

The Effect of Aloe vera Mouthwash in Reducing Periodontal Disease among Secondary School Students in Duhok, Kurdistan Region, Iraq: A Quasi-Experimental Study

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Abstract

As the prevalence of periodontal diseases increases and antibiotic resistance develops, there is a need for alternative methods of treatment, safe, reliable and economical. Worldwide, dentistry has recently shown a change in approach to the use of such modalities to treat many inflammatory oral diseases. Aloe vera is a medicinal herb with many advantages and has recently gained considerable importance in clinical research.

Aim: The aim of this study is to determine the effect of using Aloe vera mouthwashes on improving periodontal health among secondary school students in in Duhok, Kurdistan Region, Iraq.

Materials and Methods: A quasi experimental study conducted on 289 systemically healthy participants with moderate and severe gingivitis (132 females and 157 males) aged 14-20 years randomly selected from eight secondary schools using multistage random sampling in Duhok city from December 2018 to May 2019. The periodontal status was assessed by using the Gingival Index and Plaque Index before and 4 weeks after using Aloe vera mouthwash.

Results: there was a significant decrease in the means of plaque and gingival indices after using Aloe vera mouthwash in the whole sample ($p < 0.001$), and among each gender ($p < 0.001$).

Conclusion: The finding of this study showed that Aloe vera could prove to be effective mouthwash due to its ability to reduce periodontal indices. Therefore, Aloe vera can be used as an alternative product for the prevention and treatment of gingivitis.

Key words: Aloe vera, gingival index, plaque index, periodontal diseases, students.

Introduction

Periodontal diseases are chronic inflammatory processes refers to inflammation and loss of periodontal

tissues all around teeth. The disease is usually initiated as gingivitis, a reversible inflammation of the periodontal soft tissue that results in gingival bleeding and swelling and when the periodontal supporting tissues are involved, it is called periodontitis. The disease is caused by pathogenic plaque microorganisms and influenced by factors such as systemic condition, oral hygiene, age, gender, smoking and oxidative stress⁽¹⁻³⁾. In many countries and regions, periodontal disease has been underestimated, notably in those with low socio-economic status and a poor healthcare system, making

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it widespread in populations. Up to 90% of the global population has been reported to have undergone some types of periodontal disease in their lifetime ⁽⁴⁾.

Remarkably, with effective and proper approaches, periodontal disease is both preventable and treatable. The management of causal factors is one of the main fundamentals for such modalities. It is well recognized that periodontal pathogenic bacteria colonizing dental plaque or biofilm, particularly in subgingival areas, are the major etiological factor in periodontal disease. Control and eradication of certain microorganisms and microbial biofilms are considered to be the most important regimes for the prevention and treatment of such diseases ^(2, 5).

Numerous studies have demonstrated that oxidative stress is one of the pathophysiological mechanisms underlying periodontal diseases ^(6 - 8). Oxidative stress implies the accumulation of free radicals due to the over-production of free radicals which cannot be processed gradually or because antioxidants are less available. Reactive oxygen species ROS play a major role in the destruction of tissues ⁽⁶⁾.

Therefore, inflammation mediated by oxidative stress is likely to be one of the possible mechanisms leading to the development of periodontal disease. This means that traditional periodontal disease prevention and care based on the control of bacterial infections tend to be ineffective, and antioxidant supplementation oxidative stress-reducing regimens have emerged as promising preventive and therapeutic adjuncts.

For these diseases. It is notable that up to 80% of the world's population uses herbal products for their basic health care, such as extracts, teas, and other active compounds ⁽⁹⁾.

In the field of dentistry, recent advances have seen a shift in the use of numerous herbal and natural products for the treatment of different oral diseases and conditions ^(10 - 12).

Aloe vera (*Aloe barbadensis*) is a plant belonging to the Liliaceous family. It includes a variety of minerals and vitamins. It has multiple properties in nature, including immunomodulatory, antiviral and anti-inflammatory.

There are approximately 75 nutrients and 200 bioactive components in different parts of the plant, such as amino acids, carbohydrates, enzymes, vitamins, minerals, saponins, anthraquinones, lignin, and salicylic acid ^(13, 14). Furthermore, Aloe vera has significant antioxidant, antibacterial, antidiabetic and antiviral properties. It has been claimed that it can scavenge oxygen radicals and resist iron oxidation ^(14, 15). Aloe vera gel extract indicated antimicrobial activity against some oral pathological bacteria implicated in dental caries and periodontitis ⁽¹⁶⁾.

Additionally, Aloe vera contains many vitamins, including vitamins A, C, E, B1, B2, B3 (niacin), B6, choline, folic acid, alpha-tocopherol, and beta-carotene. Aloe vera is also one of the few plants containing vitamin B12. Vitamins A, C and E, which have a significant antioxidant effect ⁽¹³⁾. Moreover some of the components of Aloe vera are active in collagen formation, such as vitamin C, hyaluronic acid and dermatan sulfate, and thus offer relief from swelling and bleeding gums ⁽¹¹⁾.

The present study was designed to determine the effect of Aloe vera mouthwash to control established dental plaque and gingivitis, and to provide an overview of the impact of Aloe vera on periodontal diseases.

Materials and Methods

The study was conducted on a sub sample selected from a previous study conducted on 809 randomly selected high school students aged 14 to 20 years using multistage random sampling in Duhok city, Kurdistan region, Iraq, from October 2018 to May 2019; to estimate the prevalence of dental caries and periodontal disease. (Hamonari *et al* 2020, recently accepted for publication in JCRD).

Initially, a total of (304) systemically healthy participants were diagnosed with moderate and severe gingivitis (gingival index >1) were approached to participate in this study. However, fifteen students were dropped out from the study for various reason, resulting in a total study population of 289 participants. 132 were female and 157 were male, were selected from the students participating in the study and provided with Aloe vera mouth rinse.

Inclusion and exclusion criteria

Systemically healthy participants with an age range of 14 to 20 years diagnosed with moderate to severe gingivitis were enrolled in this study, after a detailed clinical assessment and medical history.

Exclusion criteria were: use of any mouthwash during the study; use of antibiotics therapy in the last two weeks; a history of hypersensitivity to Aloe vera, and students with orthodontic appliances.

Scientific and Ethical approval for the study was granted by the Scientific Committee of College of Dentistry/Duhok University (approval no. 690).

The aim was outlined to all students prior to inclusion in the study, and the Aloevera mouthwash (Origin: France, Carrefour 0% alcohol consisted of Aqua, Aloe barbadensis leaf juice, preservative, lemon-lime flavor, and sorbitol, CI 42090, CI 19140) was given to the participants in order to obtain consent from their parents authorizing the enrollment of the students in the study. Participants were notified that they could withdraw from the study at any time.

Clinical dental examination

All examinations were performed by the researcher under standardized conditions using a disposable mouth mirror, probes, masks, and gloves in their schools on a regular classroom chair using daylight.

To determine the periodontal status of the participants in the current study; the following indices were recorded in the subsequent order: Plaque Index (PI) by Silness and Loe⁽¹⁷⁾ and Gingival Index (GI) by Loe and Silness⁽¹⁸⁾. The researcher conducted clinical parameter (PI and GI) measurements for 289 participants on 2 occasions, 4 weeks apart. The examination method involves the assessment of four surfaces (buccal, lingual/palatal, mesial and distal) of six index teeth (18, 23, 26, 38, 43, 46). Dental plaque (PI) and gingivitis (GI) were examined on the basis of an analysis of the four surfaces of the index teeth, to assess the presence or lack of signs of the mentioned indices. The sites were probed with a calibrated periodontal probe, having to wait 10 seconds to confirm the presence / absence of gingival bleeding.

The existence of dental plaque was assessed whether it was visualised with the naked eye or there was an accumulation of soft matter within the gingival margin and/or on the tooth and gingival pocket (score 2 and 3 in accordance with PI) and considered to be existing if the characteristic sign is seen at least one site. The PI was rated as: Healthy = PI < 1; Fair = PI 1-1.9; Bad = PI ≥ 2.

Where gingivitis was assumed to be present when at least one site reported bleeding on examination (scores 2 and 3 for the GI ranking).

The gingival index tests the severity of gingivitis on a scale ranging from 0.1 to 3.0 (0.1-1.0: mild gingivitis, 1.1-2.0: moderate gingivitis, and 2.1-3.0: severe gingivitis)⁽¹⁾. Moderate and severe gingivitis was considered with gingival index >1 (as a mean value for all tooth surfaces scored).

A quasi experimental study was conducted. The participants have been advised to follow their regular brushing protocol. Students were instructed to rinse their mouths with 10 ml of their assigned mouthrinse (Aloevera mouthwash 500 ml with 0% of alcohol) for a period of 1 min twice a day after breakfast and before going to bed and not to rinse with water thereafter for the experimental period of 4 weeks. Over the four-week period of mouthrinse home use, during which there will be no restrictions regarding diet or smoking habits. The use of any other new oral hygiene products or procedures, such as floss or interdental stimulators, was not permitted during the study.

Clinical assessment of PI and GI was performed again at the end of four weeks by the same examiner, and compared with baseline gingivitis and dental plaque evaluation.

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 22). Numerical variables were presented and summarized as means and standard deviations. Chi-square and Fisher's exact tests were used to compare proportions. Paired t-test used to measure the differences in mean PI and GI between the two occasions. A p-value of ≤ 0.05 was considered to be statistically significant.

Results

Table (1) shows that there was a significant decrease in the mean of plaque index and the mean of the gingival

index after the intervention whether among females ($p < 0.001$), among males ($p < 0.001$), or in the whole sample ($p < 0.001$).

Table (1): Means of Plaque index and gingival index before and after intervention by gender

	Pre-intervention		Post-intervention		p†
	Mean	(±SD)	Mean	(±SD)	
Plaque index					
Female	1.75	(±0.28)	1.29	(±0.32)	< 0.001
Male	1.50	(±0.34)	1.18	(±0.27)	< 0.001
Whole sample	1.61	(±0.34)	1.23	(±0.30)	< 0.001
Gingival index					
Female	1.69	(±0.28)	1.15	(±0.27)	< 0.001
Male	1.86	(±0.42)	1.18	(±0.32)	< 0.001
Whole sample	1.78	(±0.38)	1.17	(±0.30)	< 0.001

*By Paired t- test, †P ≤ 0.05 (Significant).

It is evident in Table (2) that the PI of 45 patients was categorized as bad before the intervention, but after the intervention there was a downgrading of the PI where 38 patients of them (84.4%) became fair and 4 patients (8.9%) became healthy. The table shows that 240 patients had fair PI before the intervention, and 43 (17.9%) patients became healthy after the intervention ($p < 0.001$).

Table (2): Categories of plaque index before and after intervention

PI After intervention								
	Healthy		Fair		Bad		Total number	P†
	No.	(%)	No.	(%)	No.	(%)		
PI before intervention	No.	(%)	No.	(%)	No.	(%)		
Healthy	4	(100.0)	0	(0.0)	0	(0.0)	4	< 0.001
Fair	43	(17.9)	197	(82.1)	0	(0.0)	240	
Bad	4	(8.9)	38	(84.4)	3	(6.7)	45	
Total	51	(17.6)	235	(81.3)	3	(1.0)	289	

*By McNamara Bowker test. Healthy = PI < 1; Fair = PI 1-1.9; Bad = PI ≥ 2. †P ≤ 0.05 (Significant).

Table (3) reveals that 286 patients had moderate gingivitis before the intervention, around one third of them (32.5%) became mild after the intervention ($p < 0.001$).

Table (3): Severity of gingivitis before and after intervention

Gingivitis after intervention							
	Mild		Moderate		Total		P†
Before intervention	No.	(%)	No.	(%)	No.	(%)	< 0.001
Mild	3	(100.0)	0	(0.0)	3	(100.0)	
Moderate	93	(32.5)	193	(67.5)	286	(100.0)	
Total	96	(33.2)	193	(66.8)	289	(100.0)	

*By McNemar test. †P ≤ 0.05 (Significant).

Discussion

The current research aims to investigate the effectiveness of Aloe vera mouthwash in the prevention of plaque formation and gingival inflammation. Aloe vera seems to be a potential antimicrobial product that is as effective in reducing plaque and gingivitis as chlorhexidine^(11, 12). Chlorhexidine is recognized as a benchmark control for plaque and gingivitis reduction, however side effects such as teeth and tongue staining, altered taste sensation, and increased calculus formation also discourage it from being used for long periods of time. Thus a naturally occurring, indigenous and cost-effective oral hygiene aid must be created^(10, 11). Aloe vera is such product that has several advantages and has recently acquired considerable significance in clinical research⁽¹²⁾. The viscous secretion known as mucilage in Aloe vera contains several vitamins and amino acids. Principally, vitamins A, C and E are antioxidant substances that relate to the elimination of potentially damaging oxidative agents and carcinogens^(19, 20). Mucilage also produces antioxidant enzymes that function to combat free radicals generated from the infection site, such as glutathione peroxidase and superoxide dismutase. The antioxidant properties of the plant function synergistically with the anti-inflammatory compounds to promote wound healing⁽²⁰⁾. Furthermore, a previous study of fifty-three healthy volunteers received 250 mL of Aloe vera gel extract daily for 14

consecutive days to investigate the effect of Aloe vera gel extract on plasma total antioxidant capacity (TAC) and oral pathogenic bacteria. The daily consumption of Aloe vera gel extract was found to decrease the amount of oral pathogenic bacteria, *Lactobacillus* spp and *Streptococcus mutans* in saliva. In addition, the gel extract helps to increase plasma total antioxidant ability, with no clinical adverse effects⁽²¹⁾.

Plaque index and gingival index have been frequently used in clinical and epidemiological research as indicators of periodontal status. Plaque index provide a tool to follow and record oral hygiene practices.

The gingival index was calculated based on the inflammation symptoms including swelling, redness, and bleeding. Therefore, major reduction in the GI decreases inflammation markers in the case group⁽²²⁾.

The study s showed that the mean plaque index and the mean gingival index decreased significantly after the intervention, whether among females, among males, or in the entire sample.

The study results are consistent with a thirty-day randomized controlled trial of 390 dental students with gingival Index score >1.1, comparing the efficacy of Aloe vera mouthwash and chlorhexidine on periodontal health, the results concluded that Aloe vera had the same efficacy as chlorhexidine. It can therefore be used as an

alternative product to treat and prevent gingivitis⁽¹²⁾. The results of the study are also in accordance with the findings of Karim *et al.* in a randomized controlled trial of 345 voluntary university students in India, to evaluate the effect of Aloe vera mouthwash on periodontal health over a 30-day period. This demonstrated that the test groups with Aloe vera mouthwash showed significant reductions in periodontal indices at the end of the trial within 30 days, Aloe vera mouthwash did not indicate any side effects as shown with chlorhexidine⁽¹¹⁾. The results of this study were in line with those provided by Gupta *et al.* Who reported a significant reduction in plaque scores after 4 days of mouth rinsing with Aloe Vera over 300 students. It was concluded that there was no statistical difference between chlorhexidine gluconate mouthwash and Aloe vera mouthwash within the limits of this 4-day plaque formation analysis⁽¹⁰⁾.

A further research was performed to determine the effectiveness of Aloe vera juice mouthwash after scaling therapy in 30 patients having gingivitis aged 20 to 49 years. The result indicates that a significant reduction in gingival inflammation compared to the control group without mouthwash was evident with the use of Aloe vera for 7 days⁽²³⁾. Additional study by Moghaddam *et al.* in Iran. Assessed the effects of local use of Aloe vera gel in the treatment of 20 patients with chronic periodontitis. The investigation found that the local application of Aloe vera gel can be recognized as an adjuvant therapy for chronic periodontitis with scaling and root planning⁽²²⁾.

Consequently, Aloe vera mouthwash can be an effective antiplaque agent and can be an inexpensive herbal alternative for chlorhexidine with appropriate refinements in taste and nutritional value.

However, a randomized controlled trial by Chandrahas *et al.* among 120 systemically healthy participants in the age group of 18-25 years was screened to test the effectiveness of Aloe vera mouth rinse on experimental plaque formation and gingivitis, which showed that Aloe vera-containing mouth wash reported a substantial decrease in the Plaque Index and Bleeding Index scores for the use of Aloe vera mouthwash for 7, 14 and 22 days intervals, but the effect was less significant compared to chlorhexidine⁽²⁴⁾.

The low plaque index found in the study participants may be explained by the fact that Aloe vera is a high antimicrobial agent. Aloe vera has shown antibacterial activity against a number of bacteria, mainly *Streptococcus mutans*, which are responsible for its anti-plaque effect^(21, 24).

Aloe vera has resulted in a considerable decline in the gingival index probably due to that Aloe vera gel was shown to contain biologically active compounds such as mannose-6-phosphate, carboxypeptidase, glutathione peroxidase, and superoxide dismutase. These compounds possess anti-inflammatory, antioxidant and anti-bacterial properties and regulate the immune system and promote wound healing⁽²⁵⁾.

Several anti-inflammatory properties are found in Aloe vera. Carboxypeptidase present in Aloe vera inactivates bradykinin, thereby decreasing prostaglandin synthesis and preventing the oxidation of arachidonic acid, which can minimize inflammation and relieve pain. Magnesium lactate, which is also present in Aloe vera, has been shown to inhibit Histidine Decarboxylase, preventing the production of histidine histamine in mast cells. Decreased gingival index can also be due to the presence of sterols as an anti-inflammatory agent and lupeol as an antiseptic analgesic agent in Aloe vera⁽¹¹⁾.

The antioxidant properties of Aloe vera inhibits the production of free oxygen radicals by active polymorphonuclear leukocytes (PMNs). Furthermore the vitamin C found in Aloe vera is associated with the formation of collagen and raises the oxygen levels at the damaged tissue due to blood vessel dilation. It has also been shown to relieve swelling, and gum bleeding⁽²⁶⁾.

Limitations

The study has limitations, including the wash-out time cross-over design would have been more authenticated as it removes the variable host response bias. However, future research (with long-term rinse duration) can be carried out to conclude the advantages and disadvantages of antioxidant mouthwash.

Conclusion and Recommendations

The study concluded that Aloe vera is an effective

herb and has enormous potentials in treating periodontal diseases, especially in patients who prefer to use herbal mouthwash. It might function as an affordable herbal alternative for chlorhexidine and may lead to the maintenance of periodontal health. The existing literature studies are short-term studies. Future study should include larger sample sizes and longer follow-up intervals to better understand the mechanisms of action and side effects.

Conflict of Interest: The authors declare that there are no conflicts of interest in this paper.

Source of Funding- Self

References

- Singh AK. Prevalence of gingivitis and periodontitis among school children in Lucknow region of Uttar Pradesh, India. *IOSR J Dent Med Sci.* 2014; 13:21–23. doi: 10.9790/0853-13752123.
- Kinane DF, Stathopoulou PG, Papapanou PN. Periodontal diseases. *Nat Rev Dis Primers.* 2017; 3: 17038. doi: 10.1038/nrdp.2017.38. PMID: 28805207.
- Murakami S, Mealey BL, Mariotti A, Chapple ILC. Dental plaque-induced gingival conditions. *J Periodontol.* 2018 Jun; 89 Suppl 1:S17-S27. doi: 10.1002/JPER.17-0095. PMID: 29926958.
- Gasner NS, Schure RS. Periodontal Disease. 2020 May 18. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan–. PMID: 32119477.
- Falcao A, Bullón P. A review of the influence of periodontal treatment in systemic diseases. *Periodontol 2000.* 2019 Feb; 79(1):117-128. doi: 10.1111/prd.12249. PMID: 30892764.
- Miricescu D, Totan A, Calenic B, Mocanu B, Didilescu A, Mohora M, et al. Salivary biomarkers: relationship between oxidative stress and alveolar bone loss in chronic periodontitis. *Acta Odontol Scand.* 2014;72(1):42-7. doi: 10.3109/00016357.2013.795659. Epub 2013 Jul 22. PMID: 238696
- Tóthová L, Celec P. Oxidative Stress and Antioxidants in the Diagnosis and Therapy of Periodontitis. *Front Physiol.* 2017 14; 8:1055. doi: 10.3389/fphys.2017.01055. PMID: 29311982
- Chen M, Cai W, Zhao S, Shi L, Chen Y, Li X, et al. Oxidative stress-related biomarkers in saliva and gingival crevicular fluid associated with chronic periodontitis: A systematic review and meta-analysis. *J Clin Periodontol.* 2019; 46(6):608-622. doi: 10.1111/jcpe.13112. PMID: 30989678
- World Health Organization. The world medicines situation 2011. In *Traditional Medicines: Global Situation, Issues and Challenges*; WHO: Geneva, Switzerland, 2011; pp. 1–14.
- Gupta RK, Gupta D, Bhaskar DJ, Yadav A, Obaid K, Mishra S. Preliminary antiplaque efficacy of aloe vera mouthwash on 4 day plaque re-growth model: randomized control trial. *Ethiop J Health Sci.* 2014 Apr;24 (2):139-44. doi: 10.4314/ejhs.v24i2.6. PMID: 24795515
- Karim B, Bhaskar DJ, Agali C, Gupta D, Gupta RK, Jain A, et al. Effect of Aloe vera mouthwash on periodontal health: triple blind randomized control trial. *Oral Health Dent Manag.* 2014; 13(1):14-9. PMID: 24603910
- Vangipuram S, Jha A, Bhashyam M. Comparative efficacy of aloe vera mouthwash and chlorhexidine on periodontal health: A randomized controlled trial. *J Clin Exp Dent.* 2016; 8(4):e442-e447. doi: 10.4317/jced.53033. PMID: 27703614
- Mangaiyarkarasi SP, Manigandan T, Elumalai M, Cholan PK, Kaur RP. Benefits of Aloe vera in dentistry. *J Pharm Bioallied Sci.* 2015;7(Suppl 1):S255-9. doi: 10.4103/0975-7406.155943. PMID: 26015726
- Radha MH, Laxmipriya NP. Evaluation of biological properties and clinical effectiveness of Aloe vera: A systematic review. *J Tradit Complement Med.* 2014 Dec 23;5(1):21-6. doi: 10.1016/j.jtcme.2014.10.006. PMID: 26151005
- Nejatzadeh-Barandozi F. Antibacterial activities and antioxidant capacity of Aloe vera. *Org Med Chem Lett.* 2013; 3(1):5. doi: 10.1186/2191-2858-3-5. PMID: 23870710
- 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 Feb;20(1):32-7. doi: 10.1590/s1678-77572012000100007. PMID: 22437675
- Silness J, Løe H. Periodontal Disease in Pregnancy II. Correlation between oral hygiene and periodontal condition. *Acta Odontol Scand.* 1964; 22:121-

- 135.doi: 10.3109/00016356408993968 PMID: 14158464
18. Løe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. *Acta Odontol Scand.* 1963; 21:533-551. doi:10.3109/00016356309011240 PMID: 14121956
19. Hashemi SA, Madani SA, Abediankenari S. The Review on Properties of Aloe Vera in Healing of Cutaneous Wounds. *Biomed Res Int.* 2015; 2015:714216. doi: 10.1155/2015/714216. Epub 2015 May 19. PMID: 26090436
20. Neena IE, Ganesh E, Poornima P, Korishettar R. An ancient herb aloe vera in dentistry: a review. *J Oral Res Rev.* 2015; 7: 25–30. doi: 10.4103/2249-4987.160174
21. Prueksrisakul T, Chantarangsu S, Thunyakitpisal P. Effect of daily drinking of Aloe vera gel extract on plasma total antioxidant capacity and oral pathogenic bacteria in healthy volunteer: a short-term study. *J Complement Integr Med.* 2015 Jun;12 (2):159-64. doi: 10.1515/jcim-2014-0060. PMID: 25803090
22. Moghaddam AA, Radafshar G, Jahandideh Y, Kakaei N. Clinical Evaluation of Effects of Local Application of Aloe vera Gel as an Adjunct to Scaling and Root Planning in Patients with Chronic Periodontitis. *J Dent (Shiraz).* 2017 Sep; 18 (3):165-172. PMID: 29034270
23. Andi Mardian A, Harun A, Fahrudin AM. Efficacy of mouthwash from Aloe vera juice after scaling treatment on patients with gingivitis: A clinical study. *Pesq Bras Odontoped Clin Integr.* 2018; 18:e3959. doi: <http://dx.doi.org/10.4034/PBOCI.2018.181.32> ISSN 1519-0501.
24. Chandrabhas 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(4):543-8. doi: 10.4103/0972-124X.106905. PMID: 23493442
25. Biju T, Shabeer MM, Amitha R, Rajendra BP, Suchetha K. Comparative evaluation of serum superoxide dismutase and glutathione levels in periodontally diseased patients: an interventional study. *Indian J Dent Res.* 2014 Sep-Oct;25(5):613-6. doi: 10.4103/0970-9290.147105. PMID: 25511061
26. Aggarwal BB, Prasad S, Reuter S, Kannappan R, Yadav VR, Park B, et al. Identification of novel anti-inflammatory agents from Ayurvedic medicine for prevention of chronic diseases: “reverse pharmacology” and “bedside to bench” approach. *Curr Drug Targets.* 2011;12(11):1595-1653. doi:10.2174/138945011798109464