



Current Perspectives on Use of *Aloe vera* in Dentistry

Erika Tayal¹, Divesh Sardana^{1*}, K. R. InduShekar¹, Bhavna G. Saraf¹
and Neha Sheoran¹

¹Department of Pediatric Dentistry, Sudha Rustagi College of Dental Sciences, Faridabad, India.

Authors' contributions

This work was carried out in collaboration between all authors. Author ET designed and wrote the first draft of the manuscript. Author DS performed the literature search and revised the manuscript under the guidance of authors KRI and BGS. Author NS went through a final draft of the manuscript. All authors read and approved the final manuscript.

Mini-review Article

Received 12th April 2014
Accepted 9th June 2014
Published 30th July 2014

ABSTRACT

Introduction: *Aloe vera* is known from centuries as a medicinal plant. It's a wonder plant with a lot of health benefits and hence often been called the '*natural healer*'. It is a tropical plant that flourishes in warm and dry climate and looks like a cactus with fleshy thorny leaves. There are around 400 species of Aloe, but it is the *Aloe barbadensis* Miller (*Aloe vera* or "*true aloe*") plant which has been used most (found mainly in Asia, Africa and other tropical areas) because of its medicinal uses like moisturizing, anti-inflammatory, antioxidant, anticancer, antibacterial, antiviral and antifungal properties.

Medicinal Uses: *Aloe vera* has its uses in various systemic conditions like skin disorders (e.g. psoriasis), arthritis, asthma, digestive and bowel disorders, diabetes and lowering lipid levels in hyper-lipidemic patients. It has also be used as a detoxifying agent, for topical application of first and second degree burns, as a immune enhancer, in Alzheimer's disease and in various cosmetic, medical and dental products.

Dental Uses: This wonder plant has also been used in dentistry for its beneficial properties in various conditions like lichen planus, aphthous stomatitis, oral submucous fibrosis, pulpotomy of primary teeth, prevention of dry sockets, obturation of primary teeth, disinfection of irrigation units, bleeding and painful gums, disinfection of gutta percha cones, burning mouth syndrome and in radiated head and neck cancer patients. The

*Corresponding author: Email: doc_divesh@yahoo.co.in;

purpose of this article is to highlight the role of *A. barbadensis* in various branches of dentistry and its potential future role.

Conclusion: *Aloe vera* indeed has a definitive useful role in dentistry. However, future researches should be aimed to determine its method of preparation, optimal concentration, time of application and effects on the oral cavity.

Keywords: *Aloe vera*; herbal; dental; anti-inflammatory; antioxidant; antimicrobial.

1. INTRODUCTION

Aloe vera has a long history of its uses because of its beneficial properties. *Aloe vera* derives its name from the Arabic word “*Alloeh*” and Latin word “*vera*” meaning “*shining bitter substance*” and “*true*” respectively. Nearly 2000 years ago, the Greek scientists regarded *Aloe vera* as the universal panacea. The Egyptians called it “*the plant of immortality*”. Mainly two species having a slightly different chemical composition are used in medicine viz. *A. barbadensis* and *A. arborescens* (endemic to south eastern part of South Africa, natural habitat usually at mountainous areas). *Aloe vera* is a stem-less or short stemmed perennial, drought resisting, succulent xerophyte (store water in tissues to survive under conditions of water shortage) plant. It belongs to the lily (*Liliaceae*) family, and has stiff grey to bright pear green lance-shaped leaves. The *A. barbadensis* leaf has two parts-peripheral bundle sheath cells and inner thin and clear gel like substance. This gel should be distinguished clearly from the bitter yellow exudates originating from the bundle sheath cells, which is used for its purgative effects [1]. This gel like substance contains various amino acids, minerals, enzymes and sugars which have properties like moisturizing properties [2,3], anti-inflammatory [4,5,6], antioxidant [7] antibacterial [8,9,10], antiviral and antifungal properties [11]. *Aloe vera* has its uses in various systemic conditions like skin disorders (e.g. psoriasis) [12,13], arthritis [14,15], asthma [16], digestive and bowel disorders [17], diabetes [18] and lowering lipid levels in hyper-lipidemic patients [19]. It can also be used as a detoxifying agent, for topical application of first and second degree burns [20,21], as an immune enhancer [22], in Alzheimer’s disease [23] and in various cosmetic and medical products [24,25].

2. COMPOSITION

The inner clear gel is 99% water and contains around 75 active ingredients including vitamins, enzymes, sugars, minerals, lignin, saponins, salicylic acid and amino acids. Various vitamins present in Aloe are Vitamin A (beta carotene), C and E which have antioxidant properties. Also present are vitamin B1, B2, B3, B6, B12, folic acid and choline. Several inorganic ingredients and trace elements are also present like aluminium, boron, barium, calcium, iron, magnesium, sodium, phosphorus, silicon and strontium. It also contains enzymes such as acid phosphatase, alkaline phosphatase, amylase, lactic dehydrogenase and lipase, numerous organic compounds such as aloin, barbaloin and emodin and around 28 different monosaccharides and polysaccharides. Polysaccharide component mainly consists of glucomannans of various composition (long chains of glucose and mannose units hooked together), some of which were acetylated. Polymers of galactose and galacturonic acid also have been found in the gel. The presence of this acetylated glucomannans closely resembles the body fluids in composition, viscosity and rheological properties and this type of gel composition is rarely found in any other plant. This gel also contains various glycoproteins.

3. DENTAL USES

3.1 Lichen Planus

Lichen planus is a chronic inflammatory disorder involving the skin and the oral mucosa. Considering the chronic nature of the disease, no definite cure has been discovered. Topical application of *Aloe vera* 3 times a day, provides pain relief, improves the oral lesions and the quality of life of patients with oral lichen planus [26,27]. Pain and burning (oral lichen planus) and pruritus of skin (skin lesions) can be relieved with the use of *Aloe vera* juice and topical application of *Aloe vera* [28]. Steroids have remained the mainstay treatment modality in case of lichen planus, however, long term steroids therapy is associated with multiple systemic complications which provides *Aloe vera* an added advantage due its lesser side effects. Also, when compared with triamcinolide better results were obtained with topical *Aloe vera* [29].

3.2 Antifungal

Various studies have been done to assess the antimicrobial activity of *Aloe vera* on *Candida albicans* [30]. *Aloe vera* leaf extracts can inhibit both the germ tube formation and hence the growth of *C. albicans* [31]. The purified Aloe protein has been found to exhibit potent anti-fungal activity against *Candida parapsilosis*, *Candida krusei* and *Candida albicans* [32].

3.3 Aphthous Stomatitis

Aloe vera oral gel is not only effective in decreasing the recurrent aphthous stomatitis patient's pain score and wound size but also decreases the aphthous wound healing period [33,34]. The new formulated Aloe and Myrrh-based gels proved to be effective in topical management of minor recurrent aphthous stomatitis. Aloe was superior to Myrrh in decreasing ulcer size, erythema, and exudation; whereas Myrrh resulted in more pain reduction [35]. Acemannan, which is one of the polysaccharide components in *Aloe vera*, has been used for the treatment of oral aphthous ulceration in patients who wish to avoid the use of steroid medication [36]. US Food and Drug Administration has also found derivative of *Aloe vera* an effective treatment alternative in treating oral ulcers [37].

3.4 Oral Submucous Fibrosis (OSMF)

Aloe vera gel was found to be effective as an adjuvant in treatment of OSMF [38]. When compared with antioxidant (lycopene) better improvement in mouth opening and reduction of burning symptoms were seen [39]. Mouth opening was found to be 5.1mm in *Aloe vera* treated group, 3.4mm in antioxidant treated group and 4.6mm in antioxidant with steroid treated group. Thus, use of *Aloe vera* in treatment of OSMF may find a future role, potentially reducing the need of surgical intervention in serious OSMF cases.

3.5 Pulpotomy of Primary Teeth

Aloe vera has been successfully used in pulpotomy of primary teeth. Pulpotomy involves removal of coronal pulp with a spoon excavator and then irrigating with saline and finally control of hemorrhage with wet cotton pellets. After that *Aloe vera* gel when applied to the remaining pulp stumps followed by non eugenol cement and permanent restoration was found to be effective in relief of symptoms and also prevention of re-infection. Follow up was

done at 30 days and after 60 days to check vitality of teeth. No evidence of abscess, mobility, pain or swelling was found after that period [40].

3.6 Prevention of Dry Sockets (Alveolar Osteitis)

Aloe vera is a traditional wound healing medicine. Acemannan has been found to be effective in bone regeneration [41]. SaliCept Patch (The SaliCept Patch is a freeze-dried pledget that contains acemannan hydrogel obtained from the clear inner gel of *Aloe vera* leaf) significantly reduces the incidence of Alveolar osteitis compared with Clindamycin-soaked Gelfoam [42].

3.7 Obturation of Primary Teeth

Aloe vera has proved to be a good obturative material for primary teeth. A study was done to evaluate the antimicrobial effectiveness of 6 root canal filling materials [*Aloe vera*, sterile water with zinc oxide and eugenol, zinc oxide eugenol with *Aloe vera*, calcium hydroxide and sterile water, Calcium hydroxide with sterile water and *Aloe vera*, calcium hydroxide and iodoform (Metapex) and vaseline (control)]. *Aloe vera* with sterile water was found to have maximum antimicrobial activity against most of the microorganisms followed by ZOE+*Aloe vera*, Calcium hydroxide + *Aloe vera*, ZOE, Calcium hydroxide, Metapex in the descending order and Vaseline showed no inhibition [43].

3.8 Ingredient in Toothpastes and Mouthwashes

Aloe vera and *propolis* (bee glue) dentifrice reduced the contamination of toothbrush bristles by *Streptococcus mutans* [44]. Toothpaste containing *Aloe vera* showed significant improvement in gingival and plaque index scores as well as microbiologic counts compared with placebo dentifrice (comparable to those achieved with toothpaste containing triclosan) [45]. *Aloe vera* tooth gel and the toothpastes were equally effective against *Candida albicans*, *Streptococcus mutans*, *Lactobacillus acidophilus*, *Enterococcus faecalis*, *Prevotella intermedia*, and *Peptostreptococcus anaerobius*. *Aloe vera* tooth gel demonstrated enhanced antibacterial effect against *S. mitis* [46].

3.9 Intra Canal Medicament

For achieving long term success of root canal treatments, elimination of microorganisms is critical. Retention of microorganisms within the dentinal tubules is thought to be a source of persistent endodontic infection. In persistent cases of root canal infection and in failed root canal treatments main organism identified is *E. faecalis*. Recently herbal extracts are gaining attention in dentistry and *Aloe vera* has proved a good antibacterial (because of anthraquinones) against *E. faecalis* if used in root canals [47].

3.10 Disinfection of Irrigation Units

Waterlines of dental operatory are highly contaminated with microorganisms and are a source of infection. Proper disinfection of these pipelines is very important. In a study after obtaining baseline water samples, the dental unit waterlines were treated with 3 disinfectant solutions to draw inter-comparisons viz. *Aloe vera*, 10% hydrogen peroxide, and 5% sodium hypochlorite. Each of the three disinfectants was used in increasing concentrations and their inhibiting effect was compared. There was significant reduction in mean CFU/ml when treated with disinfectants each for a period of one week. *Aloe vera* solution was found to be

the most effective in reducing the microbial colonies. The authors concluded that chemical-based disinfectants can be replaced with herbal disinfectants for treating microbial contamination in dental unit waterlines [48].

3.11 Antiviral

A purified sample of Aloe emodin was prepared from aloin, and its effects on the infectivity of *herpes simplex virus type 1* and *type 2*, *varicella-zoster virus*, *pseudorabies virus*, *influenza virus*, *adenovirus*, and *rhinovirus* were seen. The results proved that Aloe emodin inactivated all of the viruses tested except adenovirus and rhinovirus. Electron microscopic examination of anthraquinone-treated herpes simplex virus showed that the envelopes were partially disrupted. These results conclude that anthraquinones are directly virucidal to enveloped viruses [49,50,51].

3.12 Denture Adhesive Formulations

Acemannan was found to have good adhesive properties and less cytotoxicity to gingival fibroblasts when used as a denture adhesive [52].

3.13 Bleeding and Painful Gums

Aloe vera gel can be used as a local drug delivery system in periodontal pockets [53]. Subgingival administration of *Aloe vera* gel has been found to result in improvement of periodontal and gingival conditions. Acemannan stimulated both soft and hard tissue healing and is a bioactive molecule and scaffold for periodontal tissue regeneration [54]. Application of the gel is done directly to the sites of periodontal surgeries [55] along with periodontal dressing or to the gum tissues. *Aloe vera* has also been tried as a mouthwash which can be used as an adjunct to mechanical therapy for treating plaque-induced gingivitis [56,57].

3.14 Disinfection of GP (Gutta Percha) Cones

To date no promising chemical and herbal agent has been found to be effective in decontaminating GP cones. With dry and moist heat, cones tend to deform and with chemical agents there are chances of contamination. However, chair side decontamination prior to obturation cannot be ruled out. Many chemicals such as, chlorhexidine, ethyl alcohol, hydrogen peroxide, polyvinyl pyrolidone iodine, quaternary ammonium compounds have been tried for GP decontamination. Even the use of electron beam sterilization has also been tried. However, none of these methods have been proven as fully effective. The recommended method for decontamination of GP points consists of treating the cones using a 1% Sodium hypochlorite for 1 minute, or 0.5% Sodium hypochlorite for 5 minutes. But there are chances of Sodium hypochlorite causing crystal deposition within the canals which can impede the obturation [58]. *Aloe vera* gel has been found to be effective in decontaminating GP cones within one minute [59]. Under sterile conditions some GP points were placed in the thioglycolate broth and incubated for 24 hours. Some new GP cones were taken alongside and decontaminated for 1 minute in 90% *Aloe vera* gel. The cones were then removed from the gel, cleaned with sterile gauze and then incubated in thioglycolate broth for 24 hours. Both the tubes were then closely monitored for the development of turbidity. The GP cones which were not decontaminated and directly placed in the broth developed turbidity. The cones decontaminated with *Aloe vera* and then placed in the broth remained clear even after 24 hours, indicating the absence of the microbial growth.

3.15 Wound Healing

The polysaccharides contained in the gel of the leaves, promote wound healing. Acemannan induced cell proliferation (gingival fibroblasts), and stimulated keratinocyte growth factor 1 (KGF-1), vascular endothelial growth factor (VEGF) and type 1 collagen expressions. These findings show that acemannan plays a significant role in oral wound healing [60]. *Aloe vera* - derived products (for example dressings and topical gels) are found to be effective in the healing of acute wounds (for example lacerations, surgical incisions and burns) and chronic wounds (for example infected wounds, arterial and venous ulcers) [61,62,63].

3.16 Burning Mouth Syndrome

Burning mouth syndrome is a painful condition of multifactorial etiology often described as a burning sensation in the tongue, lips, palate, or throughout the mouth. There may be tingling or numbness on the tip of the tongue or in the mouth, bitter or metallic changes in taste and dry or sore mouth. The condition is very disturbing. To assess the efficacy of *Aloe vera* in this condition, patients with Burning mouth syndrome were divided into three groups: Group I -tongue protector (The protector consisted of a transparent, low density polyethylene sheath covering the tongue from the tip to the posterior third.) worn for 15 minutes three times a day, Group II (tongue protector and 0.5 ml AV at 70% three times a day) and Group III (tongue protector and 0.5 ml placebo three times a day). Treatment continued for 3 months. The overall clinical improvement was greater for Group II, thus concluding that prescription of tongue protector and *Aloe vera* is effective for treating patients with burning mouth syndrome [64].

3.17 Radiated Head and Neck Cancer Patients

Topical *Aloe vera* gel has been found to have an inhibitory effect on cariogenic and periodonto-pathogenic micro-organisms of the radiated head and neck cancer patients and hence may have a preventive role in these patients [65,66]. *Aloe vera* mouthwash may not only prevent radiation-induced mucositis [67,68] by its wound-healing and anti-inflammatory mechanism, but also may reduce oral candidiasis of patients undergoing head and neck radiotherapy due to its antifungal and immunomodulatory properties [69].

3.18 Anticancer Agent

Standard treatment of any type of cancer carries a lot of side effects. Plant extracts are gaining popularity as alternatives to the allopathic drugs in treatment of cancers [70]. Quinones are plant-derived secondary metabolites that present some anti-proliferation and anti-metastasis effects in various cancer types both in vitro and in vivo [71]. Anti-cancer prospects of plant-derived quinones, namely, Aloe-emodin are taking a consideration which is richly present in *Aloe vera* [72,73].

4. CONTRAINDICATIONS

As with all pharmacological agents, *Aloe vera* is associated with some side effects. In some cases contact dermatitis and hypersensitivity reactions after topical applications of *Aloe vera* gel have been noted [74]. Aloe should not be used during pregnancy or lactation except under medical supervision. Abdominal spasms and pain may occur after even a single dose. Abdominal spasms, pain and formation of thin and watery stools can occur after overdose. Because of these side effects, oral use of *Aloe vera* in children under 10 years of age is

contraindicated [75]. In diabetic patients, increased hypoglycemia might be seen in conjunction with oral antidiabetics or insulin [76]. *Aloe vera* gel for systemic application is not recommended in combination with antidiabetic, diuretic, or laxative drugs; sevoflurane; or digoxin [77].

5. CONCLUSION

Aloe vera may find a promising role in various branches of dentistry in future. Future research should be aimed to determine its method of preparation, optimal concentration, time of application and effects on the oral cavity. Also, the potential long term side effects of *Aloe vera* need to be studied and evaluated.

Composition		
1	Vitamins	Vitamin A (Beta carotene), C, E, B12, Folic acid and Choline
2	Enzymes	Alkaline phosphatase, Amylase, Bradykinase, Carboxy peptidase, Catalase, Cellulase, Lipase and Peroxidase
3	Minerals	Calcium, Chromium, Copper, Selenium, Magnesium, Manganese, Potassium, Sodium and Zinc
4	Sugars	Monosaccharides (glucose and fructose) and Polysaccharides (glucomannans/polymannose)
5	Anthraquinones	
6	Fatty acids	Four plant steroids Cholesterol, Campesterol, Beta sitosterol and Lupeol
7	Hormones	Auxins and Gibberellins
8	Others	Amino acids, Salicylic acid, Lignin and Saponins
Uses in various branches of dentistry		
A. Oral medicine		
1	Lichen planus	
2	Antifungal	
3	Antiviral	
4	Apthous stomatitis and canker sores	
5	Oral submucous fibrosis	
6	Wound healings	
7	Burning mouth syndrome	
B. Pediatric dentistry		
8	Pulpotomy of primary teeth	
9	Obturation of primary teeth	
C. Oral surgery		
10	Prevention of dry sockets (Alveolar osteitis)	
D. Preventive dentistry		
11	In toothpastes and mouthwashes	
E. Endodontics		
12	Intracanal medicament	
F. Disinfection and asepsis		
13	Disinfection of irrigation units	
14	Disinfection of gutta percha cones	
G. Prosthodontics		
15	In denture adhesive formulations	
H. Periodontics		
16	Bleeding and painful gums	
I. Oral oncology		
17	Radiated head and neck cancer patients	
18	Anticancer agent	

CONSENT

Not applicable.

ETHICAL APPROVAL

Not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Wintola OA, Sunmonu TO, Afolayan AJ. The effect of Aloe ferox Mill in treatment of loperamide-induced constipation in Wistar rats. BMC Gastroenterol. 2010;10:95.
2. Saraf S, Sahu S, Kaur CD, Saraf S. Comparative measurement of hydration effects of herbal moisturizers. Pharmacognosy Res. 2010;2:146-51.
3. Dal'Belo SE, Gaspar LR, Maia Campos PM. Moisturizing effect of cosmetic formulations containing *Aloe vera* extract in different concentrations assessed by skin bioengineering techniques. Skin Res Technol. 2006;12:241-6.
4. Sudarshan R, Annigeri RG, Vijayabala GS. *Aloe vera* in dentistry. Journal of Oral Stomatology. 2013;4:45-47. Ruchi. *Aloe vera*: Use of herbal plant in dentistry. Guident. 2012;5:80.
5. Ruchi. *Aloe vera*: Use of herbal Plant in dentistry. Guident. 2012;5:80.
6. Herman A, Herman AP, Domagalska BW, Młynarczyk A. Essential oils and herbal extracts as antimicrobial agents in cosmetic emulsion. Indian J Microbiol. 2013;53:232-7.
7. Kang MC, Kim SY, Kim YT, Kim EA, Lee SH, Ko SC, et al. In vitro and in vivo antioxidant activities of polysaccharide purified from *Aloe vera* (*Aloe barbadensis*) gel. Carbohydr Polym. 2014;99:365-71.
8. Lawrence R, Tripathi P, Jeyakumar E. Isolation, Purification and Evaluation of Antibacterial Agents from *Aloe vera*. Braz J Microbiol. 2009;40:906-15. Ndhlala AR, Amoo SO, Stafford GI, Finnie JF, Van Staden J. Antimicrobial, anti-inflammatory and mutagenic investigation of the South African tree aloe (*Aloe barberae*). J Ethnopharmacol. 2009;124:404-8.
9. Ndhlala AR, Amoo SO, Stafford GI, Finnie JF, Van Staden J. Antimicrobial, anti-inflammatory and mutagenic investigation of the South African tree aloe (*Aloe barberae*). J Ethnopharmacol. 2009;124:404-8.
10. Coopoosamy RM, Naidoo KK. A comparative study of three Aloe species used to treat skin diseases in South African rural communities. J Altern Complement Med. 2013;19:425-8.
11. Bawankar R, Deepti VC, Singh P, Subashkumar R, Vivekanandhan G, Babu S. Evaluation of bioactive potential of an *Aloe vera* sterol extract. Phytother Res. 2013;27:864-8.
12. Syed TA, Ahmad SA, Holt AH, Ahmad SA, Ahmad SH, Afzal M. Management of psoriasis with *Aloe vera* extract in a hydrophilic cream: a placebo-controlled, double-blind study. Trop Med Int Health. 1996;1:505-9.
13. Morelli V, Calmet E, Jhingade V. Alternative therapies for common dermatologic disorders, part 2. Prim Care. 2010;37:285-96.

14. Cowan D. Oral *Aloe vera* as a treatment for osteoarthritis: a summary. Br J Community Nurs. 2010;15:280-2.
15. Obalum DC, Ogo CN. Usage of Complementary and Alternative Medicine (CAM) among osteoarthritis patients attending an urban multi-specialist hospital in Lagos, Nigeria. Niger Postgrad Med. J. 2011;18:44-7.
16. Clement YN, Williams AF, Aranda D, Chase R, Watson N, Mohammed R et al. Medicinal herb use among asthmatic patients attending a specialty care facility in Trinidad. BMC Complement Altern Med. 2005;5:3.
17. Langmead L, Makins RJ, Rampton DS. Anti-inflammatory effects of *Aloe vera* gel in human colorectal mucosa in vitro. Aliment Pharmacol Ther. 2004;19:521-7.
18. Choudhary M, Kochhar A, Sangha J. Hypoglycemic and hypolipidemic effect of *Aloe vera* L. in non-insulin dependent diabetics. J Food Sci Technol. 2014;51:90-6.
19. Huseini HF, Kianbakht S, Hajiaghvae R, Dabaghian FH. Anti-hyperglycemic and anti-hypercholesterolemic effects of *Aloe vera* leaf gel in hyperlipidemic type 2 diabetic patients: a randomized double-blind placebo-controlled clinical trial. Planta Med. 2012;78:311-6.
20. Somboonwong J, Thanamitramanee S, Jariyapongskul A, Patumraj S. Therapeutic effects of *Aloe vera* on cutaneous microcirculation and wound healing in second degree burn model in rats. J Med Assoc Thai. 2000;83:417-25.
21. Maenthaisong R, Chaiyakunapruk N, Niruntraporn S, Kongkaew C. The efficacy of *Aloe vera* used for burn wound healing: a systematic review. Burns. 2007;33:713-8.
22. Lee JK, Lee MK, Yun YP, Kim Y, Kim JS, Kim YS et al. Acemannan purified from *Aloe vera* induces phenotypic and functional maturation of immature dendritic cells. Int Immunopharmacol. 2001;1:1275-84.
23. Lewis JE, McDaniel HR, Agronin ME, Loewenstein DA, Riveros J, Mestre R, et al. The effect of an aloe polymannose multinutrient complex on cognitive and immune functioning in Alzheimer's disease. J Alzheimers Dis. 2013;33:393-406.
24. Surjushe A, Vasani R, Saple DG. *Aloe vera*: a short review. Indian J Dermatol. 2008;53:163-6.
25. Fowler JF Jr, Woolery-Lloyd H, Waldorf H, Saini R. Innovations in natural ingredients and their use in skin care. J Drugs Dermatol. 2010;9:S72-81.
26. Radwan-Oczko M. Topical Application of Drugs Used in Treatment of Oral Lichen Planus Lesions. Adv Clin Exp Med. 2013;22:893-898.
27. N Salazar-Sanchez, P. Lopez-Jornet, F Camacho-Alonso M. Sanchez-Siles. Efficacy of topical *Aloe vera* in patients with oral lichen planus: a randomized double blind study Journal of Oral Path Med. 2010;39:735-740.
28. Patil BA, Bhaskar HP, Pol JS, Sodhi A, Madhu AV. *Aloe vera* as cure for lichen planus. N Y State Dent J. 2013;79:65-8.
29. Reddy RL, Reddy RS, Ramesh T, Singh TR, Swapna LA, Laxmi NV. Randomized trial of *Aloe vera* gel vs triamcinolone acetamide ointment in the treatment of oral lichen planus. Quintessence Int. 2012;43:793-800.
30. Doddanna SJ, Patel S, Sundarrao MA, Veerabhadrapa RS. Antimicrobial activity of plant extracts on *Candida albicans*: An *in vitro* study. Indian J Dent Res 2013;24:401-5.
31. Bernardes I, Felipe Rodrigues MP, Bacelli GK, Munin E, Alves LP, Costa MS. *Aloe vera* extract reduces both growth and germ tube formation by *Candida albicans*. Mycoses. 2012;55:257-61
32. Das S, Mishra B, Gill K, Ashraf MS, Singh AK, Sinha M, et al. Isolation and characterization of novel protein with anti-fungal and anti-inflammatory properties from *Aloe vera* leaf gel. Int J Biol Macromol. 2011;48:38-43.

33. Garnick JJ, Singh B, Winkley G. Effectiveness of a medicament containing silicon dioxide, aloe, and allantoin on aphthous stomatitis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1998;86:550-6.
34. Sudarshan R, Annigeri G, Sree Vijayabala G. *Aloe vera* In Dentistry. *Indian J Stomatol.* 2013;4:45-47.
35. Mansour G, Ouda S, Shaker A. Clinical efficacy of new *Aloe vera*- and myrrh-based oral mucoadhesive gels in the management of minor recurrent aphthous stomatitis: a randomized, double-blind, vehicle-controlled study. *J Oral Pathol Med.* 2013;25. doi: 10.1111/jop.12130. [Epub ahead of print]
36. Bhalang K, Thunyakitpisal P, Rungsirisatean N. Acemannan, a polysaccharide extracted from *Aloe vera*, is effective in the treatment of oral aphthous ulceration. *J Altern Complement Med.* 2013;19:429-34.
37. Jacob, Julie A. Oral ulcers remedy gets FDA clearance. *J Am Dent Assoc.* 1994;125(10):1308-1310.
38. Alam, Sarwar Ali, Iqbal Giri, Gokkulakrishnan KY, Natu S, Subodh S. Faisal, Mohammad Agarwal, Anshita Sharma, Himanshu. Efficacy of *Aloe vera* gel as an adjuvant treatment of oral submucous fibrosis. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2013;116:717-724.
39. Sudarshan R, Annigeri RG, Sree Vijayabala G. *Aloe vera* in the treatment for oral submucous fibrosis-a preliminary study. *J Oral Pathol Med.* 2012;41:755-61.
40. Gupta N, Bhat M, Devi P, Girish. *Aloe vera*: A Nature's Gift to Children. *Int J Clin Pediatr Dent.* 2010;3;87-92.
41. Boonyagul S, Banlunara W, Sangvanich P, Thunyakitpisal P. Effect of acemannan, an extracted polysaccharide from *Aloe vera*, on BMSCs proliferation, differentiation, extracellular matrix synthesis, mineralization, and bone formation in a tooth extraction model. *Odontology.* [Epub ahead of print]. 2013;12.
42. Poor MR, Hall JE, Poor AS. Reduction in the incidence of alveolar osteitis in patients treated with the SaliCept patch, containing Acemannan hydrogel. *J Oral Maxillofac Surg.* 2002;60:374-9.
43. Kriplani R, Thosar N, Baliga MS, Kulkarni P, Shah N, Yeluri R. Comparative evaluation of antimicrobial efficacy of various root canal filling materials along with *Aloe vera* used in primary teeth: a microbiological study. *J Clin Pediatr Dent.* 2013;37:257-62.
44. Bertolini PF, Biondi Filho O, Pomilio A, Pinheiro SL, Carvalho MS. Antimicrobial capacity of *Aloe vera* and propolis dentifrice against *Streptococcus mutans* strains in toothbrushes: an in vitro study. *J Appl Oral Sci.* 2012;20:32-7.
45. Pradeep AR, Agarwal E, Naik SB. Clinical and microbiologic effects of commercially available dentifrice containing *Aloe vera*: a randomized controlled clinical trial. *J Periodontol.* 2012;83:797-804.
46. George D, Bhat SS, Antony B. Comparative evaluation of the antimicrobial efficacy of *Aloe vera* tooth gel and two popular commercial toothpastes: an in vitro study. *Gen Dent.* 2009;57:238-41.
47. Bhardwaj A, Ballal S, Velmurugan N. Comparative evaluation of the antimicrobial activity of natural extracts of *Morinda citrifolia*, papain and *Aloe vera* (all in gel formulation), 2% chlorhexidine gel and calcium hydroxide, against *Enterococcus faecalis*: An in vitro study. *J Cons Dent.* 2012;15:293-297.
48. Pareek S, Nagaraj A, Sharma P, Atri M, Walia S, Naidu S, Yousuf A. Disinfection of dental unit water line using *Aloe vera*: in vitro study. *Int J Dent.* 2013;618962. doi: 10.1155/2013/618962. Epub 2013 Sep 8.
49. Sydskis RJ, Owen DG, Lohr JL, Rosler KH, Blomster RN. Inactivation of enveloped viruses by anthraquinones extracted from plants. *Antimicrob Agents Chemother.* 1991;35:2463-6.

50. Andersen DO, Weber ND, Wood SG, Hughes BG, Murray BK, North JA. In vitro virucidal activity of selected anthraquinones and anthraquinone derivatives. *Antiviral Res.* 1991;16:185-96.
51. Alves DS, Pérez-Fons L, Estepa A, Micol V. Membrane-related effects underlying the biological activity of the anthraquinones emodin and barbaloin. *Biochem Pharmacol.* 2004;68:549-61.
52. Tello CG, Ford P, Iacopino AM. In vitro evaluation of complex carbohydrate denture adhesive formulations. *Quint Int.* 1998;9:585-93.
53. Bhat G, Kudva P, Dodwad V. *Aloe vera*: Nature's soothing healer to periodontal disease. *J Indian Soc Periodontol.* 2011;15:205–209.
54. Chantarawatit P, Sangvanich P, Banlunara W, Soontornvipart K, Thunyakitpisal P. Acemannan sponges stimulate alveolar bone, cementum and periodontal ligament regeneration in a canine class II furcation defect model. *J Periodontal Res.* 2013;28. [Epub ahead of print] doi: 10.1111/jre.12090
55. Rieger L, Carson RE. The clinical effects of saline and *Aloe vera* rinses on periodontal surgical sites. *J Okla Dent Assoc.* 2002;92:40-3.
56. Ajmera N, Chatterjee A, Goyal V. *Aloe vera*: It's effect on gingivitis. *J Ind Soc Periodontol.* 2013;17:435-8.
57. Chandahas B, Jayakumar A, Naveen A, Butchibabu K, Reddy PK, Muralikrishna T. A randomized, double-blind clinical study to assess the antiplaque and antigingivitis efficacy of *Aloe vera* mouth rinse. *J Indian Soc Periodontol.* 2012;16:543-8.
58. Pang NS, Jung IY, Bae KS, Baek SH, Lee WC, Kum KY. Effects of short-term chemical disinfection of gutta-percha cones: identification of affected microbes and alterations in surface texture and physical properties. *J Endod.* 2007;33(5):594-8.
59. Athiban PP, Borthakur BJ, Ganesan S, Swathika B. Evaluation of antimicrobial efficacy of *Aloe vera* and its effectiveness in decontaminating gutta percha cones. *J Conserv Dent.* 2012;15:246-8.
60. Jettanacheawchankit S, Sasithanasate S, Sangvanich P, Banlunara W, Thunyakitpisal P. Acemannan stimulates gingival fibroblast proliferation; expressions of keratinocyte growth factor-1, vascular endothelial growth factor, and type I collagen; and wound healing. *J Pharmacol Sci.* 2009;109:525-31.
61. Dat AD, Poon F, Pham KB, Doust J. *Aloe vera* for treating acute and chronic wounds. *Cochrane Database Syst Rev.* 2012;2:2:CD008762. doi: 10.1002/14651858.CD008762.pub2.
62. Khan AW, Kotta S, Ansari SH, Sharma RK, Kumar A, Ali J. Formulation development, optimization and evaluation of *Aloe vera* gel for wound healing. *Pharmacogn Mag.* 2013;9:S6-S10.
63. Gupta VK, Malhotra S. Pharmacological attribute of *Aloe vera*: Revalidation through experimental and clinical studies. *Ayu.* 2012;33:193-6.
64. López-Jornet P, Camacho-Alonso F, Molino-Pagan D. Prospective, randomized, double-blind, clinical evaluation of *Aloe vera* Barbadosensis, applied in combination with a tongue protector to treat burning mouth syndrome. *J Oral Pathol Med.* 2013;42:295-301.
65. Fani M, Kohanteb J. Inhibitory activity of *Aloe vera* gel on some clinically isolated cariogenic and periodontopathic bacteria. *J Oral Sci.* 2012;54:15-21.
66. Bidra AS, Tarrand JJ, Roberts DB, Rolston KV, Chambers MS. Antimicrobial efficacy of oral topical agents on microorganisms associated with radiated head and neck cancer patients: an in vitro study. *Quint Int.* 2011;42:307-315.

67. Worthington HV, Clarkson JE, Bryan G, Furness S, Glenny AM, Littlewood A, et al. Interventions for preventing oral mucositis for patients with cancer receiving treatment. *Cochrane Database Syst Rev.* 2011;(4):CD000978. doi:10.1002/14651858.CD000978.pub5.
68. Worthington HV, Clarkson JE, Eden OB. Interventions for preventing oral mucositis for patients with cancer receiving treatment. *Cochrane Database Syst Rev.* 2007;17;(4):CD000978.
69. Ahmadi A. Potential prevention: *Aloe vera* mouthwash may reduce radiation-induced oral mucositis in head and neck cancer patients. *Chin J Integr Med.* 2012;18:635-40.
70. Ochwang'i DO, Kimwele CN, Oduma JA, Gathumbi PK, Mbaria JM, Kiama SG. Medicinal plants used in treatment and management of cancer in Kakamega County, Kenya. *J Ethnopharmacol;* 2013. pii: S0378-8741(13)00855-6. doi: 10.1016/j.jep.2013.11.051. [Epub ahead of print]
71. Khuda-Bukhsh AR, Das S, Saha SK. Molecular Approaches toward Targeted Cancer Prevention with some food plants and their products: Inflammatory and other signal pathways *Nutr Cancer.* [Epub ahead of print]; 2013
72. Lu JJ, Bao JL, Wu GS, Xu WS, Huang MQ, Chen XP, et al. Quinones derived from plant secondary metabolites as anti-cancer agents. *Anticancer Agents Med Chem.* 2013;13:456-63.
73. Mulakayala C, Banaganapalli B, Mulakayala N, Pulaganti M, CMA, Chitta SK. Design and evaluation of new chemotherapeutics of aloe-emodin (AE) against the deadly cancer disease: an in silico study. *J Chem Biol.* 2013;6:141-53.
74. Cosmetic Ingredient Review Expert Panel. Final report on the safety assessment of Aloe Andongensis Extract, Aloe Andongensis Leaf Juice, aloe Arborescens Leaf Extract, Aloe Arborescens Leaf Juice, Aloe Arborescens Leaf Protoplasts, Aloe Barbadosensis Flower Extract, Aloe Barbadosensis Leaf, Aloe Barbadosensis Leaf Extract, Aloe Barbadosensis Leaf Juice, aloe Barbadosensis Leaf Polysaccharides, Aloe Barbadosensis Leaf Water, Aloe Ferox Leaf Extract, Aloe Ferox Leaf Juice, and Aloe Ferox Leaf Juice Extract. *Int J Toxicol.* 2007;26(Suppl 2):1-50.
75. Bisset NG, Boca Raton, FL, CRC Press *sennae folium.* In; Max wichtl's herbal drugs and Phytopharmaceuticals. 1994;463-69.
76. World Health Organization (WHO), ed WHO monographs on selected medical plants. Geneva, Switzerland: World Health Organization. Organization WH, ed. WHO monographs on selected medical plants. 1999;1(1 ed.):1
77. Brinker F. *Herb Contraindications and Drug Interactions.* 2nd ed: Eclectic Medical Publications; 1998.

© 2014 Tayal et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<http://www.sciencedomain.org/review-history.php?iid=618&id=13&aid=5576>