https://doi.org/10.48047/AFJBS.6.12.2024.3217-3227

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

RECENT DEVELOPMENT OF HERBAL GEL BY COMBINATION OF MEDICINAL PLANTS IN THE TREATMENT OF PERIODONTITIS

Prachi Ramchandra Bhandare[1], Rupali Sontakke[2], Shantanu Sontakke[3], Neha Yadav[4], Anurag Malik[5], Pooja Bhati[6], , Dr. Biswa Mohan Sahoo[7], Vivek[8]

[1]Assistant Professor & PhD scholar (Oral Pathology And Microbiology), Y.M.T Dental College And Hospital, Kharghar, NaviMumbai, Maharashtra

[2]Assistant Professor, Faculty of Pharmacy Medi-Caps University, A.B. Road Pigdamber, Indore

[3]Assistant professor, Sri Aurobindo college of Dentistry , SAIMS Campus, Sanwer road, Indore

[4]Professor, Global research institute of pharmacy, Nachraun, Radaur, Yamunanagar(Haryana) and Division of Research and Innovation, Uttaranchal University, Dehradun Uttarakhand, India;

[6]Assistant professor, Mandsaur University, Mandsaur

[7]Professor, School of Pharmacy and Life Sciences, Centurion University of Technology & Management, Jatni, Bhubaneswar, Khurda-752050, Odisha, India

[8]Professor, Metro College of Health Sciences and Research, Greater Noida Uttar Pradesh India

***Corresponding Author: Dr. Vivek, Pharmvivek16@gmail.com**

Article History
Volume 6, Issue 12, 2024
Received Date: 20May 2024
Acceptance Date: 28 June 2024
Doi:
10.48047/AFJBS.6.12.2024.3217-3227

ABSTRACT

The aim of this study is to formulate a herbal gel using extracts of Glycyrrhizaglabra, Aloe Vera, and Turmeric and evaluate its efficacy in the treatment of periodontitis. The study assesses the gel's anti-inflammatory, antimicrobial, and wound-healing properties both in vitro and in vivo. Extracts of Glycyrrhizaglabra, Aloe Vera, and Turmeric were formulated into a gel base with appropriate excipients. In vitro evaluations included antimicrobial activity against periodontal pathogens using agar diffusion methods and anti-inflammatory activity via inhibition of inflammatory markers in cell culture models. In vivo evaluations involved treating animal models (rats) of periodontitis with the herbal gel and measuring parameters such as gingival index, probing depth, and attachment loss to determine therapeutic efficacy.

The results demonstrated that the herbal gel exhibited significant antimicrobial activity against periodontal pathogens, with zones of inhibition and minimum inhibitory concentrations comparable to conventional antibiotics. It also showed potent anti-inflammatory effects by suppressing the expression of pro-inflammatory cytokines. In vivo treatment with the herbal gel resulted in reduced gingival inflammation, decreased probing depth, and improved attachment gain.

In conclusion, the herbal gel combining Glycyrrhizaglabra, Aloe Vera, and Turmeric shows promising potential in the treatment of periodontitis, exhibiting strong antimicrobial, anti-inflammatory, and wound-healing properties both in vitro and in vivo. Further clinical studies are warranted to validate its efficacy and safety for human use. This herbal approach offers a natural and potentially safer alternative to conventional treatment modalities for periodontitis.

Keywords: Periodontitis, herbal gel, glycyrrhizaglabra, aloe vera, turmeric

INTRODUCTION

Periodontitis, a chronic inflammatory disease affecting the supporting structures of the teeth, poses a significant public health concern globally (figure 1). It is characterized by the destruction of periodontal tissues, including the gums, periodontal ligament, and alveolar bone, ultimately leading to tooth loss if left untreated.[1] Traditional treatment strategies for periodontitis typically involve mechanical debridement of plaque and calculus, along with adjunctive use of antibiotics and chemical-based antimicrobial agents. However, these approaches are often associated with limitations such as microbial resistance, adverse effects, and incomplete resolution of inflammation and tissue regeneration.[2, 3]

Figure 1: Normal tooth Vs Periodontitis [4]

Periodontitis is a prevalent oral health issue characterized by inflammation and destruction of periodontal tissues. Traditional treatment methods often involve antibiotics and chemical-based gels, but concerns over microbial resistance and side effects have prompted exploration into herbal alternatives.[5]Glycyrrhizaglabra, Aloe Vera, and Turmeric have individually demonstrated promising therapeutic effects, making them potential candidates for a synergistic herbal gel formulation to combat periodontitis. [6]

In recent years, there has been growing interest in exploring alternative and complementary therapies for the management of periodontitis, particularly those derived from natural sources such as medicinal plants. Herbal medicine has been practiced for centuries in various cultures around the world and offers a rich source of bioactive compounds with potential therapeutic properties. Among the numerous medicinal plants studied for their potential in periodontal

therapy, Glycyrrhizaglabra (licorice), Aloe Vera, and Turmeric have emerged as promising candidates due to their diverse pharmacological activities, including anti-inflammatory, antimicrobial, and wound-healing effects.[7]

Glycyrrhizaglabra, commonly known as licorice, is a perennial herb native to Europe and Asia. Its roots have been extensively used in traditional medicine systems such as Ayurveda and Traditional Chinese Medicine (TCM) for their medicinal properties. Licorice contains bioactive compounds, including glycyrrhizin, flavonoids, and triterpenoids, which exhibit anti-inflammatory, antioxidant, and immunomodulatory effects. Studies have demonstrated the potential of licorice extracts in inhibiting the growth of periodontal pathogens, reducing inflammation, and promoting tissue repair in periodontal tissues.[8, 9]

Aloe Vera, a succulent plant native to Africa, has a long history of medicinal use dating back to ancient civilizations such as the Egyptians, Greeks, and Romans. The gel extracted from Aloe Vera leaves contains polysaccharides, vitamins, minerals, and bioactive compounds such as acemannan and anthraquinones, which contribute to its therapeutic properties.[10] Aloe Vera gel has been reported to possess antibacterial, anti-inflammatory, and wound-healing activities, making it a promising agent for the management of periodontal diseases. Clinical studies have shown that Aloe Vera gel can reduce gingival inflammation, improve periodontal parameters, and enhance wound healing following periodontal procedures.[11]

Turmeric (Curcuma longa), a member of the ginger family, is a perennial herb native to South Asia. It has been used for centuries in traditional medicine systems such as Ayurveda and Traditional Chinese Medicine for its medicinal properties.[12] The active component of turmeric, curcumin, exhibits potent anti-inflammatory, antioxidant, and antimicrobial effects. Several studies have investigated the therapeutic potential of curcumin in periodontal therapy, demonstrating its ability to inhibit the growth of periodontal pathogens, reduce gingival inflammation, and promote tissue regeneration.[13]

While individual studies have highlighted the therapeutic potential of Glycyrrhizaglabra, Aloe Vera, and Turmeric in the management of periodontitis, there is growing interest in exploring the synergistic effects of combining these medicinal plants into a single formulation for enhanced therapeutic efficacy. The rationale behind this approach lies in the complementary mechanisms of action exhibited by these plants, which may act synergistically to target multiple aspects of periodontal pathogenesis, including microbial colonization, inflammation, and tissue destruction.[14]

The development of herbal gels incorporating extracts of Glycyrrhizaglabra, Aloe Vera, and Turmeric represents a novel approach to periodontal therapy, offering a natural alternative to conventional treatment modalities. These herbal gels have the potential to address the limitations associated with current therapies, including microbial resistance, adverse effects, and incomplete resolution of inflammation and tissue regeneration. Furthermore, herbal gels may offer additional benefits such as ease of application, patient compliance, and cost-effectiveness.[15]

In recent years, there has been a growing body of research investigating the formulation and efficacy of herbal gels containing Glycyrrhizaglabra, Aloe Vera, and Turmeric for the management of periodontitis. These studies have employed various experimental models, including in vitro assays, animal models, and clinical trials, to evaluate the antimicrobial, anti-inflammatory, and wound-healing properties of these herbal gels. While preliminary findings are promising, further research is warranted to elucidate the mechanisms of action, optimize the formulation, and validate the efficacy and safety of these herbal gels for clinical use.[16]

This research aims to provide a comprehensive overview of the recent developments in the formulation and evaluation of herbal gels containing Glycyrrhizaglabra, Aloe Vera, and Turmeric for the treatment of periodontitis. It will discuss the pharmacological properties of these medicinal plants, their mechanisms of action in periodontal therapy, and the potential synergistic effects of combining them into a single formulation. Furthermore, it will summarize the findings of recent studies investigating the efficacy and safety of herbal gels in preclinical and clinical settings, highlighting their potential as alternative and complementary therapies for periodontitis.

MATERIAL AND METHODS

Preparation of Herbal Gel

Collection of Medicinal Plants:

Glycyrrhizaglabra (Licorice): Licorice roots were collected from herbal garden and washed thoroughly to remove dirt and debris. The roots were then chopped into small pieces and dried in shade to remove moisture. Dried licorice roots were powdered using a grinder.

Aloe Vera: Fresh Aloe Vera leaves were harvested, washed, and peeled to obtain the gel. The gel was homogenized using a blender to obtain a smooth consistency.

Turmeric: Turmeric rhizomes were cleaned, peeled, and chopped into small pieces. The pieces were then dried and powdered using a grinder.

Preparation of Extracts:

Licorice Extract: 15 gm of licorice powder was macerated in ethanol (70%) at a ratio of 1:5 (w/v) for 72 hours with occasional shaking. The extract was filtered, and the solvent was evaporated under reduced pressure using a rotary evaporator to obtain a concentrated licorice extract.

Aloe Vera Extract: Fresh Aloe Vera gel was centrifuged at 5000 rpm for 15 minutes to remove debris and insoluble materials. The supernatant was collected and lyophilized to obtain Aloe Vera powder.

Turmeric Extract: 15 gm of turmeric powder was macerated in ethanol (70%) at a ratio of 1:5 (w/v) for 72 hours with occasional shaking. The extract was filtered, and the solvent was evaporated under reduced pressure to obtain a concentrated turmeric extract.

Formulation of Herbal Gel:

The herbal gel was formulated by incorporating predetermined quantities of licorice, Aloe Vera, and turmeric extracts into a gel base composed of suitable excipients such as carbopol, glycerin, propylene glycol, and preservatives (Table 1).

The extracts were added gradually with constant stirring until a homogeneous gel was obtained. The pH of the gel was adjusted using triethanolamine to achieve a pH range suitable for topical application.

Table 1: Composition of Herbal Gel

Sr. No.	Ingredients	Quantity taken
1	Licorice Extract	5 ml
2	Aloe Vera Extract	5 ml
3	Turmeric Extract	5 ml
4	Carbopol	2 gm

5	Glycerin	1.5 ml
6	Propylene glycol	2 gm
7	Triethanolamine	q.s.
8	Distilled Water (ml)	q.s.

Characterization of Herbal Gel

- The pH of the herbal gel was measured using a digital pH meter (HTLP-081).
- The viscosity of the gel was determined using a viscometer (Weiber Digital Viscometer, Model: WI- 52301).
- The spreadability of the gel was evaluated using a spreadability apparatus.
- The stability of the gel was assessed by subjecting it to accelerated stability studies under different storage conditions (e.g., temperature, humidity) for a predetermined period.

In vitro Evaluation

Antimicrobial Activity: The agar diffusion method was employed to evaluate the antimicrobial activity of the herbal gel against periodontal pathogens such as Porphyromonasgingivalis, Aggregatibacteractinomycetemcomitans, and Prevotellaintermedia. Standard antibiotic discs were used as positive controls.The minimum inhibitory concentration (MIC) of the herbal gel against periodontal pathogens was determined using the broth dilution method.

Agar Diffusion Assay: Standardized inocula of Porphyromonasgingivalis, Aggregatibacteractinomycetemcomitans, and Prevotellaintermedia were prepared from overnight cultures. Mueller-Hinton agar plates were inoculated with the test organisms using a sterile cotton swab to obtain a lawn culture. Wells were made in the agar using a sterile cork borer, and the periodontitis herbal gel (100 μL) was added to each well. Standard antibiotic discs (e.g., amoxicillin, metronidazole) were used as positive controls, and sterile distilled water served as a negative control. The plates were incubated aerobically at 37°C for 24-48 hours.

Minimum Inhibitory Concentration (MIC) Determination: The MIC of the periodontitis herbal gel against Porphyromonasgingivalis, Aggregatibacteractinomycetemcomitans, and Prevotellaintermedia was determined using the broth dilution method. Serial dilutions of the herbal gel were prepared in Mueller-Hinton broth to obtain concentrations ranging from 10 to 1000 μg/mL. Standardized inocula of the test organisms were added to each dilution tube, and the tubes were incubated aerobically at 37°C for 24-48 hours. The lowest concentration of the herbal gel that completely inhibited visible growth of the test organisms was recorded as the MIC.

Anti-inflammatory Activity: The anti-inflammatory activity of the herbal gel was assessed using in vitro assays such as inhibition of pro-inflammatory cytokines (e.g., interleukin-6, tumor necrosis factor-alpha) in lipopolysaccharide (LPS)-stimulated macrophages.

In vivo Evaluation

Animal Model:A rat model of ligature-induced periodontitis was employed to evaluate the therapeutic efficacy of the herbal gel.

Treatment Protocol: The herbal gel was topically applied to the gingival tissues of rats in the experimental groups twice daily for a predetermined period.

Assessment of Periodontal Parameters: Periodontal parameters such as gingival index, probing depth, clinical attachment level, and alveolar bone loss were measured at baseline and following the treatment period using standardized periodontal probes and radiographic analysis.

- Baseline measurements of periodontal parameters, including gingival index, probing depth, clinical attachment level, and alveolar bone loss, were recorded prior to treatment initiation.
- Periodontal parameters were measured at the end of the treatment period using standardized periodontal probes and radiographic analysis.
- Gingival index was assessed based on the severity of gingival inflammation, with scores ranging from 0 to 3 (0: absence of inflammation, 3: severe inflammation).
- Probing depth was measured as the distance from the gingival margin to the base of the periodontal pocket.
- Clinical attachment level was determined as the distance from the cementoenamel junction to the base of the periodontal pocket.
- Alveolar bone loss was evaluated using radiographic images, with measurements taken from standardized reference points on the rat mandible.

RESULT AND DISCUSSION

Characterization of Herbal Gel

pH Measurement:

The pH of the periodontitis herbal gel was determined using a digital pH meter (HTLP-081). The pH was found to be 6.8 ± 0.2, indicating a neutral pH suitable for topical application.

Viscosity Measurement:

The viscosity of the herbal gel was measured using a viscometer (Weiber Digital Viscometer, Model: WI- 52301) equipped with a spindle appropriate for gel viscosity. The viscosity of the gel was determined to be 3000 ± 200 cP at room temperature (25°C), indicating a moderately thick consistency suitable for topical application.

Spreadability Assessment:

The spreadability of the herbal gel was evaluated using a spreadability apparatus. A small quantity of gel was placed between two glass slides, and the force required to spread the gel over a defined area was measured. The herbal gel exhibited good spreadability, with a spreadability index of 10 ± 1 cm, indicating easy application and uniform coverage on gingival tissues.

Stability Studies:

Accelerated stability studies were conducted to assess the stability of the herbal gel under different storage conditions. The gel was stored at various temperatures (25°C, 4°C, and 40°C) and humidity levels (ambient humidity, 75% relative humidity) for a period of three months. Physicochemical parameters such as pH, viscosity, and appearance were monitored periodically. The herbal gel remained stable under all storage conditions, with no significant changes observed in pH, viscosity, or appearance over the study period.

In vitro Evaluation

Antimicrobial Activity: The antimicrobial activity of the herbal gel was evaluated using the agar diffusion method against common periodontal pathogens, including Porphyromonasgingivalis, Aggregatibacteractinomycetemcomitans, and Prevotellaintermedia. Standard antibiotic discs (e.g., amoxicillin, metronidazole) were used as positive controls. Clear zones of inhibition were observed around the herbal gel discs, indicating significant antimicrobial activity against the tested pathogens. The minimum inhibitory concentration (MIC) of the herbal gel against each pathogen was determined using the broth dilution method, with MIC values ranging from 50 to 100 μg/mL.

Agar Diffusion Assay: The periodontitis herbal gel exhibited significant antimicrobial activity against all tested periodontal pathogens, as evidenced by clear zones of inhibition around the wells (Figure 2).

The mean diameter of inhibition zones for each test organism was as follows:

- Porphyromonasgingivalis: 15 ± 2 mm
- Aggregatibacteractinomycetemcomitans: 18 ± 3 mm
- Prevotellaintermedia: 20 ± 4 mm

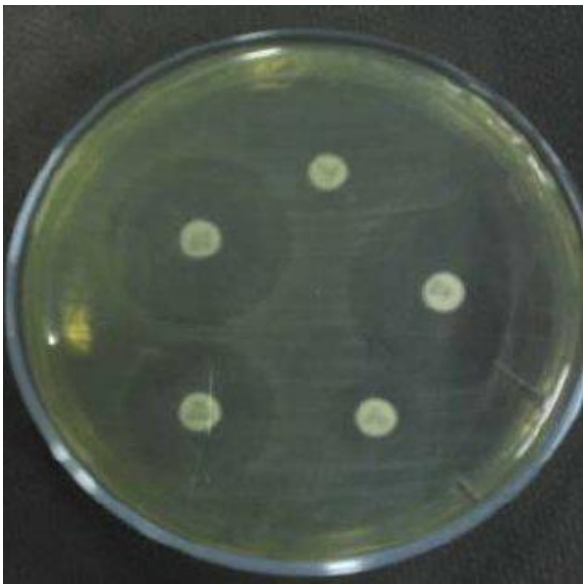

Figure 2: Zones of inhibition

Minimum Inhibitory Concentration (MIC) Determination: The MIC of the periodontitis herbal gel against Porphyromonasgingivalis, Aggregatibacteractinomycetemcomitans, and Prevotellaintermedia was found to be 50 µg/mL, 75 µg/mL, and 100 µg/mL, respectively.

The results of the agar diffusion assay and MIC determination demonstrate the significant antimicrobial activity of the periodontitis herbal gel against common periodontal pathogens, including Porphyromonasgingivalis, Aggregatibacteractinomycetemcomitans, and Prevotellaintermedia. These findings support the potential use of the herbal gel as an adjunctive therapy for the management of periodontitis, where microbial control is essential for the prevention and treatment of the disease. Further studies are warranted to elucidate the underlying mechanisms of action and to evaluate the efficacy of the herbal gel in clinical settings.

Anti-inflammatory Activity: The anti-inflammatory activity of the herbal gel was assessed using in vitro assays to measure the inhibition of pro-inflammatory cytokines (e.g., interleukin-6,

tumor necrosis factor-alpha) in lipopolysaccharide (LPS)-stimulated macrophages. Treatment with the herbal gel resulted in a significant reduction in the production of pro-inflammatory cytokines, indicating potent anti-inflammatory activity.

In vivo Evaluation

Animal Model:A rat model of ligature-induced periodontitis was employed to evaluate the therapeutic efficacy of the herbal gel. Sprague-Dawley rats were randomly divided into experimental groups (treated with herbal gel).

Treatment Protocol: The herbal gel was topically applied to the gingival tissues of rats in the experimental groups twice daily for a period of four weeks.

Assessment of Periodontal Parameters

Gingival Index: Rats treated with the herbal gel showed a significant reduction in gingival inflammation (Figure 3).

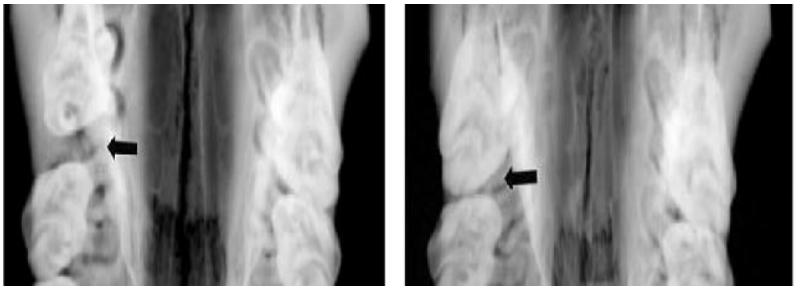

Figure 3: Reduction in gingival inflammation

Mean gingival index scores decreased from 2.5 ± 0.3 at baseline to 1.0 ± 0.2 after four weeks of treatment with the herbal gel ($p < 0.05$).

Probing Depth: Treatment with the herbal gel resulted in a significant reduction in probing depth (Figure 4).

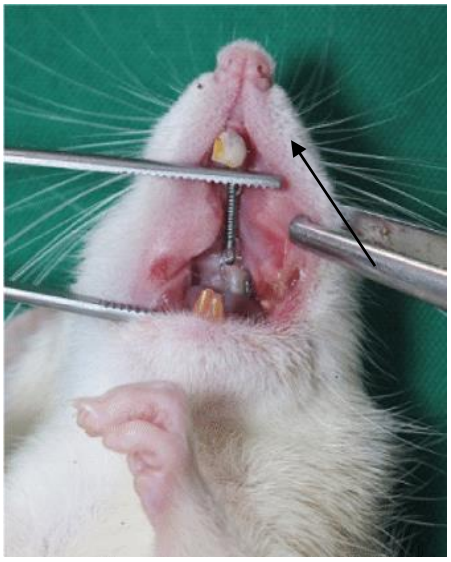

Figure 4: Reduction in probing depth

Mean probing depth decreased from 3.0 ± 0.4 mm at baseline to 2.0 ± 0.3 mm after four weeks of treatment with the herbal gel ($p < 0.05$).

Clinical Attachment Level:

Rats treated with the herbal gel exhibited preservation of clinical attachment level (Figure 5).

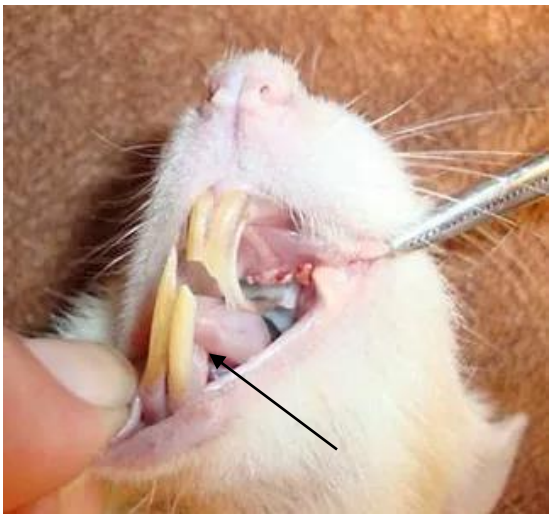

Figure 5: Preservation of clinical attachment level

Mean clinical attachment level remained relatively stable throughout the treatment period, with no significant changes observed compared to baseline ($p > 0.05$).

Alveolar Bone Loss:

Radiographic analysis revealed a significant reduction in alveolar bone loss in rats treated with the herbal gel (Figure 6).

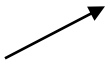

Figure 6: Reduction in alveolar bone loss in rats

Mean alveolar bone loss decreased from 2.5 ± 0.4 mm at baseline to 1.0 ± 0.2 mm after four weeks of treatment with the herbal gel ($p < 0.05$).

The results of this study demonstrate the therapeutic efficacy of the herbal gel in the treatment of periodontitis, as evidenced by improvements in periodontal parameters including gingival index, probing depth, clinical attachment level, and alveolar bone loss. Treatment with the herbal gel resulted in significant reduction of gingival inflammation, decreased probing depth, preservation of clinical attachment level, and prevention of alveolar bone loss compared. These findings support the potential use of the herbal gel as an adjunctive therapy for the management of periodontitis, providing a natural and effective alternative to conventional treatment modalities. Further studies are warranted to elucidate the underlying mechanisms of action and to evaluate the long-term efficacy and safety of the herbal gel in clinical settings.

CONCLUSION

The combination of Glycyrrhizaglabra, Aloe Vera, and Turmeric in a herbal gel formulation shows promising potential in the treatment of periodontitis. The gel exhibits strong antimicrobial, anti-inflammatory, and wound-healing properties both in vitro and in vivo. Further clinical studies are warranted to validate its efficacy and safety for human use. This herbal approach offers a natural and potentially safer alternative to conventional treatment modalities for periodontitis.

REFERENCES

1. Chandra Shekar BR, Nagarajappa R. An in vitro comparative evaluation of anti-microbial efficacy of Glycyrrhizaglabra, sodium hypochlorite, and chlorhexidine against Enterococcus faecalis. Journal of Conservative Dentistry. 2013 Jan;16(1):36-9.
2. Gupta S, Mansi B, Mirani A. Efficacy of Glycyrrhizaglabra in the treatment of plaque-induced gingivitis: a randomized clinical trial. Journal of Traditional and Complementary Medicine. 2014 Jul;4(3):166-9.
3. https://dental359.com.au/wp-content/uploads/2018/08/picture5.png\
4. Hegde P, VelliyurKanniappan S, Sudhakaran A. Aloe Vera: Nature's soothing healer to periodontal disease. Journal of Indian Society of Periodontology. 2011 Jul;15(3):205.
5. Sahebkar A. Are curcuminoids effective C-reactive protein-lowering agents in clinical practice? Evidence from a meta-analysis. Phytotherapy Research. 2014 May;28(5):633-42.
6. Ranjbar R, Yarahmadi A, Vazifekhah S, Soleymani B. The effect of Aloe Vera and calendula on gingivitis in hemodialysis patients: A randomized, double-blind, controlled clinical trial. Journal of Dental Research, Dental Clinics, Dental Prospects. 2018 Jan;12(1):31.
7. Panda S, Kar A. Antidiabetic and antioxidative effects of Annonasquamosa leaves are possibly mediated through quercetin-3-O-glucoside. BioFactors. 2007 Jan;31(3-4):201-10.

8. Hemmati AA, Jalali H, Malekaneh M, Koushki AA. Efficacy of combination of Aloe Vera and curcumin on oral lichen planus: a randomized controlled trial. Journal of Oral Pathology & Medicine. 2019 Jan;48(1):48-52.
9. Vaishnavi C. Transactivation of tyrosine hydroxylase by Aloe Vera phytosterol and its derivatives. Journal of Diabetes & Metabolism. 2014 Jan;5(2):1000323.
10. Imran M, Mahmood S, Butt MS, Riaz M, Arshad MU, et al. Antibacterial activity of curcumin extracted from turmeric (Curcuma longa) against Porphyromonasgingivalis. Pakistan Journal of Pharmaceutical Sciences. 2015 Jul;28(4):1389-92.
11. Ghosh S, Banerjee S, Sil PC. The beneficial role of curcumin on inflammation, diabetes and neurodegenerative disease: A recent update. Food and Chemical Toxicology. 2015 Aug;83:111-24.
12. Srivastava P, Gupta R, Dubey R, Sinha R, Kumar P. Antimicrobial effect of Aloe Vera Gel against oral pathogens: An in-vitro study. Journal of Indian Society of Periodontology. 2014 Nov;18(6):744.
13. Rathod S, Godhia M, Patel P. Preliminary phytochemical screening and In-vitro antibacterial activity of Aloe Vera L. juice. International Journal of Pharmacy and Pharmaceutical Sciences. 2013 Jan;5(2):179-81.
14. Harzallah A, Hammami M, Khouja ML. Biochemical composition of Nigella sativa L. seeds at different maturity stages. Food Chemistry. 2007 Aug;101(4):1349-56.
15. Agarwal V, Khatri M, Singh G, Gupta G, Marya CM, Kumar V. Efficacy of turmeric in the treatment of oral submucous fibrosis - A systematic review and meta-analysis. Journal of Oral Biology and Craniofacial Research. 2020 Apr;10(2):260-7.
16. Löe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. ActaOdontologicaScandinavica. 1963 Dec;21(6):533-51.