Comparative analysis of the effect of 20% Curcumin mouthwash and 0.2% Chlorhexidine mouthwash on dental plaque and gingival inflammation: a randomized clinical trial

Nima Nadafpour[1]
Saeed Sadat Mansouri[1]
Navid Mirazimi[1]
Siamak Nehzat[1]
Ramin Asgharian[2]
Maziar Farhadi[1]

[1] Periodontics department, Faculty of dentistry, Tehran Medical sciences, Islamic Azad University, Tehran, Iran
[2] Department of Pharmaceutics, Faculty of Pharmaceutical Sciences, Islamic Azad University, Tehran, Iran

Corresponding Author: Author: Siamak Nehzat
e-mail: siamak.nehzat99@gmail.com

Abstract

Introduction: Microbial plaque constitutes the primary etiological factor for dental caries, gingivitis, and periodontal disease, thereby underscoring the necessity for effective plaque reduction strategies. Mechanical removal techniques may present difficulties for certain individuals, thereby accentuating the importance of alternative methods. Curcumin, a naturally occurring compound with documented antimicrobial and anti-inflammatory properties, demonstrates potential benefits for oral health. This study aims to evaluate the anti-inflammatory and antibacterial efficacy of a 20% curcumin mouthwash in comparison to a 0.2% chlorhexidine mouthwash concerning dental plaque accumulation and gingivitis.
Materials and methods: In this randomized clinical trial, 39 patients aged 20 and older with gingivitis participated, randomly assigned to three groups of 13. All participants initially received scaling treatment. Group 1 utilized chlorhexidine mouthwash (SRP/CHX Gr-1), while Group 2 used curcumin mouthwash (SRP/CUR Gr-2). Group 3 received only scaling (SRP Gr-3) with the placebo mouthwash (distilled water). Gingival bleeding and plaque indices were recorded on Day 0 (before treatment) and Day 14, and the differences among the groups were statistically analyzed using repeated-measure ANOVA and paired t-tests.
Results: Clinical parameters improved in all three groups compared to baseline. Both the curcumin and chlorhexidine groups exhibited statistically significant improvements in the gingival bleeding index compared to the control group (Gr-3) ($P < 0.05$). In contrast, no significant difference was observed in the dental plaque index ($P > 0.05$). Additionally, there were no statistically significant differences in the modified sulcular bleeding index and plaque index (Turesky) between the curcumin and chlorhexidine groups ($P > 0.05$).
Conclusion: The results of this study indicate that curcumin is comparable to chlorhexidine as an anti-inflammatory mouthwash and can serve as an effective adjunct in periodontal treatments.

Keywords: chlorhexidine, curcumin, dental plaque, gingivitis

Introduction

Microbial plaque is widely recognized as the primary etiological factor in the development of caries, gingivitis, and periodontal disease[1]. It accumulates at the gingival margin, prompting gingivitis characterized by bleeding, swelling, and redness. If not addressed,

License

This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

Authors contributing to Oral and Implantology agree to publish their articles under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which allows third parties to copy and redistribute the material providing appropriate credit and a link to the license but does not allow to use the material for commercial purposes and to use the material if it has been remixed, transformed or built upon.

How to Cite

Nima Nadafpour, Saeed Sadat Mansouri, Navid Mirazimi, Siamak Nehzat, Ramin Asgharian, Maziar Farhadi.
Comparative analysis of the effect of 20% curcumin mouthwash and 0.2% chlorhexidine mouthwash on dental plaque and gingival inflammation: a randomized clinical trial.
Oral and Implantology
Vol. 17 No. 3 (2025), 254-260.
DOI 10.11138/oi.v17i3.186

it may advance to periodontitis, a more severe condition. The correlation between dental plaque and systemic diseases, including cardiovascular disease, diabetes, and arthritis, is well substantiated. Therefore, the implementation of strategies aimed at reducing or preventing the accumulation of this microbial mass is essential for the prophylaxis of caries and periodontal diseases. The professional removal of dental biofilm through scaling and root planing, complemented by consistent at-home oral hygiene practices, markedly diminishes the presence of periopathogens. Although this mechanical approach is efficacious, microbial recolonization can be unpredictable, and some individuals may encounter difficulties with mechanical methods. This includes patients with mobility issues or those who have undergone extensive maxillofacial surgeries. Consequently, reliance on chemical agents, such as mouthwashes, may be necessary. [2,5–6]

In recent years, extracts and oils from medicinal plants with antimicrobial and anti-inflammatory properties have been utilized to prevent oral and dental infections. [7] In vitro studies have shown that these materials inhibit pathogens associated with periodontal disease and dental caries. Notable examples include garlic, essential oils [8–9], pomegranate [10], grapefruit [11], and aloe vera. [12] Curcumin, a well-known herbal compound and popular Indian spice, has a variety of therapeutic applications. [13]. It is commonly used as an herbal anti-inflammatory agent to alleviate pain, reduce inflammation, and promote wound healing. With its anti-inflammatory, antioxidant, antimicrobial, and antibacterial properties, curcumin benefits systemic and localized treatment of periodontal diseases. [14–16]. Previous research has demonstrated that curcumin stimulates tissue repair and shows promising therapeutic effects in periodontal conditions. It helps reduce local and systemic inflammation, aids in preventing hyperglycemia and bacteremia and protects against the destruction of connective tissue. [17–18]

In light of the limitations identified within the existing literature and the necessity to investigate the effects of curcumin in human subjects, as well as the impact of various administration approaches, this study aims to evaluate the anti-inflammatory and antibacterial properties of a 20% curcumin mouthwash in comparison to a 0.2% chlorhexidine mouthwash on dental plaque and gingivitis. It is hypothesized that there is no significant difference between the effects of the 20% curcumin mouthwash and the 0.2% chlorhexidine mouthwash on dental plaque and gingivitis.

Materials and methods

Ethical approval for this study was secured from the IAU Local Research Ethics Committee (IR.IAU.DENTAL.REC.1399.159).

This randomized clinical trial involved the selection of 39 participants from the periodontics department and a private clinic, based on the following criteria.

Inclusion Criteria:

Participants must exhibit generalized gingivitis, characterized by:

1. Changes in gum color and consistency
2. Bleeding on probing (BOP) rate exceeding 30%
3. Presence of dental plaque
4. Exclusion Criteria:
5. Participants exhibiting symptoms of periodontitis
6. Participants with clinical attachment loss
7. Pregnant and breastfeeding women
8. Individuals who have undergone periodontal treatment in the past 6 months
9. Patients undergoing systemic antibiotic treatment
10. Tobacco users
11. Those with a history of sensitivity to turmeric and chlorhexidine

According to the findings of Muglikar et al., the minimum sample size necessary for each of the three study groups was determined to be 13 samples. Employing a one-way analysis of variance with $\alpha = 0.05$ and $\beta = 0.2$, the standard deviation of the changes was 0.89 mm, and the effect size was 0.53.

Initially, all patients referred to the Islamic Azad University, Tehran Dental Branch's periodontics department underwent scaling treatment and received oral health instructions. The participants were randomly assigned to three groups of 13: a control group, a curcumin mouthwash group, and a chlorhexidine mouthwash group. Randomization was done using a computer-generated randomization method. Allocation concealment was ensured using sealed opaque envelopes to prevent selection bias. The first group underwent scaling and root planing (SRP) and then used a 0.2% chlorhexidine mouthwash (Iran Najo Company, Iran) twice daily for 14 days. The second group received SRP, followed by a 20% curcumin mouthwash. This mouthwash was prepared by mixing one teaspoon of curcumin extract in 2 cups of water, boiling the mixture until reduced by half, and filtering it. For application, one teaspoon (containing 5.139 grams of curcumin) was mixed with 50 ml of distilled water and filtered using filter paper to achieve a 20% concentration. The third group of participants received SRP, followed by a placebo mouthwash (distilled water). Both participants and outcome assessors were blinded to the group assignments, ensuring double-blinding throughout the study. Participants were instructed to brush their teeth twice daily (in the morning and evening) and to use 10 ml of mouthwash for 30 seconds, 30 minutes after brushing. They were advised not to eat or drink anything for 30 minutes after using the mouthwash.

After a period of 14 days, the participants reconvened at the faculty to undergo the required follow-up observations. All patients were duly informed regarding the nature of the research, and their informed consent for participation was secured.

The pertinent indicators were assessed and documented prior to scaling and root planing (SRP) on Day 0, and subsequently re-evaluated on Day 14.

The quantity of dental plaque was evaluated utilizing the Turesky index in conjunction with disclosing tablets, with scores assigned on a scale from 0 to 5 based on the presence or absence of plaque. A score of 0 signifies no plaque, whereas a score of 1 indicates plaque present at discrete points within the cervical region of the tooth. A score of 2 denotes a thin, continuous band of plaque

in the cervical area. A score of 3 corresponds to a band of plaque exceeding 1 mm in width but covering less than one-third of the tooth crown. A score of 4 signifies that plaque covers at least one-third but less than two-thirds of the crown of the tooth. Lastly, a score of 5 indicates plaque covering two-thirds or more of the crown.

The extent of gingival bleeding was assessed utilizing the modified sulcular bleeding index, performed by a trained individual. This index quantifies bleeding based on affected areas and is rated on a scale from 0 to 3, according to the presence or absence of bleeding. A score of 0 signifies no bleeding, a score of 1 indicates pinpoint bleeding, a score of 2 corresponds to bleeding manifested as a red line around the gum margin, and a score of 3 signifies severe bleeding.

The Kolmogorov-Smirnov test was conducted to assess the normality of the data, and all data sets successfully passed this test. To compare changes in plaque index and gingival inflammation at two time points across the three study groups, a repeated measures ANOVA and a one-way ANOVA followed by Tukey's post hoc test were performed. A paired t-test was also used to analyze differences between the two time points within each group. Statistical analyses were conducted using IBM SPSS Statistics 28 software, and results were considered statistically significant at $P < 0.05$.

The dependent variables of the study, namely the dental plaque and the gingival bleeding index, were evaluated on two occasions: Day 0 and Day 14.

Results

The average age and gender distribution of the participants in this study are presented in Table 1.

The results of the statistical analysis demonstrated no statistically significant differences in the mean dental plaque levels among the three treatment groups at any time point ($p > 0.05$) (see Table 2). Furthermore, there were no significant differences observed in the mean change in dental plaque between the two time points ($p > 0.05$) (refer to Table 3).

Furthermore, the analysis of variance demonstrated no statistically significant difference in the mean gingivitis levels across the three treatment groups at any measured time point ($p > 0.05$). Nonetheless, a significant disparity was observed in the mean change of gingivitis between the two time points ($p < 0.05$). According to the post hoc analysis, in the pairwise comparisons among the groups regarding the gingivitis parameter, none of the variables exhibited significant differences at any time point ($p > 0.05$). However, the mean change in variables between the control group and the curcumin group, as well as between the control group and the chlorhexidine group, was statistically significant ($p < 0.05$). (Table 4)

Furthermore, the results of the paired t-test demonstrated that the differences in the mean values of dental plaque and gingival bleeding before and after the initiation of treatment within each treatment group were statistically significant ($p < 0.05$) (Tables 5, 6).

Table 1. Average age and gender of the subjects studied.

Groups	Gender	Average age	number
Control	6 men 7 women	34 years 45 > Age > 20	13
Curcumin	6 men 7 women	33 years 45 > Age > 20	13
Chlorhexidine	6 men 7 women	31 years 45 > Age > 20	13

Table 2. Using the one-way ANOVA test, the mean difference in the dental plaque index (Turesky) before and after the start of treatment, among the three treatment groups.

		F	p-value
Before starting treatment	Between groups	1.07	0.35
Two weeks later	Between groups	2.28	0.11
Difference between two times	Between groups	2.89	0.06

Table 3. The mean difference in the modified sulcular bleeding index before and after the start of treatment among the three treatment groups analyzed using a one-way ANOVA test.

		F	p-value
Before starting treatment	Between groups	0.10	0.90
Two weeks later	Between groups	0.32	0.72
Difference between two times	Between groups	4.83	0.01

Table 4. Pairwise Comparison of study groups using One-way Anova with Post-Hoc Tukey test

	Treatment Group 1	Treatment Group 2	Mean difference	p-value
Before Treatment	**control**	**curcumin**	-0.043	0.968
		CHX	-0.08	0.895
	Curcumin	**control**	-0.043	0.968
		CHX	-0.03	0.976
	CHX	**control**	0.08	0.895
		curcumin	0.03	0.976
After 2Weeks	**control**	**curcumin**	0.1	0.739
		CHX	0.08	0.803
	Curcumin	**control**	-0.1	0.739
		CHX	-0.01	0.993
	CHX	**control**	-0.08	0.803
		curcumin	0.01	0.993
After 4 Weeks	**control**	**curcumin**	0.14	0.045
		CHX	0.16	0.019
	Curcumin	**control**	-0.14	0.045
		CHX	0.02	0.929
	CHX	**control**	-0.16	0.019
		curcumin	-0.02	0.929

Table 5. The mean difference in the dental plaque index (Turesky) before and after the start of treatment, analyzed separately for each group using a paired t-test.

Groups			Mean	standard deviation	P-value
Control	dental plaque	before starting treatment	2.56	.57	0.013
		Two weeks later	2.32	49.	
Curcumin	dental plaque	before starting treatment	2.36	.75	<0.001
		Two weeks later	1.89	62.	
Chlorhexidine	dental plaque	before starting treatment	2.75	.67	<0.001
		Two weeks later	2.26	52.	

Table 6. The mean difference in the modified sulcular bleeding index before and after the start of treatment for each group, analyzed using a paired t-test.

Groups			Mean	standard deviation	P-value
Control	modified sulcular bleeding index	before starting treatment	1.1	47.	0.001
		Two weeks later	.98	.40	
Curcumin	modified sulcular bleeding index	before starting treatment	1.14	42.	<0.001
		Two weeks later	.87	.30	
Chlorhexidine	modified sulcular bleeding index	before starting treatment	1.18	45.	<0.001
		Two weeks later	.89	.34	

Discussion

Following the implementation of scaling and oral health education, the study results demonstrated a statistically significant reduction in gingival bleeding across all three groups (curcumin, chlorhexidine, and control). Although a decrease in dental plaque was observed, this change did not reach statistical significance. Notably, significant differences were identified in the gingival bleeding index when comparing the control group with the curcumin group and the chlorhexidine group, signifying greater improvements in gingival inflammation with these mouthwashes relative to the control. However, no significant difference was observed between the chlorhexidine and curcumin groups. Consequently, the initial hypothesis was corroborated.

Research conducted by Curylofo-Zotti et al compared the effects of natural curcumin with chemically modified curcumin (CMC 2.24) on osteoclasts responsible for bone resorption, apoptosis, and inflammation in rats suffering from periodontal disease. The findings demonstrated that both CMC 2.24 and natural curcumin significantly decreased the number of inflammatory cells. Furthermore, natural curcumin substantially reduced the quantity of apoptotic cells within the gingiva and diminished osteoclast presence in the alveolar bone crest. Additionally, Elburki et al. established through their research that curcumin attenuates both local and systemic inflammation.

Furthermore, it assists in preventing hyperglycemia and bacteremia, as well as the degradation of connective tissue. Stabili et al. concluded that curcumin promotes tissue repair and possesses potential therapeutic effects on periodontal diseases.

This study concludes that, irrespective of the assigned groups, plaque treatment and health education typically diminish gingivitis and dental plaque. Multiple studies corroborate this conclusion, suggesting that scaling mitigates inflammatory factors by decreasing the microbial burden in the gums, consequently reducing gingival inflammation. Raghava et al. demonstrated that scaling has a beneficial effect on clinical parameters, including dental plaque.

Current findings indicate that curcumin mouthwash markedly diminishes gingivitis. Consistent with these results, Heydar and Ghafori utilized curcumin gel to manage periodontal pockets. After one month, they observed that the application of curcumin gel reduced bleeding on probing (BOP) within the test group. A study by He et al. demonstrated that curcumin influences inflammatory cells, thereby decreasing inflammation and chronic conditions. Kaur et al. reported that curcumin mouthwash demonstrates greater efficacy in reducing gingival inflammation compared to curcumin gel. Abdel-Fatah et al. also evaluated the plaque index, gingival index, clinical attachment level, and probing depth after six weeks of scaling and root planing (SRP) treatment, concluding that periodontal health improved with the use of curcumin gel. Siddharth et al. determined that periodontal and microbiological parameters, including the sulcus bleeding index and probing pocket depth, showed improvement when curcumin was employed as a subgingival agent.

The current study demonstrated that curcumin mouthwash did not significantly affect dental plaque compared to the other groups. This finding aligns with the conclusions of Malekzade et al., who suggested that chemical interventions such as mouthwash may not significantly influence dental plaque as a physical factor. However, Divvi et al.'s study reported results contrary to the current research regarding dental plaque. This discrepancy may be attributed to variations in sample size (45 participants) and the duration of the investigation (6 weeks). Mali et al. and Muglikar et al. also found that curcumin mouthwash is effective against dental plaque. The difference in curcumin concentration—0.1% in the study by Mali et al. compared to 20% in the current study—could explain the differing results.

Chlorhexidine mouthwash is regarded as the most potent antimicrobial agent and is regarded as the "Gold Standard" among various chemotherapeutic agents. The findings of the present study are consistent with this assertion; however, statistical analyses indicate no significant correlation between its use and the reduction of dental plaque ($p = 0.06$). Deshpande et al. assessed the plaque index at three intervals (baseline, 15 days, and 30 days) and found chlorhexidine to be effective in enhancing the plaque index. Although a significant difference was observed between the baseline and the initial follow-up, chlorhexidine demonstrated a greater reduction after 30 days; it is pertinent to note that participants in this study did not undergo scaling and root planing. The sample size comprised 60 patients. James et al. conducted a study involving 50 participants over a six-week period, while Storti et al. examined 120 participants. Both studies concluded that chlorhexidine not only reduced gingivitis but also exerted a significant effect on dental plaque. Consequently, increasing the sample size and prolonging the duration of the study may yield more substantively meaningful results.

The results comparing chlorhexidine and curcumin revealed no significant differences between the two groups in any investigated variables (gingival bleeding and dental plaque), indicating comparable outcomes for both mouthwashes, in the study by Guru et al. [33]. A 2% curcumin formulation delivered via a nanocarrier system demonstrated results similar to those of chlorhexidine gel. Chatterjee et al. also found that while both curcumin and chlorhexidine types of mouthwash impacted gingival factors, there was no significant difference between the two groups.

This research offered important insights into the utilization of curcumin mouthwash for the reduction of dental plaque and gingival inflammation. Nonetheless, limitations such as a limited sample size, a brief follow-up period, and the investigation of only a single concentration of curcumin are acknowledged. Future research should investigate a wider spectrum of concentrations and extend follow-up durations with larger participant groups.

Conclusion

In conclusion, this study established that both curcumin and chlorhexidine mouthwashes markedly diminished

gingival bleeding following scaling procedures and oral health education initiatives. Although curcumin did not demonstrate a statistically significant impact on dental plaque levels, it exhibited potential advantages in controlling gingival inflammation. Further research employing larger sample sizes and different concentrations of curcumin is required to more comprehensively assess its efficacy in dental care.

References

1. Kakodkar, P. and S. Mulay, Effect of sugar-free gum in addition to tooth brushing on dental plaque and interdental debris. Dental Research Journal, 2010. 72: p. 64.
2. Modiri, S., et al., A tangible prospect for the treatment of gingivitis using a potentially probio-tic strain Lactobacillus plantarum MK06 isolated from traditional dairy products: a triple blind randomized clinical trial. BMC Oral Health, 2023. 231: p. 870. phttps://doi.org/10.1186/s12903-023-03494-x
3. Genco, R.J., Current view of risk factors for periodontal diseases. Journal of periodontolo-gy, 1996. 67: p. 1041-1049.phttps://doi.org/10.1902/jop.1996.67.10.1041
4. Arweiler, N., L. Netuschil, and E. Reich, Alcohol-free mouthrinse solutions to reduce supra-gingival plaque regrowth and vitality: A controlled clinical study. Journal of Clinical Periodonto-logy, 2001. 282: p. 168-174.phttps://doi.org/10.1034/j.1600-051x.2001.028002168.x
5. Jünger, H., et al., Anti-inflammatory potential of an essential oil-containing mouthwash in el-derly subjects enrolled in supportive periodontal therapy: a 6-week randomised controlled cli-nical trial. Clinical oral investigations, 2020. 24: p. 3203-3211.phttps://doi.org/10.1007/s00784-019-03194-3
6. Liu, C., et al., Oral care measures for preventing nursing home-acquired pneumonia. Co-chrane Database of Systematic Reviews, 20189.phttps://doi.org/10.1002/14651858.CD012416.pub2
7. Elavarasu, S., et al., Evaluation of anti-plaque microbial activity of Azadirachta indica (neem oil) in vitro: A pilot study. Journal of pharmacy and bioallied sciences, 2012. 4(Suppl 2): p. S394-S396.phttps://doi.org/10.4103/0975-7406.100299
8. Mathai, K., et al., Antimicrobial Effect of Ginger, Garlic, Honey, and Lemon Extracts on Streptococcus mutans. The journal of contemporary dental practice, 2017. 1811: p. 1004-1008.phttps://doi.org/10.5005/jp-journals-10024-2165
9. Sakkas, H. and C. Papadopoulou, Antimicrobial activity of basil, oregano, and thyme essen-tial oils. Journal of microbiology and biotechnology, 2017. 273: p. 429-438.phttps://doi.org/10.4014/jmb.1608.08024
10. Alexandre, E.M., et al., Antimicrobial activity of pomegranate peel extracts performed by high pressure and enzymatic assisted extraction. Food research international, 2019. 115: p. 167-176.phttps://doi.org/10.1016/j.foodres.2018.08.044
11. Lee, S.S., W. Zhang, and Y. Li, The antimicrobial potential of 14 natural herbal dentifrices: results of an in vitro diffusion method study. The Journal of the American Dental Association, 2004. 1358: p. 1133-1141.phttps://doi.org/10.14219/jada.archive.2004.0372
12. Vangipuram, S., A. Jha, and M. Bhashyam, Comparative efficacy of aloe vera mouthwash and chlorhexidine on periodontal health: A randomized controlled trial. Journal of clinical and experimental dentistry, 2016. 84: p. e442. phttps://doi.org/10.4317/jced.53033
13. Mustafa, M.W., et al., Effectiveness of an alcohol-free chitosan-curcuminoid mouthwash compared with chlorhexidine mouthwash in denture stomatitis treatment: a randomized trial. The Journal of Alternative and Complementary Medicine, 2019. 255: p. 552-558.phttps://doi.org/10.1089/acm.2018.0459
14. Muglikar, S., et al., Efficacy of curcumin in the treatment of chronic gingivitis: a pilot study. Oral health & preventive dentistry, 2013. 111.
15. Alalwan, H., et al., The anti-adhesive effect of curcumin on Candida albicans biofilms on denture materials. Frontiers in Microbiology, 2017. 8: p. 659.phttps://doi.org/10.3389/fmicb.2017.00659
16. Inchingolo, F., et al., The Role of Curcumin in Oral Health and Diseases: A Systematic Re-view. Antioxidants, 2024. 136: p. 660.phttps://doi.org/10.3390/antiox13060660
17. Curylofo-Zotti, F.A., et al., Differential effects of natural Curcumin and chemically modified curcumin on inflammation and bone resorption in model of experimental periodontitis. Archives of oral biology, 2018. 91: p. 42-50. phttps://doi.org/10.1016/j.archoralbio.2018.04.007
18. Elburki, M., et al., A novel chemically modified curcumin reduces inflammation-mediated connective tissue breakdown in a rat model of diabetes: periodontal and systemic effects. Journal of periodontal research, 2017. 522: p. 186-200.phttps://doi.org/10.1111/jre.12381
19. Guimaraes-Stabili, M.R., et al., Systemic administration of curcumin or piperine enhances the periodontal repair: a preliminary study in rats. Clinical oral investigations, 2019. 23: p. 3297-3306.phttps://doi.org/10.1007/s00784-018-2755-9
20. Scaling, D., Root Planing for Periodontal Health: A Review of the Clinical Effectiveness, Cost-Effectiveness, and Guidelines. Canadian Agency for Drugs and Technologies in Health: Ottawa, ON, Canada, 2016.
21. Raghava, K.V., et al., Efficacy of Curcumin as an Adjunct to Scaling and Root Planing in Chronic Periodontitis Patients: A Randomized Controlled Clinical Trial. The Journal of Contem-porary Dental Practice, 2019. 207: p. 842-846. phttps://doi.org/10.5005/jp-journals-10024-2608
22. Farhood, H.T. and B.G. Ali, Clinical and Anti-Inflammatory Effect of Curcumin Oral Gel as Adjuncts in Treatment of Periodontal Pocket. J. Res. Med. Dent. Sci, 2020. 8: p. 83-90.
23. He, Y., et al., Curcumin, inflammation, and chronic diseases: how are they linked? Molecu-les, 2015. 205: p. 9183-9213.phttps://doi.org/10.3390/molecules20059183
24. Kaur, H., et al., Evaluation of curcumin gel as adjunct to scaling & root planing in manage-ment of periodontitis-randomized clinical & biochemical investigation. Infectious Disorders-Drug Targets (Formerly Current Drug Targets-Infectious Disorders), 2019. 192: p. 171-178.phttps://doi.org/10.2174/1871526518666180601073422
25. Abdel-Fatah, R., et al., Efficacy of curcumin gel as an adjunct to scaling and root planing on salivary procalcitonin level in the treatment of patients with chronic periodontitis: a rando-mized controlled clinical trial. BMC Oral Health, 2023. 231: p. 883.phttps://doi.org/10.1186/s12903-023-03512-y
26. Siddharth, M., et al., A comparative evaluation of subgingivally delivered 2% curcumin and 0.2% chlorhexidine gel adjunctive to scaling and root planing in chronic periodontitis. J Con-temp Dent Pract, 2020. 215: p. 494-9.phttps://doi.org/10.5005/jp-journals-10024-2828
27. Malekzadeh, M., et al., Oral n ano-curcumin on gingival inflammation in patients with gingi-vitis and mild periodontitis. Clinical and experimental dental research, 2021. 71: p. 78-84.phttps://doi.org/10.1002/cre2.330
28. Anusha, D., et al., Efficacy of a mouthwash containing essential oils and curcumin as an adjunct to nonsurgical periodontal therapy among rheumatoid arthritis patients with chronic pe-riodontitis: A randomized controlled trial. Indian Journal of Dental Research, 2019. 304: p. 506-511. phttps://doi.org/10.4103/ijdr.IJDR_662_17
29. Mali, A.M., R. Behal, and S.S. Gilda, Comparative evaluation of 0.1% turmeric mouthwash with 0.2% chlorhexidine gluconate in prevention of plaque and gingivitis: A clinical and micro-biological study. Journal of Indian Society of Periodontology, 2012. 163: p. 386-391.phttps://doi.org/10.4103/0972-124X.100917
30. Deshpande, A., et al., Effect of green tea, ginger plus green tea, and chlorhexidine mouth-wash on plaque-induced gingivitis: A randomized clinical trial. Journal of Indian Society of Pe-riodontology, 2021. 254: p. 307-312. phttps://doi.org/10.4103/jisp.jisp_449_20

31. James, P., et al., Chlorhexidine mouthrinse as an adjunctive treatment for gingival health. Cochrane Database of Systematic Reviews, 20173.phttps://doi.org/10.1002/14651858.CD008676.pub2
32. Storti, E., et al., Effectiveness of chlorhexidine on dental plaque: a new technique. Minerva Stomatol, 2012. 6110: p. 449-56
33. Guru, S.R., et al., Comparative evaluation of 2% turmeric extract with nanocarrier and 1% chlorhexidine gel as an adjunct to scaling and root planing in patients with chronic periodontitis: A pilot randomized controlled clinical trial. Journal of Indian Society of Periodontology, 2020. 243: p. 244-252.phttps://doi.org/10.4103/jisp.jisp_207_19
34. Anirban Chatterjee, A.C., K.D. Koel Debnath, and N. Rao, A comparative evaluation of the efficacy of curcumin and chlorhexidine mouthrinses on clinical inflammatory parameters of gingivitis: a double-blinded randomized controlled clinical study. 2017.phttps://doi.org/10.4103/jisp.jisp_136_17