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Comparative Evaluation of a Locally Administered Plant-Derived Chip and Doxycycline Gel as Adjuncts to Scaling and Root Planning in the Treatment of Periodontitis

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ABSTRACT: The study aimed to compare clinical efficacy of a locally administered plant-derived biodegradable chip and doxycycline gel when used as adjunct to SRP in patients with periodontitis. Participants diagnosed with periodontitis were randomly allocated to two treatment groups. Group I received SRP followed by placement of a plant-derived biodegradable chip (Ocimum sanctum), whereas Group II received SRP followed by locally administered doxycycline gel. PI, GI, PPD, CAL assessed at baseline, 1 month, and 3 months. Both treatment groups demonstrated statistically significant improvements in PI, GI, PPD, and CAL over the 3-month follow-up period ($P < 0.05$). Mean PPD in the plant-derived chip group decreased from 4.19 ± 0.83 mm at baseline to 2.63 ± 0.62 mm at 1 month and 2.00 ± 0.00 mm at 3 months. In the doxycycline group, mean PPD reduced from 4.44 ± 0.51 mm to 3.13 ± 0.72 mm and 2.13 ± 0.34 mm, respectively. Mean CAL in the plant-derived chip group decreased from 4.31 ± 0.60 mm at baseline to 2.56 ± 0.63 mm at 1 month and 1.81 ± 0.40 mm at 3 months, whereas the corresponding values in the doxycycline group were 4.50 ± 0.52 mm, 3.00 ± 0.52 mm, and 1.94 ± 0.44 mm. No statistically significant intergroup differences were observed for PI, GI, PPD, or CAL at any assessment point ($P > 0.05$). Both local drug delivery modalities, when used as adjuncts to SRP, were associated with significant clinical improvement over 3 months. The plant-derived chip therefore demonstrated clinical outcomes comparable to those of locally administered doxycycline gel.

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1. INTRODUCTION

Scaling and root planning (SRP) remains as fundamental nonsurgical approach for periodontitis because mechanical disruption and removal of subgingival biofilm and calculus reduces the microbial burden and facilitates resolution of periodontal inflammation. However, complete mechanical debridement may be difficult in deep periodontal pockets, root concavities, furcation areas and other anatomically inaccessible regions. Residual microorganisms may subsequently contribute to recolonisation of treated sites[1].

Local drug delivery (LDD) systems have consequently been developed to provide therapeutic agents directly within periodontal pockets. Local administration can produce a relatively high concentration of antimicrobial agent at the diseased site while limiting systemic exposure. The controlled-release concept is particularly attractive because maintenance of the therapeutic agent within the periodontal pocket may enhance antimicrobial activity during the healing period[2].

Several antimicrobial agents have been investigated for local periodontal delivery, including tetracyclines, doxycycline, minocycline, metronidazole and chlorhexidine. Clinical trials have demonstrated that locally delivered doxycycline can improve periodontal clinical parameters when used in conjunction with nonsurgical periodontal therapy[3]. Large multicentre trials have also demonstrated that controlled-release doxycycline can produce clinical effects comparable to SRP, while being superior to placebo or oral-hygiene measures alone in selected clinical settings[4].

The use of doxycycline in periodontal therapy is not limited to its antimicrobial action. Tetracyclines have also demonstrated host-modulatory properties, including inhibition of matrix metalloproteinases, which may contribute to periodontal tissue stability. Nevertheless, concern regarding repeated antibiotic exposure and antimicrobial resistance have increased interest in non-antibiotic and plant-derived therapeutic approaches[5].

Plant-derived compounds possess antimicrobial, anti-inflammatory and antioxidant properties. Their incorporation into biodegradable local delivery systems may permit prolonged contact between the active compound and periodontal tissues. Several experimental and clinical investigations have evaluated plant-derived agents including *Salvadora persica*[6], *Azadirachta indica*[7], *lemongrass*[8], *Ocimum sanctum L*[9] and other botanical compounds as adjunct to periodontal therapy.

Herbal chips offer distinct advantages over gel-based local drug delivery (LDD) systems in periodontal therapy. Unlike gels, which may be easily washed away by saliva or gingival crevicular fluid, chips provide prolonged retention in the periodontal pocket, allowing for sustained and controlled drug release over days to weeks[10]. This result in improved bioavailability of the active agents at the target site and enhanced clinical efficacy in reducing dental plaque, inflammation of gingiva, pocket depth, and promoting clinical attachment gain.

To overcome antimicrobial resistance also plant derived chip are beneficial to that of doxycycline. Despite this growing evidence, relatively limited clinical evidence directly compares a plant-derived biodegradable containing *Ocimum sanctum L* as chip formulation with an established local antimicrobial formulation such as doxycycline gel. Such comparisons are clinically relevant because an alternative local delivery system should demonstrate at least comparable clinical effectiveness before it can be considered for further development. The present randomised clinical trial designed to assess clinical effectiveness of a locally administered plant-derived biodegradable chip containing *oscimum sanctum L* with doxycycline gel as adjuncts to SRP.

MATERIALS AND METHODS:

Design of the study:

The randomised, parallel-arm controlled clinical trial was conducted in the Department of Periodontology, Sibar Institute of Dental Sciences, Guntur, India, between June 2025 and November 2025. The study protocol was approved by the institutional ethical committee, Sibar Institute of Dental Sciences under approval number Pr. 671/IEC/SIBAR/2025 dated 16-6-2025. Informed consent obtained from all participants.

Sample Size and Study Participants

Sample size was calculated using G power 3.1.9.2 software version based on an anticipated effect size of 0.6, $\alpha = 0.05$, and power of 90%. Eligible patients divided into 2 treatment groups by computer-generated randomization sequence. The study included 32 participants, who were randomly allocated into two treatment groups out of which 28 were included and remaining 4 lost to follow up. Figure 1 shows allocation flowchart.

Participants were eligible if they were aged 25–60 years, systemically healthy, diagnosed with periodontitis, and had at least one periodontal site with a probing pocket depth ≥6 mm and clinical attachment loss ≥3 to 4 mm that was suitable for local drug delivery. Participants were excluded if they were smokers or tobacco users, pregnant or lactating, had received systemic antibiotic therapy within the preceding 3 months, had undergone periodontal treatment within the preceding 6 months, had systemic conditions likely to influence periodontal healing or treatment response, or had a known allergy or hypersensitivity to doxycycline or any component of the plant-derived formulation.

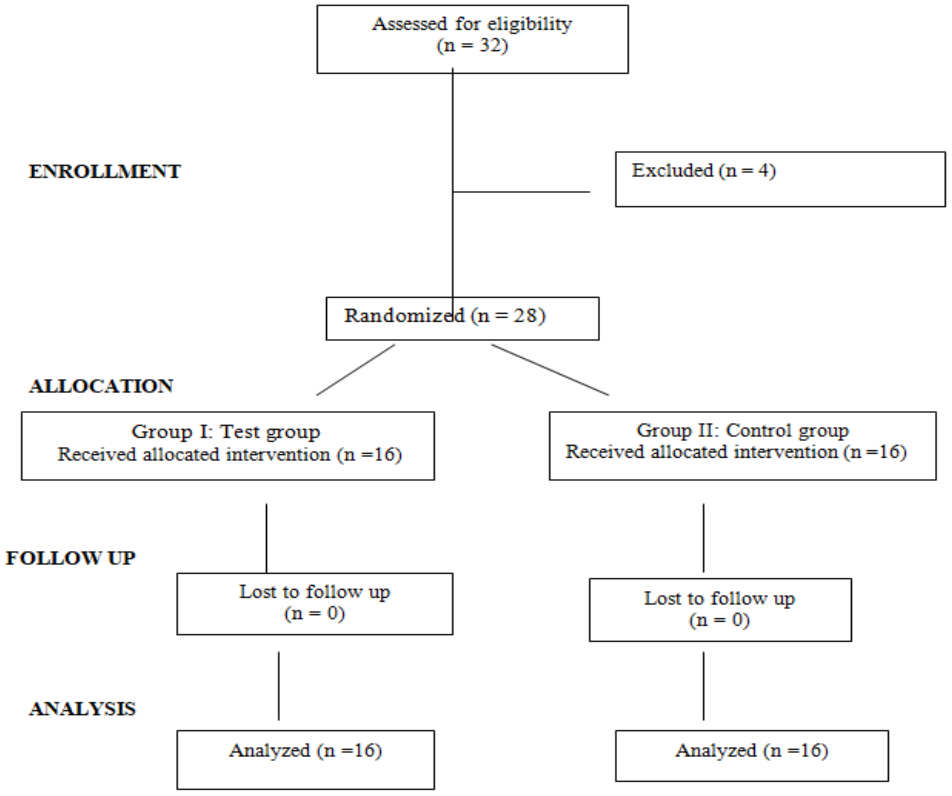


Fig 1: CONSORT flow diagram

Preparation of 2% *Ocimum sanctum* Chips for Local Drug Delivery (LDD)

Fresh leaves of *Ocimum sanctum* (Tulsi) were authenticated after collection. The leaves were thoroughly washed with distilled water and dried at room temperature. After complete drying, the leaves were pulverized into a coarse powder and subjected to extraction using ethanol in a Soxhlet apparatus. The obtained extract was concentrated under reduced pressure using a rotary evaporator to yield a dry, semi solid crude extract. A precise quantity corresponding to a 2% (w/v) final drug loading was weighed. Biodegradable and biocompatible Hydroxypropyl Methylcellulose polymer (HPMC) was selected as the release-controlling matrix. The designated amounts of polymers were weighed and dissolved in an appropriate volatile organic solvent mixture under continuous magnetic stirring until a clear, homogeneous solution was obtained. A plasticizer, such as Polyethylene Glycol (PEG-400) was incorporated to impart adequate flexibility, tensile strength, and reduce film brittleness. The 2% *Ocimum sanctum* extract was added to the polymeric solution and stirred continuously at room temperature for 1–2 hours to achieve uniform drug dispersion and avoid agglomeration. The resulting formulation was placed in an ultrasonic bath under low vacuum to remove entrapped air bubbles. The homogeneous polymeric-drug poured into petri dish of uniform surface area. An inverted funnel was placed over the Petri dish to ensure controlled and uniform solvent evaporation. The casting dried for 24 hours. This test product measures 4 x 5mm with a thickness of 0.4mm. (Periobiologics LLP, Hyderabad, Telangana, India)

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Preparation of 10% Doxycycline gel

The Poloxamer 407 was initially mixed with propylene glycol to form smooth, uniform slurry. This step ensured that the gelling agent would hydrate without forming clumps. Chilled purified water was slowly added to the slurry. The mixture was stirred gently to minimize the incorporation of air bubbles and prevent excessive foaming. To ensure complete hydration of the polymer, the solution was placed in a refrigerator for 18 hours until it became a clear, viscous liquid. Once the base was fully hydrated and clear, 10.0 g of doxycycline hyclate was weighed. The powder was incorporated into the chilled liquid base using the method of geometric dilution. The mixture was stirred until the doxycycline was completely dissolved and the solution reached a uniform, yellow-to-amber clarity. The liquid was allowed to reach room temperature, at which sol-to-gel transition occurred, resulting in a thick, mucoadhesive oral gel. (Periobiologics LLP, Hyderabad, Telangana, India)

Clinical procedure

Figure 2 shows armamentarium used for the procedure. Baseline clinical measurements including plaque index (PI), gingival index (GI), probing pocket depth (PPD), clinical attachment level (CAL) were obtained before treatment. Full-mouth SRP was performed using Woodpecker ultrasonic scaler (UDS-B LED, Guilin Woodpecker Medical Instrument Co., Ltd., Guilin, China) and Universal curettes (Columbia 13/14, Hu-Friedy Mfg. Co., LLC, Chicago, IL, USA) under local anaesthesia. Test group received plant-derived biodegradable chip (2% *Ocimum sanctum*) and control group received 10% doxycycline gel into the selected periodontal pocket and pack placed. All participants received standardised oral-hygiene instructions. They were advised to avoid flossing or use of interdental aids at the treated site for 1 week. PI, GI, PPD, CAL measured at1 month and 3 month follow up.

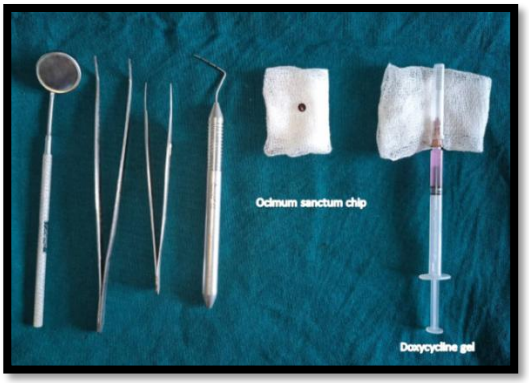


Figure 2: Armamentarium

Statistical Analysis

IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA) was used. Changes within each treatment group were evaluated using the Friedman test. Intergroup comparisons at each assessment were evaluated using the Mann–Whitney U test. Statistically significant was considered at P value <0.05.

RESULTS

28 participants included with 32 ± 2 years of mean age. Both groups had a comparable gender distribution. Table 1 shows intragroup Comparison**.** Plant-derived chip group (test), the mean PI decreased from 2.46 ± 0.13 at baseline to 0.44 ± 0.24 at 1 month and remained at 0.44 ± 0.24 at 3 months. Corresponding values in the doxycycline group (control) were 2.48 ± 0.11, 0.44 ± 0.24 and 0.44 ± 0.24, respectively. In the plant-derived chip group, mean GI reduced from 2.46 ± 0.11 at baseline to 0.43 ± 0.22 at 1 month and 0.44 ± 0.22 at 3 months. In the doxycycline group, mean GI reduced from 2.47 ± 0.09 to 0.44 ± 0.22 and 0.44 ± 0.21. Both groups demonstrated improvements in probing pocket depth (PPD) and clinical attachment level (CAL) from baseline to 3 months. In the test group, mean PPD decreased from 4.19 ± 0.83 mm at baseline to 2.63 ± 0.62 mm at 1 month and 2.00 ± 0.00 mm at 3 months. In the control group, mean PPD decreased from 4.44 ± 0.51 mm to 3.13 ± 0.72 mm and 2.13 ± 0.34 mm, respectively. Similarly, mean CAL in the test group decreased from 4.31 ± 0.60

mm at baseline to 2.56 ± 0.63 mm at 1 month and 1.81 ± 0.40 mm at 3 months, whereas in the control group, it decreased from 4.50 ± 0.52 mm to 3.00 ± 0.52 mm and 1.94 ± 0.44 mm, respectively.

Table1. Intragroup comparison of periodontal parameters across three time points

Parameter	Time point	Test, mean ± SD	Control, mean ± SD	Mann–Whitney U	P value
PI	Baseline	2.46 ± 0.13	2.48 ± 0.11	120.5	0.80
PI	1 month	0.44 ± 0.24	0.44 ± 0.24	128.0	1.00
PI	3 months	0.44 ± 0.24	0.44 ± 0.24	128.0	1.00
GI	Baseline	2.46 ± 0.11	2.47 ± 0.09	124.5	0.92
GI	1 month	0.43 ± 0.22	0.44 ± 0.22	125.5	0.95
GI	3 months	0.44 ± 0.22	0.44 ± 0.21	122.0	0.83
PPD (mm)	Baseline	4.19 ± 0.83	4.44 ± 0.51	115.5	0.66
PPD (mm)	1 month	2.63 ± 0.62	3.13 ± 0.72	80.5	0.08
PPD (mm)	3 months	2.00 ± 0.00	2.13 ± 0.34	104.0	0.38
CAL (mm)	Baseline	4.31 ± 0.60	4.50 ± 0.52	115.5	0.66
CAL (mm)	1 month	2.56 ± 0.63	3.00 ± 0.52	80.5	0.08
CAL (mm)	3 months	1.81 ± 0.40	1.94 ± 0.44	100.5	0.32

Friedman test, $p<0.05$ considered statistically significant

Table 2 shows intergroup comparison. At baseline, the test and control groups showed comparable PI (2.46 ± 0.13 vs. 2.48 ± 0.11), GI (2.46 ± 0.11 vs. 2.47 ± 0.09), PPD (4.19 ± 0.83 mm vs. 4.44 ± 0.51 mm), and CAL (4.31 ± 0.60 mm vs. 4.50 ± 0.52 mm). Both groups demonstrated significant improvements in all parameters over the 3-month follow-up ($p < 0.05$) PI and GI decreased substantially by 1 month and remained nearly stable at 3 months in both groups. PPD decreased to 2.00 ± 0.00 mm in the test group and 2.13 ± 0.34 mm in the control group at 3 months, while CAL decreased to 1.81 ± 0.40 mm and 1.94 ± 0.44 mm, respectively. Although the test group showed numerically lower PPD and CAL values at 3 months, these findings do not establish statistically significant intergroup superiority.

Table2. Intergroup periodontal parameters between the plant-derived chip and doxycycline groups

Parameter	Group	Baseline, mean ± SD	1 month, mean ± SD	3 months, mean ± SD	Friedman χ^2	P value
PI	Test	2.46 ± 0.13	0.44 ± 0.24	0.44 ± 0.24	32.000	<0.05
PI	Control	2.48 ± 0.11	0.44 ± 0.24	0.44 ± 0.24	32.000	<0.05
GI	Test	2.46 ± 0.11	0.43 ± 0.22	0.44 ± 0.22	28.444	<0.05
GI	Control	2.47 ± 0.09	0.44 ± 0.22	0.44 ± 0.21	27.429	<0.05
PPD (mm)	Test	4.19 ± 0.83	2.63 ± 0.62	2.00 ± 0.00	26.462	<0.05
PPD (mm)	Control	4.44 ± 0.51	3.13 ± 0.72	2.13 ± 0.34	28.557	<0.05
CAL (mm)	Test	4.31 ± 0.60	2.56 ± 0.63	1.81 ± 0.40	28.964	<0.05
CAL (mm)	Control	4.50 ± 0.52	3.00 ± 0.52	1.94 ± 0.44	31.097	<0.05

Mann–Whitney U test, $p<0.05$ considered statistically significant

DISCUSSION

The present study assessed the clinical effectiveness of locally administered plant-derived periodontal chip with 10% doxycycline gel as adjunct to SRP. Plaque and gingival indices decreased substantially following treatment, while PPD and CAL showed progressive improvement at 1 and 3 months. Although plant-derived chip demonstrated numerically favourable changes in PPD and CAL at certain time points, the intergroup differences showed no significance. Plant-derived chip provided a clinical response comparable to that achieved with locally delivered doxycycline when both were used in conjunction with SRP

SRP remains the fundamental nonsurgical approach for periodontal therapy because mechanical disruption and removal of the subgingival biofilm are essential for controlling periodontal inflammation[13]. Nevertheless, complete mechanical debridement can be difficult in deeper periodontal pockets because of restricted access, root morphology, tissue anatomy, and the potential for recolonization of pathogenic microorganisms. These limitations have provided the rationale for locally delivered antimicrobial agents, which can achieve high concentrations within the periodontal pocket while minimizing systemic exposure. Doxycycline has been extensively investigated for this purpose and therefore represents an appropriate active comparator for evaluating newer local drug-delivery systems[14].

The clinical response observed with the doxycycline group previously reported in several investigations. Javali and Vandana[15]et al., evaluated 10% doxycycline hyclate delivered through the Atrigel formulation and reported improvements significantly in periodontal parameters over 90 days, with the combined SRP and doxycycline approach showing better results than doxycycline alone or SRP alone. Similarly, Eickholz et al[16]. demonstrated that adjunctive topical biodegradable doxycycline produced significantly greater PPD reduction and relative attachment-level gain than SRP alone and control at 6 months. These findings support the clinical utility of locally delivered doxycycline in reducing periodontal pocket depth and improving attachment following mechanical periodontal therapy.

More recent evidence has also supported the use of local doxycycline. Al-Shrabe et al[17]., reported improvement in PI, GI, PPD, CAL and bacterial counts in periodontitis patients treated with different doxycycline regimens. Among the tested approaches, combined systemic and local doxycycline produced the greatest overall improvement, while local doxycycline demonstrated greater improvement in PPD, CAL and bacterial counts than SRP alone. Singh et al[18]., likewise reported clinical and microbial improvement following local administration of 10% doxycycline hyclate gel, although the response varied according to smoking status. These findings reinforce the role of local doxycycline as an established adjunctive approach and support its use as the comparator in the present investigation.

However, the benefit of locally administered doxycycline has not been uniformly demonstrated across clinical studies. Al Hulami et al[19]., found that both SRP alone and SRP combined with 10% locally delivered doxycycline significantly improved plaque, bleeding and probing depth in smokers, but the additional attachment gain associated with doxycycline was not statistically significant. Their findings suggested that the incremental benefit of topical doxycycline over effective mechanical therapy may be limited in some clinical circumstances. Similarly, the systematic review and meta-analysis by Dhath et al[20]., reported a significant improvement in clinical attachment with local doxycycline among smokers. Such variability among studies may reflect differences in disease severity, smoking status, pocket depth, treatment protocols, drug formulations, follow-up duration and methods of clinical assessment.

Plant-derived chip achieved clinical improvements comparable to those observed with 10% doxycycline gel with no significance in treatment groups. This observation is consistent with the growing evidence supporting the use of medicinal plants as adjunct to conventional periodontal therapy. Mittal et al[21]., directly compared 2% lemongrass gel with 10% doxycycline hyclate gel as adjunct to SRP and reported significant reductions in GI, PPD and CAL in both groups. Microbial counts of *Porphyromonas gingivalis, Actinomyces naeslundii* and *Prevotella intermedia* also decreased significantly in both treatment groups. Importantly, the authors concluded that lemongrass gel produced an effect comparable to 10% doxycycline gel. The similarity between these findings and the present results suggests that plant-derived local formulations may have potential as alternatives or complementary agents to conventional antimicrobial drug delivery.

The biological plausibility of using *Ocimum sanctum* as a periodontal therapeutic agent is supported by several experimental studies. In an in vitro investigation conducted by Eswar p[22] et al.,, ethanolic *Ocimum sanctum* extract demonstrated antimicrobial activity against Actinobacillus actinomycetemcomitans, with the greatest inhibition observed at a 6%

concentration and a 22-mm zone of inhibition. Although the inhibition was slightly lower than that produced by 0.2% chlorhexidine, the findings demonstrated that *Ocimum sanctum* possesses measurable antimicrobial activity against an important periodontal pathogen. Jayanti I et al[23]., similarly reported concentration-dependent antibacterial effects of *Ocimum sanctum*, including activity against Actinobacillus actinomycetemcomitans and P. gingivalis and observed strong antibacterial activity at an 8% concentration, whereas Mallikarjun et al. demonstrated greater inhibitory activity with 5% and 10% preparations against Actinobacillus actinomycetemcomitans. These findings suggest that the concentration of the plant extract is an important determinant of antimicrobial activity and may partly explain differences among formulations and studies.

The clinical evidence concerning *Ocimum sanctum* further supports its potential in periodontal care. Gupta et al[24]., in a triple-blind randomized controlled trial, demonstrated that *Ocimum sanctum* mouthwash significantly reduced plaque accumulation and gingival inflammation and produced effects comparable to chlorhexidine over 15 and 30 days. These findings indicate that the potential benefits of *Ocimum sanctum* extend beyond direct antibacterial activity to clinically observable reductions in plaque-associated gingival inflammation. However, mouth rinse formulations differ considerably from locally retained periodontal delivery systems. A mouth rinse is rapidly removed from the oral cavity, whereas a periodontal chip can be positioned directly within the periodontal pocket and may provide prolonged contact with the target site. Therefore, the clinical results of previous mouthwash studies provide biological support for *Ocimum sanctum*.

The anti-inflammatory and antioxidant properties of *Ocimum sanctum* may provide an additional explanation for its clinical effectiveness. Ramamurthy and Jayakumar[25] reported that a 2% *Ocimum sanctum* intraoral gel exhibited antioxidant activity and inhibited protein denaturation, demonstrating anti-inflammatory activity approaching that of diclofenac gel in their experimental model. Periodontitis is characterized not only by microbial challenge but also by an excessive host inflammatory response that contributes to connective-tissue and alveolar-bone destruction. Consequently, an agent possessing both antimicrobial and anti-inflammatory properties could theoretically provide benefits beyond microbial suppression alone. The improvements in GI, PPD and CAL observed in the current study with the plant-derived chip showed combined effects of biofilm control and modulation of local inflammatory activity. Nevertheless, because inflammatory biomarkers were not evaluated in the present investigation, this proposed mechanism should be regarded as biologically plausible rather than directly demonstrated.

Of particular relevance is the clinical study by Deepika and Ramamurthy[26] et al., which evaluated 2% *Ocimum sanctum* gel as a local drug-delivery adjunct to SRP and compared it with tetracycline fibers. Their results demonstrated that PI and GI did not differ significantly between the groups during follow-up, while significant differences in PPD and CAL emerged at 8 months. The authors concluded that 2% *Ocimum sanctum* gel could be effectively used as an adjunct to SRP and could contribute to PPD and CAL. The present study extends these observations by evaluating *Ocimum sanctum* in a chip-based local delivery system and by directly comparing it with 10% doxycycline gel. The absence of significant intergroup differences of current study is in alignment with earlier observation that a plant-derived local formulation can achieve clinical periodontal improvements comparable to established local antimicrobial delivery systems.

The favourable response observed with the plant-derived chip may also be related to the advantages of localized drug delivery. Placement of a formulation directly into a periodontal pocket permits the therapeutic agent to act close to the diseased site while potentially reducing dilution and systemic exposure. A biodegradable chip may additionally provide greater retention within the pocket than a conventional rinse and may maintain contact with the periodontal tissues for a longer period. These characteristics are particularly relevant in periodontal pockets where mechanical access is limited. The present findings suggest that the local plant-derived formulation can function effectively as an adjunct to SRP.

The present study has several strengths. The randomized parallel-group design allowed direct comparison of the plant-derived chip with an established local antimicrobial comparator. The use of both clinical parameters provided a broader assessment of treatment response. Furthermore, evaluation for short periods permitted assessment of early and short-term maintenance of the clinical response. The study population also included patients with greater than 6 mm pocket thereby providing clinical relevance to routine nonsurgical periodontal management.

Larger randomized controlled trials with longer follow-up, microbiological analysis, biomarker assessment and standardized drug-release evaluation would be valuable for confirming the clinical role of the plant-derived chip. Overall clinical response observed in plant-derived chip was comparable to that obtained with 10% doxycycline gel.

CONCLUSION

Plant-derived biodegradable chip and doxycycline gel can be used as adjuncts to SRP. Local drug delivery systems as chip enhance the effectiveness of conventional scaling and root planing in the treatment of chronic periodontitis. Plant-derived biodegradable chip may provide safe, effective alternative to doxycycline gel for periodontal therapy.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this study.

REFERENCES:

[1] Cobb CM, Sottosanti JS. A re-evaluation of scaling and root planing. J Periodontol. 2021 Oct;92(10):1370-1378. doi: 10.1002/JPER.20-0839. Epub 2021 Mar 16. PMID: 33660307.

[2] H R R, Dhamecha D, Jagwani S, Rao M, Jadhav K, Shaikh S, Puzhankara L, Jalalpure S. Local drug delivery systems in the management of periodontitis: A scientific review. J Control Release. 2019 Aug 10;307:393-409. doi: 10.1016/j.jconrel.2019.06.038. Epub 2019 Jun 27. PMID: 31255689.

[3] Szulc M, Zakrzewska A, Zborowski J. Local drug delivery in periodontitis treatment: A review of contemporary literature. Dent Med Probl. 2018 Jul-Sep;55(3):333-342. doi: 10.17219/dmp/94890. PMID: 30328312.

[4] Garrett, S., Adams, D.F., Bogle, G., Donly, K., Hastings Drisko, C., Hallmon, W.W., Brady Hancock, E., Hanes, P., Hawley, C.E., Johnson, L., Kiger, R., Killoy, W., Mellonig, J.T., Raab, F.J., Ryder, M., Stoller, N., Polson, A., Wang, H.-L., Wolinsky, L.E., Yukna, R.A., Harrold, C.Q., Hill, M., Johnson, V.B. and Lee Southard, G. (2000), The Effect of Locally Delivered Controlled-Release Doxycycline or Scaling and Root Planing on Periodontal Maintenance Patients Over 9 Months. Journal of Periodontology, 71: 22-30. https://doi.org/10.1902/jop.2000.71.1.22

[5] Golub LM, Lee HM. Periodontal therapeutics: Current host-modulation agents and future directions. Periodontol 2000. 2020 Feb;82(1):186-204. doi: 10.1111/prd.12315. PMID: 31850625; PMCID: PMC6973248.

[6] Ramli H, Nor Aripin KN, Mohd Said S, Mohamad Hanafiah R, Mohd Dom TN. The effectiveness of miswak (Salvadora persica L. and Azadirachta indica A.Juss.) practices in reducing plaque and gingivitis among adults: A systematic review and meta-analysis. J Ethnopharmacol. 2022 Nov 15;298:115598. doi: 10.1016/j.jep.2022.115598. Epub 2022 Aug 6. PMID: 35944735.

[7] Ganvir MN, Parwani SR, Chaudhary DS, Parwani R, Dadlani H, Vikey AK, Kawadkar KP, Jaju NS, Armogida NG, Spagnuolo G. Comparative Evaluation of Azadirachta indica (Neem) Chip and Soft Tissue Diode Lasers as a Supplement to Phase I Periodontal Therapy in Localized Chronic Moderate Periodontitis: A Randomized Controlled Clinical Trial. Int J Dent. 2022 Jun 15;2022:6109040. doi: 10.1155/2022/6109040. PMID: 35756957; PMCID: PMC9217592.

[8] Mittal P, Gokhale ST, Manjunath S, Al-Qahtani SM, Magbol MA, Nagate RR, Tikare S, Chaturvedi S, Agarwal A, Venkataram V. Comparative Evaluation of Locally Administered 2% Gel Fabricated from Lemongrass Polymer and 10% Doxycycline Hyclate Gel as an Adjunct to Scaling and Root Planing in the Treatment of Chronic Periodontitis-A Randomized Controlled Trial. Polymers (Basel). 2022 Jul 6;14(14):2766. doi: 10.3390/polym14142766. PMID: 35890542; PMCID: PMC9322070.

[9] Dharsono HDA, Putri SA, Kurnia D, Dudi D, Satari MH. Ocimum Species: A Review on Chemical Constituents and Antibacterial Activity. Molecules. 2022 Sep 26;27(19):6350. doi: 10.3390/molecules27196350. PMID: 36234883; PMCID: PMC9573401.

[10] Anumala D, Katuri KK, Marella Y, Mandagaddi RJ, Seelam HV, Boyapati R. Evaluation of herbal chip as an adjunct to scaling and root planing in the management of chronic periodontitis: a systematic review. J Chem Health Risks. 2025;15(6):1993-2000.

[11] Löe H. The Gingival Index, the Plaque Index and the Retention Index System. J Periodontol. 1967;38:610-6.

[12] Pihlstrom BL. Measurement of attachment level in clinical trials: probing methods. J Periodontol. 1992;63(12 Suppl):1072-7.

[13] Verdugo J, Laughter L, Chambers DW. Shared decision-making in scaling and root planing. Eur J Dent Educ. 2024 Feb;28(1):184-190. doi: 10.1111/eje.12935. Epub 2023 Aug 12. PMID: 37571971.

[14] Andreu R, del Riego SS (2020) Effects of topical doxycycline on inflammatory markers in periodontal disease. Clin Sci Res Rep 3: DOI: 10.15761/CSRR.1000130.

[15] Javali MA, Vandana KL. A comparative evaluation of atrigel delivery system (10% doxycycline hyclate) Atridox with scaling and root planing and combination therapy in treatment of periodontitis: A clinical study. J Indian Soc Periodontol. 2012;16(1):43-48. doi: 10.4103/0972-124X.94603. PMID: 22628962; PMCID: PMC3357034.

[16] Eickholz P, Kim TS, Bürklin T, Schacher B, Renggli HH, Schaecken MT, Holle R, Kübler A, Ratka-Krüger P. Non-surgical periodontal therapy with adjunctive topical doxycycline: a double-blind randomized controlled multicenter study. Journal of Clinical Periodontology. 2002;29:108-117. https://doi.org/10.1034/j.1600-051x.2002.290204.x

[17] Al-Shrabe A, Al-Hajj W, Al-Hajri M, Alahmari M, Alahmari D, Al Moaleem M, Homeida H, Mehta V. Clinical and Microbiological Effects of Systemic, Local, and Combined Application of Doxycycline in the Treatment of Periodontitis. Open Dent J. 2025;19:e18742106388003. http://dx.doi.org/10.2174/0118742106388003250619103615

[18] Singh G, Gokhale ST, Manjunath S, Al-Qahtani SM, Nagate RR, Venkataram V, Joseph B. Evaluation of locally-administered controlled-release doxycycline hyclate gel in smokers and non-smokers in the management of periodontitis: An Indian study. Tropical Journal of Pharmaceutical Research. August 2021;20(8):1739-1747.

[19] Al Hulami H, Babay N, Awartani F, Anil S. The effect of locally delivered doxycycline as an adjunctive therapy to scaling and root planing in smokers. Saudi Dent J. 2011;23:143-148. PMCID: PMC3723283; PubMed: 23960508.

[20] Dhath S, Pulikkotil SJ, Dharmarajan L, Arunachalam M, Jing KT. Effect of locally delivered doxycycline as an adjunct to scaling and root planing in the treatment of periodontitis in smokers: A systematic review of randomized controlled trials with meta-analysis and trial sequential analysis. Dent Res J (Isfahan). 2020;17(4):235-243. PMID: 33282148; PMCID: PMC7688043.

[21] Mittal P, Gokhale ST, Manjunath S, Al-Qahtani SM, Magbol MA, Nagate RR, Tikare S, Chaturvedi S, Agarwal A, Venkataram V. Comparative Evaluation of Locally Administered 2% Gel Fabricated from Lemongrass Polymer and 10% Doxycycline Hyclate Gel as an Adjunct to Scaling and Root Planing in the Treatment of Chronic Periodontitis—A Randomized Controlled Trial. Polymers. 2022;14:2766. https://doi.org/10.3390/polym14142766

[22] Eswar P, Devaraj CG, Agarwal P. Anti-microbial Activity of Tulsi {Ocimum Sanctum (Linn.)} Extract on a Periodontal Pathogen in Human Dental Plaque: An Invitro Study. J Clin Diagn Res. 2016 Mar;10(3):ZC53-6. doi: 10.7860/JCDR/2016/16214.7468. Epub 2016 Mar 1. PMID: 27135002; PMCID: PMC4843387.

[23] Jayanti I, Jalaluddin M, Avijeeta A, Ramanna PK, Rai PM, Nair RA. In vitro Antimicrobial Activity of Ocimum sanctum (Tulsi) Extract on Aggregatibacteractinomycetemcomitans and Porphyromonas gingivalis. J Contemp Dent Pract. 2018 Apr 1;19(4):415-419. PMID: 29728546.

[24] Gupta D, Bhaskar DJ, Gupta RK, Karim B, Jain A, Singh R, Karim W. A randomized controlled clinical trial of Ocimum sanctum and chlorhexidine mouthwash on dental plaque and gingival inflammation. J Ayurveda Integr Med. 2014;5(2):109-116. doi: 10.4103/0975-9476.131727. PMID: 24948862; PMCID: PMC4061585.

[25] Ramamurthy J, Jayakumar ND. Anti-inflammatory, anti-oxidant effect and cytotoxicity of Ocimum sanctum intra oral gel for combating periodontal diseases. Bioinformation. 2020;16(12):1026-1032. doi: 10.6026/973206300161026. PMID: 34938002; PMCID: PMC8600197.

[26] Deepika BA, Ramamurthy J, Jayakumar ND, Rajesh Kumar S. Comparative clinical data for gingivitis treatment using gels from Ocimum sanctum (Tulsi) and chlorhexidine (CHX). Bioinformation. 2021 Dec 31;17(12):1091-1098. doi: 10.6026/973206300171091. PMID: 35291347; PMCID: PMC8900163.