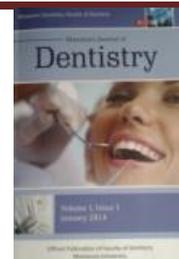




Effects of Aloe Vera Gel as an Adjunctive Therapy in the Treatment of Chronic Periodontitis: A Clinical and Microbiological Study.



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Abstract:

Objectives: To assess the clinical and microbiological effects of commercially available gel containing Aloe vera as an adjunctive therapy to scaling and root planning in the treatment of chronic periodontitis.

Methods: A total of forty patients with mild and moderate chronic periodontitis were selectively collected for contribution in the present study. This study was performed using a split-mouth design in which the patient received thorough scaling and root planning (SRP) in addition to application of Aloe vera gel to either the right or left side of dentition and thorough scaling and root planning (SRP) was only performed in the contralateral side of the same dentition.

Results: Results showed that the sites treated with SRP+Aloe vera gel 100% concentrate exhibited greater reductions in *P. gingivalis* and *P. intermedia* count than sites treated with SRP alone. Also difference between control and test side was statistically significant in clinical parameters.

Conclusions: Scaling and root planning was effective in improving clinical and microbiological parameters in patients with chronic periodontitis. Scaling and root planning plus Aloe vera gel (100% concentrate) exhibit bactericidal effect in the periodontal pocket of patients with chronic periodontitis. Aloe vera gel could be used for the treatment of periodontitis as a complementary therapy not to replace mechanical intervention (SRP).

Keywords: Aloe vera gel; chronic periodontitis; microbiology.

Introduction

Periodontal diseases are chronic infectious diseases characterized by a bacterial challenge that can provoke a destructive host response, leading to clinical attachment loss and ultimately possible tooth loss [1,2]. It is well established that supragingival plaque is the cause of gingivitis and plays a primary role in the initiation of periodontitis. Chronic periodontitis, formerly known as "adult periodontitis" or "chronic adult periodontitis", is the most prevalent form of periodontitis [3].

Cultivation of plaque microorganisms from sites of chronic periodontitis reveals high percentages of anaerobic (90%) and gram negative (75%) bacterial species [4]. The bacteria most often cultivated at high levels include *P. gingivalis*, *P. intermedia*, *Tannerella forsythia*, *Treponema denticola*, *Fusobacterium nucleatum*, *Eikenella corodens*, *Compylobacter rectus* and *A. actinomycetemcomitans* [5]. Additionally, many authors reported that *Porphyromonas gingivalis*, *Prevotella* species and *Fusobacterium nucleatum* were isolated more frequently in chronic periodontitis [6,7].

The removal of microbial plaque leads to resolution of gingival inflammation, and cessation of plaque control leads to a recurrence of inflammation [2]. The importance of plaque control in the maintenance of gingival health has been well established in the literature [9,8]. It has been shown that rigorous self-performed plaque control over long periods of time reduced the levels and altered the composition of subgingival bacteria and reduced the frequency of deep periodontal pockets [10].

The inability of the general adult population to perform adequate tooth brushing has led to the search for chemotherapeutic agents to improve plaque control [11]. These chemicals, mainly triclosan and chlorohexidine, have been used as mouthrinses or added to dentifrices to avoid plaque formation and development of gingivitis [11-13]. Because some of these substances may have undesirable side effects, such as tooth staining and taste alteration, phytotherapeutic agents with antimicrobial and anti-inflammatory properties have been investigated [14,15]. The use of natural products in the prevention and treatment of oral conditions has increased recently and could be also beneficial in plaque control especially to urban and rural communities of low socioeconomic levels [16].

Aloe vera is a perennial succulent plant belonging to the Aloeaceae family (subfamily of the *Asphodelaceae*) [17]. Among > 400 aloe species, Aloe vera is the most accepted species for various medical, cosmetic, and nutraceutical purposes [18].

The composition of Aloe vera is complex. It consists of 75 different ingredients including vitamins, minerals, enzymes, sugars, anthraquinones or phenolic compounds, lignin, saponins, sterols, amino acids and salicylic acid [19]. Anthraquinones are the phenolic compounds that found in the Aloe vera. The Aloes consist of free anthraquinones and their derivatives: barbaloin, isobarbaloin, anthrone-c-glycosides and cromones. In large amounts, these compounds exert a strong purgative effect, but in smaller amounts they appear to aid in absorption from the gut and considered as potent antimicrobial agents and possess powerful analgesic effects [20]. Saponins are

soapy substances form 3 percent of the gel and are general cleanser, having antiseptic properties. These act powerfully as anti-microbials against bacteria, viruses, fungi and yeasts [21]. Cholesterol, campesterol, b. sisosterol and lupeol are fatty acids present in Aloe vera. These four plant steroids are important anti-inflammatory agents [22]. Furthermore, salicylic acid is an aspirin like compound processing anti-inflammatory and antibacterial properties [23].

The pharmacological actions of Aloe vera gel as studied in in vitro and in vivo include anti-inflammatory, antibacterial, antioxidant, immune-boosting and hypoglycemic properties [20, 23-26].

Yagi et al. [27] reported that Aloe vera gel contains a glycoprotein with cell proliferating-promoting activity, while Davis et al. [28] noted that Aloe vera gel improved wound healing by increasing blood supply, which increased oxygenation as result.

Regarding the anti-inflammatory effect, Hanley et al. [29] reported that an Aloe vera extract decreased inflammation by 48% in a rat adjuvant-induced arthritic inflammatory model. Furthermore, the peptidase bradykinase was isolated from Aloe and shown to break down the bradykinin, an inflammatory substance that induces pain [30]. The gel was also found to possess effective anti-inflammatory effects as prednisolone and indomethacin, without having the long term toxicity of either drug [31].

Considering the antimicrobial effect, it was reported that acemannan reduced herpes simplex infection in two cultured target cell lines [32]. It was also noted that fractions of Aloe vera gel containing lectins which directly inhibited the cytomegalovirus proliferation in cell culture, perhaps by interfering with protein synthesis [33]. Moreover, anthraquinone extracted from a variety of plants (including Aloe vera) are directly virucidal to enveloped viruses [34]. A processed Aloe vera gel preparation reportedly inhibited the growth of *Candida albicans* [35]. Aloe vera gel and aloins also were effective inhibitors of stimulated granulocyte matrix metalloproteinases (MMPs). The authors observed some chemical structural similarities between the aloins and the MMP inhibitory tetracyclines and finally suggested that Aloe derivatives could inhibit the MMPs through a mechanism similar to that of inhibitory tetracyclines such as doxycycline [36].

The antimicrobial effect of a dentifrice containing Aloe vera has been also demonstrated in an in vitro study in which this phytotherapeutic agent inhibited the growth of diverse oral microorganisms, such as *S. mutans*, *S. sanguis*, *A. viscosus*, and *Candida albicans* [14]. Furthering, other investigators studied the microbiologic effects of a commercially available dentifrice containing Aloe vera and reported that it was effective in controlling *S. mutans*, *Candida albicans*, *Lactobacillus acidophilus*, *Enterococcus faecalis*, *P. intermedia* and *Peptostreptococcus anaerobius* and *Streptococcus mitis* [37].

Additionally many authors reported that mouthrinse [38] and toothpaste [39,40] containing Aloe vera might be useful herbal formulations for chemical plaque control and improvement in plaque and gingival status in chronic gingivitis. Moreover, Pradeep et al. [40] found that toothpaste containing Aloe vera was effective in reducing the microbial colonies of *S. sanguis*, *S. oralis*, *Actinomyces*

viscosus and *Actinomyces naeslund* in patients with chronic gingivitis.

The above-mentioned properties, along with the ease of availability, no known adverse effects, and cost effectiveness, make Aloe vera an ideal candidate for plaque control, thereby reducing gingivitis and most likely eventual periodontitis.

Patients and methods

The present study was carried out on fourty patients (both males and females) who were selected from the Department of Oral Medicine and Periodontology, Faculty of Dentistry, Mansoura University. Those patients were diagnosed as having chronic periodontitis after obtaining proper case history, thorough clinical examination and according to the clinical criteria.

The selected patients were free from any systemic disease, and receiving no medication for the present condition three months prior to the study. Furthering, non of them had previous periodontal treatment including scaling, root planning, and periodontal surgery in the last six months. On other hand, smokers and pregnant females were excluded from the present study.

Clinical measurements

The following clinical parameters were be measured before and after treatment:

- Plaque index [41].
- Papillary bleeding index [42].
- Gingival index [41].
- Probing pocket depth.

Study Design

This study was performed according to the split-mouth design in which the patients received two treatment modalities to the right or left half of the dentition.

The two mode of treatment was as follow:

1. Full mouth supra-and-subgingival scaling and root planing will be performed using ultrasonic and hand instruments under local anaesthesia for almost 2h as basic full-mouth disinfection [43,44] to be followed by subgingival delivery of Aloe vera gel in one side of the dentition (study side).
2. Full mouth supra-and-subgingival scaling and root planing will be performed using ultrasonic and hand instruments under local anaesthesia for almost 2h as basic full-mouth disinfection [43,44] in the other side of the same dentition (control side).

Subgingival administration of Aloe vera gel

Administration of Aloe vera gel will be preceded by flushing the area with saline to wash away any debris. Aloe vera (1cc) 100% gel concentrate will be applied subgingivally using atraumatic needle. Periodontal pack will be placed on the teeth to avoid spillage of the chemical product into the other areas of the mouth. Patients will be instructed not to rinse or drink any liquid for at least 30 minutes. The application will be performed twice weekly for 3 weeks.

Microbiological Monitoring

Subgingival plaque samples will be collected using a sterile curette at the baseline and after 3 weeks. These samples will be transported in thioglycolate broth media containing Hemin and vitamin K for microbiological analysis using culture technique. Microorganisms

monitored will be *P. gingivalis* and *P. intermedia* as indicators.

Statistical analysis:

Statistical analyses were performed using the mean value, standard deviation and student's t.test.

Results

A total of forty patients were included in the present study. Those patients had an age ranged from thirty three to forty five years (mean 37.7, SD \pm 3.42).

They were divided into two groups; Group I (patients with mild chronic periodontitis) and Group II (patients with moderate chronic periodontitis), each group included twenty patients.

Table 1 showed the variation of mean values and standard deviation of PI, GI, PBI and PD of individuals with mild chronic periodontitis participated in the study before and after treatment regimens. For the test side (SRP +Aloe vera application), the mean value and standard deviation of plaque index (PI) before treatment was 0.98 ± 0.50 . After treatment, the mean value was 0.34 ± 0.37 . So, there was highly statistically significant difference between values of PI before and after treatment (at $P < 0.001$). In the control (SRP) side, the mean value and standard deviation of plaque index (PI) before treatment was 1.66 ± 0.41 and after treatment was 0.9 ± 0.51 . Also, there was a highly statistically significant difference between values of PI before and after treatment in the control side of dentition (at $P < 0.001$). The mean value and standard deviation of gingival index (GI) scores at baseline was 0.68 ± 0.15 for the test side of dentition before treatment and after treatment was 0.33 ± 0.18 . There was a statistically significant difference between values of GI before and after treatment (at $P < 0.001$). Also, in the control side, it was 0.9 ± 0.15 before treatment and was 0.55 ± 0.31 after treatment. Hence, there was a statistically significant difference between values of GI before and after treatment in the control side (at $P < 0.001$). It was obviously observed that there was a statistically significant reduction in papillary bleeding index (PBI) at baseline in SRP+Aloe vera side of dentition with mean values 0.77 ± 0.34 compared to scores after treatment which was 0.23 ± 0.26 (at $P < 0.001$). In SRP side, there was a statistically significant reduction in PBI scores as the mean value and standard deviation was before treatment 0.9 ± 0.26 and after treatment was 0.55 ± 0.15 (at $P < 0.001$). The mean value and standard deviation of probing pocket depth (PD) at baseline in the test side was 1.75 ± 0.44 mm and after therapy, it was 1.05 ± 0.22 mm. As a result, there was a highly statistically significant difference between values of PD before and after treatment (at $P < 0.001$). In the control side, the PD was 1.55 ± 0.51 mm whereas after treatment it was 1.35 ± 0.59 mm. So, there was no statistically significant difference between values of PD before and after treatment (at $P = 0.2$).

Tables 2 showed the variation of mean values and standard deviation of PI, GI, PBI and PD of individuals with moderate chronic periodontitis participated in the study before and after treatment regimens. For the test side (SRP +Aloe vera application), the mean value and standard deviation of plaque index (PI) before treatment was 2.40 ± 0.68 . After treatment, the mean value was 0.85 ± 0.61 . So, there was highly statistically significant difference

between values of PI before and after treatment (at $P < 0.001$). In the control (SRP) side, the mean value and standard deviation of plaque index (PI) before treatment was 2.25 ± 0.6 and after treatment was 1.41 ± 0.43 . Also, there was a highly statistically significant difference between values of PI before and after treatment in the control side of dentition (at $P < 0.001$). The mean value and standard deviation of gingival index (GI) scores at baseline was 1.89 ± 0.17 for the test side of dentition before treatment and after treatment was 0.75 ± 0.33 . There was a statistically significant difference between values of GI before and after treatment (at $P < 0.001$). Also, in the control side, it was 1.93 ± 0.14 before treatment and was 1.23 ± 0.62 after treatment. Hence, there was a statistically significant difference between values of GI before and after treatment in the control side (at $P < 0.001$). It was obviously observed that there was a statistically significant reduction in bleeding on probing (PBI) scores at the test side of dentition with mean values 2.3 ± 0.57 compared to scores after treatment which was 0.8 ± 0.86 (at $P < 0.001$). In the control side, there was a statistically significant reduction in BOP scores as the mean value and standard deviation was before treatment 2.4 ± 0.55 and after treatment was 1.45 ± 0.56 (at $P < 0.001$). The mean value and standard deviation of probing pocket depth (PD) at baseline in the test side was 3.65 ± 0.49 mm and after therapy, it was 2.5 ± 0.51 mm. As a result, there was a highly statistically significant difference between values of PD before and after treatment (at $P < 0.001$). In the control side, the PD was 3.85 ± 0.37 mm whereas after treatment it was 3.25 ± 0.44 mm. So, there was high statistically significant difference between values of PD before and after treatment (at $P < 0.001$).

Tables 3 showed the variation of mean values and standard deviation of colony forming units (CFU) of *P. gingivalis* and *P. intermedia* of individuals with mild chronic periodontitis participated in the study before and after treatment regimens. For the test side (SRP +Aloe vera 100% gel concentrate), the mean value and standard deviation of CFU of *P. gingivalis* before treatment was 15.45 ± 12.16 . After treatment, the mean value was 4.9 ± 6.4 . So, there was highly statistically significant difference between values of CFU of *P. gingivalis* before and after treatment (at $P < 0.001$). In the control (SRP) side, the mean value and standard deviation of CFU of *P. gingivalis* before treatment was 16.7 ± 14.98 and after treatment was 11.65 ± 11.83 . So, there was no statistically significant difference between values of CFU of *P. gingivalis* before and after treatment in the control side of dentition (at $P = 0.1$). The mean value and standard deviation of CFU of *P. intermedia* scores at baseline was 15.1 ± 8.28 for the test side of dentition before treatment and after treatment was 4.95 ± 6.11 . There was a statistically significant difference between values of CFU of *P. intermedia* before and after treatment (at $P < 0.001$). Also, in the control side, it was 18.05 ± 7.1 before treatment and was 11.8 ± 5.02 after treatment. Hence, there was a statistically significant difference between values of CFU of *P. intermedia* before and after treatment in the control side (at $P = 0.002$).

Tables 4 showed the variation of mean values and standard deviation of colony forming units (CFU) of *P. gingivalis* and *P. intermedia* of individuals with moderate

chronic periodontitis participated in the study before and after treatment regimens. For the test side (SRP+Aloe vera 100% gel concentrate), the mean value and standard deviation of CFU of *P. gingivalis* before treatment was 29.35 ± 21.89 . After treatment, the mean value was 9.45 ± 11.14 . So, there was highly statistically significant difference between values of CFU of *P. gingivalis* before and after treatment (at $P < 0.001$). In the control (SRP) side, the mean value and standard deviation of CFU of *P. gingivalis* before treatment was 28.1 ± 22.23 and after treatment was 18.55 ± 15.08 . So, there was no statistically significant difference between values of CFU of *P. gingivalis* before and after treatment in the control side of dentition (at $P = 0.1$). The mean value and standard deviation of CFU of *P. intermedia* scores at baseline was 55.6 ± 33.24 for the test side of dentition before treatment and after treatment was 18.9 ± 16.9 . There was a statistically significant difference between values of CFU of *P. intermedia* before and after treatment (at $P < 0.001$). Also, in the control side, it was 54 ± 35.97 before treatment and was 37 ± 27.74 after treatment. Hence, there was no statistically significant difference between values of CFU of *P. intermedia* before and after treatment in the control side (at $P = 0.1$).

Discussion

Periodontal disease usually refers to the common inflammatory disorders of gingivitis and periodontitis that are caused by pathogenic microflora in the biofilm or dental plaque that forms adjacent to the teeth on a daily basis [45].

Treatment of periodontal diseases by different types of local delivery systems has been investigated [46-50]. Chlorhexidine, sodium hypochlorite, cetylpyridinium chloride and amine fluoride are widely used as mouthwashes and irrigating agents that can inhibit the growth of potentially pathogenic oral bacteria. Although these antimicrobial agents are widely used, immediate hypersensitivity reactions, toxicity, tooth staining and other side effects have been reported. Moreover, it has been reported that chlorhexidine and sodium hypochlorite are cytotoxic to human periodontal ligament cells, inhibit protein synthesis, and affect mitochondrial activity, thus having detrimental effects on vital tissues [51-53].

The natural phytochemicals isolated from medicinal plants used in traditional medicine have been considered useful alternatives to synthetic drugs. Many medicinal plants and their products are widely used for prevention and treatment of oral diseases, and among them Aloe vera is of particular interest and has been used therapeutically for a long time [54-57].

Aloe vera is a natural product contained in herbal dentifrices with commercial appeal on the control of plaque and gingivitis. Aloe latex contains anthraquinones, and enzymes bradykinase, which are chemical compounds that are used in healing and arresting pain because they are anti-inflammatory in nature. Aloe vera inhibits the cyclooxygenase pathway and reduces prostaglandin E2 production from arachidonic acid. Also, Aloe vera contains 6 antiseptic agents: Lupeol, salicylic acid, urea nitrogen, cinnamic acid, phenol and sulfur. They all have inhibitory action on fungi, bacteria and viruses [58-60].

The present study was designed to evaluate the clinical and antimicrobial efficacy of Aloe vera 100% gel

concentrate when used as adjunctive treatment to scaling and root planning on patients with chronic periodontitis. Subjects with an age range of thirty three to forty five were recruited in the study. Subject in this age range generally present with chronic periodontal diseases and can maintain proper study control.

Moreover, subjects with a history of local and/or systemic antibiotics thereby within the last 3 to 6 month before baseline examination were excluded due to the likelihood of bacterial resistance expected in the microflora of such individuals [61].

An experimental period of 21 days was chosen for permitting comparison to other studies. In this study, subjects were examined clinically at the base line and 3 weeks after treatment to score plaque index, gingival index, papillary bleeding index and probing pocket depth. Furthermore, subgingival plaque samples were collected before scaling, root planning and three weeks after treatment for determination of colony forming units.

In addition, subject with choosing Aloe vera in the form of gel because of its ease of application and the commercial availability of this form.

The present study is concerned with *Porphyromonas gingivalis* and *Prevotella intermedia* as two microbial indicators in chronic periodontitis since their role as main clusters of bacterial species commonly cohabit subgingival sites and are reproducibly associated with disease [62].

In general, the biostatistical analysis of the clinical scores obviously show high statistical significant reduction in the mean values of plaque, gingival and papillary bleeding indices in both groups of mild and moderate chronic periodontitis.

The low plaque index observed in these subjects could be explained by the fact that Aloe vera is a good antibacterial. Hegggers et al. [35] showed its antibacterial properties against *Candida albicans*, *Streptococcus pyogenes*, *Streptococcus fecalis*. Noskova [63] used Aloe vera to treat early stages of periodontitis and got good results.

The statistically significant reduction in gingival and papillary bleeding indices can be attributed to presence of sterols as anti-inflammatory agents and lupeol as a potential antiseptic ingredient. Vazquez et al, stated [64] Aloe vera decreases edema and number of neutrophils and also prevents migration of Polymorphonuclear leucocytes (PMNL). Barrantes and Guinea in 2003 [65] stated Aloe vera inhibits the stimulated granulocyte Matrix metallo proteinases (MMPs) inhibiting cyclo-oxygenase and lipo-oxygenase pathways. Payne [18] reported Aloe vera gel used in wound site lessened inflammation with less pain. Hart et al. [66] in an in vitro study stated Aloe vera depleted the chemical and alternative pathways of complement activity to inhibit the production of free oxygen radicals by activated Polymorphonuclear leucocytes (PMNs). Aloe vera is also shown to provide relief in swelling, bleeding gums and is an antiseptic for pockets and antifungal for thrush [67].

Regarding the probing pocket depth, there was a statistical significant reduction in the mean values of this clinical parameter in all groups except for the control side group of mild chronic periodontitis. These satisfactory

results could be explained by anti-inflammatory, antibacterial, wound-healing Properties of Aloe vera.

Aloe vera has numerous anti-inflammatory agents, Fujita et al. [68] stated that carboxypeptidase in Aloe vera inactivates bradykinin by about 67% and relieves pain. Rocio Bautista in 2004 [69] showed that carboxypeptidase in Aloe vera had good anti-prostaglandin synthesis properties and compounds inhibiting oxidation of arachidonic acid, which might decrease inflammation. Aloe vera contains salicylate magnesium lactate decarboxylase, which is known to inhibit histidine, thereby preventing the formation of histamine from histidine in mast cells [70]. Hegggers and Robson [71] in 1983 showed that barbolin and aloe emodin in Aloe vera block prostaglandin (PG) synthesis.

Moreover, the observed decrease in pocket depth, and relative decrease in gingival and papillary bleeding indices exhibiting good healing, which is in accordance with studies by Davis [28] who stated that wound healing with Aloe vera was due to increased blood supply; increased oxygenation, which stimulates fibroblast activity; and collagen proliferation. Davis [72] in *in-vitro* and *in-vivo* studies showed healing with fibroblast proliferation. Wound healing by means of growth factors such as gibberellins, auxin and mannose phosphate, which bind to insulin-like growth factor receptor to improve healing, is also seen. Yagi et al. [27] stated presence of glycoprotein with cell proliferation improves healing. Aloe vera also contains vitamins A, C, E, B12 and folic acid. Vitamin C, which is involved in collagen synthesis, increases concentration of oxygen at the wound site because of dilation of blood vessels. Furthermore Aloe vera penetrates and dilates capillaries going to an injured site, which improves healing.

In the present study we have noticed a reduction in colony forming units of *Porphyromonas gingivalis* and *Prevotella intermedia*. This finding with this reduction can be a result of the anti-microbial effects of Aloe vera's anthraquinones: aloe emodin, aloetic acid, aloin, anthracene, anthranol, barbaloin, chrysophanic acid, ethereal oil, ester of cinnamonic acid, isobarbaloin, and resistannol [73]. In relatively small concentrations together with the gel fraction, these anthraquinones provide analgesic, antibacterial, antifungal, and antiviral activity. Moreover, saponins which contain glycosides, are soapy substances that have both detergent and antiseptic properties [74].

Additionally, We have noticed reduction in plaque, gingival and probing pocket depth scores in control side groups, this effect could be due to the SRP and proper oral hygiene maintenance and secondary to alteration in subgingival bacteria [75].

The results of this study were in agreement with those presented by Bhat et al. [76] who used subgingival delivery of Aloe vera gel in chronic periodontitis treatment. There was a significant reduction in gingival index, plaque index, bleeding index, probing pocket depth and colony forming units measured at baseline, one month and two month after treatment of patients with chronic periodontitis.

Furthermore, our results were in agreement with those of Villalobes et al. [39] who observed a significant reduction in plaque and gingivitis after a 30 day use of mouth rinses containing Aloe vera associated with tooth brushing. Also, de Olivera et al. [40] found that both dentifrices containing Aloe vera and dentifrice containing fluoride resulted in significant reduction of plaque and gingivitis, but no statistical significant difference was observed between them.

Additionally, our results were consistent with those were found by Karim et al. [77] as they showed that Aloe vera mouthrinse is equally effective in reducing periodontal indices as Chlorhexidine. The results demonstrated a significant reduction of gingival bleeding and plaque indices in both groups over a period of 15 and 30 days as compared to placebo group. There was a significant reduction on plaque and gingivitis in Aloe vera and chlorhexidine groups and no statistically significant difference was observed among them ($P > 0.05$). Aloe vera mouthwash showed no side effects as seen with chlorhexidine. Aloe vera juice consisted of 99% aloe juice, 0.2% preservative, 0.001% lemon-lime flavor, and sweetened with sorbitol.

Furthering, our results were consistent with those of Pradeep et al. [78]. They used a controlled clinical trial to evaluate the clinical and microbiological effects of commercially available dentifrice containing Aloe vera on the reduction of plaque and gingival inflammation. Toothpaste containing Aloe vera showed significant improvement in gingival and plaque index scores as well as microbiologic counts compared with placebo dentifrice. These improvement were comparable to those achieved with toothpaste containing triclosan.

Finally, the clinical and microbiological finding of the present study is consistent with those of Vidya Dodwad and Komal Arora [79] who observed a reduction in plaque index, gingival index, papillary bleeding index, probing pocket depth index and colony forming unit of *Porphyromonas gingivalis* and *Prevotella intermedia* in patients with chronic periodontitis when treated with Aloe vera gel as a part of regular oral hygiene.

Consequently, it can be fairly stated that the use of Aloe vera gel is a valuable adjuvant with scaling and root planning for effective and successful management of chronic inflammatory periodontal diseases.

Conclusion

- Scaling and root planing was effective in improving clinical and microbiological parameters in patients with chronic periodontitis.
- Scaling and root planing in addition to subgingival administration of Aloe vera gel results in improvement of periodontal condition.
- Aloe vera can be used as an adjuvant local drug delivery system because of its various benefits including easily applicable with minimal equipment, cheap and no adverse effects, as shown in our study.

Table 1: The mean values (\pm SD) of GI, PI, PBI and PD of both test and control sides in patients before and after treatment in mild chronic periodontitis.

	Test side		Control side	
	before	after	before	after
PI	0.98 \pm 0.5	0.34 \pm 0.37	1.66 \pm 0.41	0.9 \pm 0.51
	P< 0.001**		P< 0.001**	
GI	0.68 \pm 0.15	0.33 \pm 0.18	0.9 \pm 0.15	0.55 \pm 0.31
	P< 0.001**		P< 0.001**	
PBI	0.77 \pm 0.34	0.23 \pm 0.26	0.90 \pm 0.26	0.55 \pm 0.15
	P< 0.001**		P< 0.001**	
PD	1.05 \pm 0.22 1.75 \pm 0.44		1.55 \pm 0.51	1.35 \pm 0.59
	P< 0.001**		P=0.2	

PBI = papillary bleeding index, P = Probability of significance, **Highly significant at $P < 0.001$, PD = Pocket depth in millimeters, M = Mean, SD = Standard deviation, GI= Gingival index, PI= Plaque index.

Table 2: The mean values (\pm SD) of GI, PI, PBI and PD of both test and control sides in patients before and after treatment in moderate chronic periodontitis.

	Test side		Control side	
	before	after	before	after
PI	2.4 \pm 0.68	0.85 \pm 0.61	2.25 \pm 0.60	1.41 \pm 0.43
	P< 0.001**		P< 0.001**	
GI	1.89 \pm 0.17	0.75 \pm 0.33	1.39 \pm 0.14	1.23 \pm 0.62
	P< 0.001**		P< 0.001**	
PBI	2.3 \pm 0.57	.8 \pm 0.68	2.4 \pm 0.55	1.45 \pm 0.56
	P< 0.001**		P< 0.001**	
PD	3.56 \pm 0.49	2.5 \pm 0.51	3.85 \pm 0.37	3.25 \pm 0.44
	P< 0.001**		P< 0.001**	

PBI = Bleeding on probing, P = Probability of significance, **Highly significant at $P < 0.001$, PD = Pocket depth in millimeters, M = Mean, SD = Standard deviation, GI= Gingival index, PI= Plaque index

Table 3: The mean values (\pm SD) of CFU of *P.gingivalis* and *P. intermedia* of both test and control sides in patients before and after treatment in mild chronic periodontitis (CFU x 10³/ml).

	Test side		Control side	
	before	after	before	after
P.G	15.54 \pm 12.16	4.9 \pm 6.4	16.7 \pm 14.98	11.65 \pm 11.38
	P< 0.001**		P=0.1	
P.I	15.1 \pm 8.28	4.95 \pm 6.11	18.05 \pm 7.1	11.8 \pm 5.2
	P< 0.001**		P= 0.002**	

P.G = *Porphyromonas gingivalis*, P.I= *Prevotella intermedia*, ** $P < 0.005$ i.e., There is significant difference.

Table 4: The mean values (\pm SD) of CFU of *P.gingivalis* and *P. intermedia* of both test and control sides in patients before and after treatment in moderate chronic periodontitis

	Test side		Control side	
	before	after	before	after
P.G	29.35 \pm 21.89	9.45 \pm 11.14	28.1 \pm 22.23	18.55 \pm 15.08
	P< 0.001**		P=0.1	
P.I	55.6 \pm 33.24	18.9 \pm 16.9	54 \pm 35.97	37 \pm 27.74
	P< 0.001**		P= 0.1	

P.G = *Porphyromonas gingivalis*, P.I= *Prevotella intermedia*, ** $P < 0.005$ i.e., There is significant difference.

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