used directly as well as stored for up to six hours in a refrigerator at 8°C. After removing the rind, leaves are crushed within 10-20 minutes so as not to lose important enzymes. Glucose oxidase is added as a scavenger to remove oxygen and stop the growth of microbes (**Fig. 1**). The gel obtained is finally sterilized by exposing it to UV light [26].

Fig. 1: An image of domestic Aloe Vera plant

Table 1: Ingredients of Aloe Vera gel [23]

Anthraquinones	Inorganic
Alcin	Calcium
Barbloin	Sodium
Isobarbaloin	Chlorine
Anthranol	Manganese
Aloetic Acid	Zinc
Ester of cinnarnic Acid	Chromium
Aloe-emodin	Potassium sorbate
Emodin	Copper
Chrysophanic acid	Magnesium
Resistannol	Iron
Vitamins	Essential Amino Acids
B1	Lysine
B2	Threonine
B6	Valine
Choline	Leucine
Folic acid	Isoleucine
C	Phenylalanine
Alpha-tocopherol	Methionine
Beta-carotene	-
Nonessential amino acids	Miscellaneous
Histidine	Cholesterol
Arginine	Triglycerides
Hydroxyproline	Steroids
Aspartic acid	Beta-sitosterol
Glutarnic acid	Lignins
Proline	Uric acid
Glycine	Gibberellin
Alanine	Lectine like substance
Tyrosine	Salicylic acid
	Arachidonic acid

Properties of Aloe Vera

The advantageous properties of the Aloe Vera are related to the polysaccharides present in the gel/pulp of its leaves while its rind possesses high level of anti-oxidants (**Fig. 2**) [27].

Antioxidant

The strong anti-oxidant effect of the Aloe Vera is due to the polysaccharides present in the leaf parenchyma tissue and other substances like alkaloids, indoles, and polyphenols [28].

Anti-microbial

Components like anthraquinones, aloe-emodin, and aloin present in the Aloe Vera leaves are responsible for their strong anti-bacterial and anti-viral properties. Some components like saponin and anthraquinones have direct anti-microbial properties while others like Acemannan have an indirect mechanism through phagocytosis action[29].

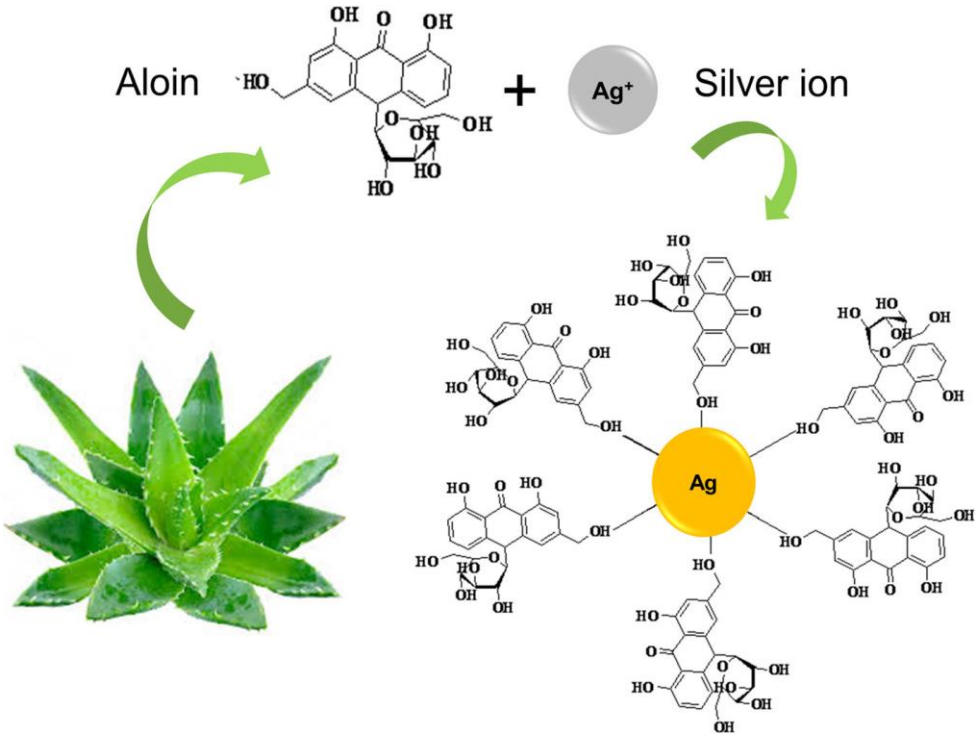

Fig. 2: The synthesis of AGNP using Aloe Vera [36].

Anti-inflammatory

The Aloe Vera plant contains several constituents with anti-inflammatory properties like brady kinase, which is an enzyme, anthraquinones commonly known as laxatives, salicylic acid, fatty acids, and hormones like gibberellins and auxins. These components work as an anti-inflammatory by inducing collagen growth and stimulating immunity and by obstructing the irritant pathways [7].

Anti-cancer properties

Aloe-emodin exhibits anti-cancer properties [30] and has found to cause cervical cancer cells apoptosis [31]. Aloesin, a component of Aloe Vera has shown that it inhibits the cell growth in ovarian cancer [32].

General uses of Aloe Vera

Cosmetics and skin care

Since the Aloe Vera stimulates collagen and elastic fibers formation by increasing the activity of the fibroblasts; it is an excellent additive in skincare products and cosmetics. It also provides and maintains skin moisture through its polysaccharides.

Latex-free gloves are made with a coating of the Aloe Vera gel for soothing and moisturizing effects for practitioner's hands during procedures [33].

Anti-cancer

Acemannan, which is the natural carbohydrate present in the Aloe Vera leaves, is known to possess multiple beneficial qualities like being anti-cancer and anti-microbial [34].

Nanoparticles

Silver nanoparticles [Ag NP] in the size 40±2 [35] are manufactured with different shapes and sizes because they have shown the potential to be incorporated into different types of sensors, data storage media, and electro-optical devices. Researchers have tried using herbs like Aloe Vera, Neem, coffee, tea, and turmeric to be incorporated into silver nanoparticles [Ag NP] as reducing and stabilizing agents. Aloe Vera is a source for spherical as well as octahedron-shaped silver nanoparticles [36].

Wound healing

Water content of Aloe Vera gel is very high, almost 99% which is essential for keeping the wound

hydrated [37]. It also contains amino acids and vitamins E&C and aloeferon in abundance which helps in tissues healing [38]. Studies have shown that vitamin E is a strong anti-oxidant and vitamin C promotes collagen synthesis resulting in accelerated wound healing[39]. Acemannan itself has also shown to increase Type I collagen synthesis [40] and potential for anti-apoptosis [41].

Tissue engineering

In the field of tissue engineering, Aloe Vera has shown its potential as a bioactive material [42] as it promotes collagen synthesis which is the main component of ECM [43] and increases cellular functions like cell migration, proliferation and growth [44]. Presence of Aloe Vera in the scaffold material increases viability of the regenerating cells [45].Using Aloe Vera gel along with chitosan membrane showed improvement in healing of full thickness wounds [46].

Ulcerative colitis

The exact mechanism of action of the Aloe Vera in the treatment of UC is unclear, however, in-vitro experiments on human colonic mucosa exhibited that Aloe Vera pulp can inhibit interleukin-8 and prostaglandin E2 suggesting its action as anti-inflammatory and anti-microbial [5]. Aloe Vera polysaccharides have shown to keep the intestinal immune mechanism in optimal state reducing inflammation and polyps' formation [47].

Use of the Aloe Vera in dentistry

Recurrent Aphthous stomatitis

Recurrent Apthous Stomatitis [RAS] is a common disorder of the oral cavity in which ulcers appear on the mucosa of cheeks, lips, or tongue margins. It is a common condition that is cured naturally in around 10-14 days. Acemannan component of the Aloe Vera gel has shown reduction in pain experienced by the patients [48] and demonstrated wound healing advantages improving the RAS condition [49].

Anti-carious

Prevention of caries is achieved by elimination of acid-producing cariogenic bacteria leading to demineralization of tooth structure[29].Fluoride which is the major ingredient added in water and toothpaste for anti-cariogenic effect is associated with the risk of dental fluorosis in children and has also been classified as a neurotoxin [50].Aloe Vera is biocompatible and non-toxic around tooth tissues even with prolonged use[51]. A study concluded that Aloe Vera gel when used in the right concentration helped formation of dentin bridge preserving the vitality of the pulp [52].

Tubing disinfestations

The inner surface of the dental unit tubing is coated with a layer of biofilm which poses a risk of cross-infection to the patients as well as dental professionals. The use of Aloe Vera gel has been shown to eliminate or reduce the proliferation of *Klebsiella pneumonia*, *E. coli*, *Pseudomonas aeruginosa*, and *Streptococcus Aureus* [53].

Anti-plaque agent

The main concept of preventing periodontal disease is to control and reduce plaque [54]. The gold standard chlorhexidine as an anti-plaque agent against periodontal diseases is associated with adverse effects like prominent extrinsic tooth staining and calculus formation with prolonged use [55]. Studies have shown that Aloe Vera is equally effective against plaque as chlorhexidine without the adverse effects of the latter [56].
Aloe Vera being anti-microbial has been demonstrated to reduce plaque and hence a very useful agent against gingivitis [57]. Phytotherapy is gaining popularity as a replacement as well as an auxiliary therapy for the control of plaque and periodontal diseases [58].

Oral submucous fibrosis

Oral Submucous Fibrosis is a precancerous condition of the oral cavity, pharynx, and upper digestive system mostly reported in the Indian sub-continent due to the use of tobacco and tobacco products. Its main discomforts are pain and the inability to open the mouth progressively. Aloe Vera which contains sterol has shown anti-inflammatory properties like cortisone without the adverse effects exhibited by cortisone in patients of OSF [59].

Osseous healing after surgery

Although it is indefinite whether putting a regenerative material into the bone after apical

surgery promotes bone healing, but Aloe Vera has shown to increase the processes of angiogenesis and granulation tissue production [60]. Acemannan in the Aloe Vera gel is considered as a potential biological molecule for periodontal wound healing as well as its regeneration [20]. Aloe Vera has good osteoinductive potential in bone healing when it is blended with various types of scaffold materials in tissue engineering process [61].

Anti-candidal activity

A study compared the efficacy of gold standard anti-candidal denture tablets with a range of herbs like Aloe Vera, Cashew leaf, and Triphala and found that though the denture cleansing tablets and Triphala had the significant output in reducing fungal load, cashew leaf and Aloe Vera also showed promising results in preventing denture stomatitis [62].

Intracanal medicament

Retention of microbial and smear layers on dentinal tubules after instrumentation may lead to periapical and endodontic infections. The gold standard intracanal medicament is calcium hydroxide and has other important functions in Endodontics. But it has many adverse effects making Aloe Vera a good choice as a replacement. Unfortunately, Aloe Vera has not shown much potential as an intracanal medicament, but further studies may prove otherwise [63]. However, when Aloe Vera gel was incorporated into calcium hydroxide, it resulted in improved diffusion of hydroxyl ions across dentinal tubules [64].

In composite restoration

Aloe Vera like standard antioxidants, when applied to the prepared tooth surface increased the shear bond strength of the composite material with the enamel of the tooth.

Storage of avulsed tooth

An avulsed tooth should be re-implanted as soon as possible but in case it is not possible immediately; it needs to be stored in a suitable medium to keep the PDL viable. A good prognosis was observed when the avulsed tooth was stored in Aloe Vera and coconut water [63].

Potential risks associated with Aloe Vera

Aloe Vera gel contains a number of compounds, one being a compound called “aloin”. Aloin has been linked with toxicity and several adverse effects in humans [65]. Mild adverse effects have been associated with herbal medicine but in some cases, these adverse effects might become serious and even life-threatening [66]. In recent years, awareness is increasing regarding the safety and adverse effects of herbal drugs and dietary supplements with pharmacovigilance playing its role in the matter [67].

Allergic Reactions

While considered innocuous because of its organic nature, Aloe Vera could still irritate certain individuals and must be administered with caution. There have been reports of severe allergic reaction to homemade Aloe Vera gels which have not been purified from irritant compounds [68].

Nephrotoxicity

Herbal medicines including Aloe Vera may cause nephrotoxicity due to their complex components or lack of full understanding of their mechanism of action in the human body. However, this has often been overlooked by the patients and the practitioners in the pretense of being natural. Some of the nephrotoxic components in herbs are plant alkaloids and aristolochic acids [69].

Anti-platelet effect

Some of the commonly used herbal agents have reports of inhibiting the clotting of blood. The literature review has suggested that most of the medicinal herbs interfere with the mechanism of blood clotting by stopping the activation and aggregation of platelets [70]. This is a concern for dentistry as there is a risk of increased loss of blood after procedures like scaling and oral surgery. Therefore, any herbal medicines or supplements should be stopped a few days before the procedure to reduce the risk of excessive bleeding [70].

Conclusion

It is safe to conclude that Aloe Vera is an economic, safe (no in-vitro cytotoxic effects [71]) and natural

product that can be used as an adjunct in dentistry from wound healing post-extraction to being anti-microbial and anti-inflammatory. The limitation of the use of herbal agents in medicine and dentistry are not only their potential adverse effects but also the time and labor needed for their extraction, purification, and the isolation of the bioactive ingredients. In short, Aloe Vera has a lot to offer to dentistry and further studies and clinical trials need to be done to make it useful and applicable in dentistry.

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Conflict of interest

The authors declare no conflict of interest.

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