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Comparative evaluation of Efficacy of a local-drug delivery agents containing Curcuma longa, Quercus infectoria and tetracycline fibers- A clinico-microbiological study

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Abstract

Aim: *To evaluate and compare the clinical effects of local drug delivery agents—Curcuma longa, Quercus infectoria, and tetracycline fibers—in periodontal pockets with a probing depth of 5–7 mm, and to assess their antimicrobial activity against Porphyromonas gingivalis.*

Methodology: *A total of 30 subjects reporting to the Department of Periodontology, College of Dental Sciences were randomly allotted into 3 groups, 10 in each group. Clinical parameters such as PPD, CAL, PBI, and PI were measured at baseline and 1 month after LDD placement. Microbiologically quantity of P. gingivalis colonies was measured before and after LDD placement. Herbal medicament containing extracts from Curcuma longa, Quercus infectoria were formulated in the gel form for subgingival application in group I and group II which was compared with group III with tetracycline LDD. Data analysed by SPSS software, ANOVA test.*

Result*: All 3 LDDS improved clinical parameters and reduced subgingival P.gingivalis counts.*

Conclusion: *Tetracycline group showed more better improvement in clinical parameters, than Curcuma longa group followed by Quercus infectoria group. P.gingivalis colony forming units reduction was more in tetracycline followed by Curcuma longa and Quercus infectoria.*

Keywords: *Curcuma longa, Local drug delivery, Periodontal pocket, P. gingivalis, Quercus infectoria, Tetracycline*

I. Introduction:

Periodontitis is a chronic inflammatory disease of the gingival tissues, characterized by degeneration of the periodontal ligament, formation of periodontal pockets, and resorption of the alveolar bone, ultimately leading to the destruction of the tooth-supporting structures.[1] According to WHO estimates, it affects approximately 10–15% of the global population. Successful periodontal therapy focuses on reducing bacterial biofilm, bleeding on probing (BOP), and minimizing or eliminating pocket depth.

Local drug delivery (LDD) refers to the targeted administration of therapeutic agents directly to the affected site to achieve maximal pharmacological action with minimal systemic exposure.[2] The use of local drug delivery system (LDDS) as an adjunct to scaling and root planing (SRP) has emerged as a promising approach, offering improved clinical outcomes and controlled drug release with fewer systemic side effects.[1]

According to current guidelines, the standard treatment for periodontitis includes patient motivation and education, control of systemic and local risk factors such as diabetes, cardiovascular disease, and smoking cessation, as well as thorough subgingival instrumentation. As adjunctive therapy, local drug delivery (LDD) agents such as tetracyclines, metronidazole, statins, lipoxin, aspirin, curcumin, and mangosteen—administered in the form of fibers, strips, films, microparticles, nanosystems, and gels—can be utilized for Stages I, II, and III periodontitis, as recommended by Sanz *et al.*[3] For Stage IV periodontitis, in addition to the aforementioned interventions, surgical correction of bone defects and multidisciplinary management are required. This may involve temporary control of secondary occlusal trauma, orthodontic therapy, rehabilitation of edentulous spaces, and the use of tooth- or implant-supported prostheses. Adjunctive LDD therapies for Stage IV may also include agents such as amoxicillin, BMP-2, and mesenchymal stem cells (MSCs), delivered via membranes or scaffolds, as suggested by Herrera *et al.*[4]

Herbal local drug delivery (LDD) involves the use of natural plant-derived substances or herbal extracts as therapeutic agents within LDD systems. Several herbal formulations- such as neem (*Azadirachta indica*), lemongrass (*Cymbopogon citratus*), green tea (*Camellia sinensis*), aloe vera (*Aloe arborescens*), curcumin or turmeric (*Curcuma longa*), and pomegranate (*Punica granatum*)- have been explored and shown to provide beneficial effects in periodontal therapy.[5]

Oak galls, also known as Turkish galls or mazu, are rounded outgrowths that develop on the young twigs of *Quercus infectoria* (Qi), a species belonging to the family Fagaceae. These galls are formed when a gall wasp pierces the branches and lays its eggs inside. After hatching, the larva becomes encapsulated within the developing gall, which represents the plant's defense response to larval growth. The gall continues to enlarge as long as the larva remains inside, eventually allowing the insect to pupate and emerge as an adult. Once the mature insect exits, the remaining galls are known to possess a variety of medicinal properties. It is widely recognized in Ayurvedic and Unani medicine for its diverse therapeutic properties, including analgesic, antibacterial, anticarcinogenic, anti-inflammatory, antioxidant, antidiabetic, depigmenting, wound-healing, and osteoblastic activities.[6]

Basri Dayang Fredalina *et al.* (2012), in an *in vitro* study, reported that galls of *Quercus infectoria* exhibited significant antimicrobial activity against oral pathogens, supporting their potential use as an adjunctive agent in the clinical management of periodontal diseases.[7] Noori Zohreh Tabibzadeh *et al.* (2023) demonstrated that the hydroalcoholic extract of *Quercus infectoria* galls exhibited antibacterial activity against *Aggregatibacter*

actinomycetemcomitans in vitro, indicating its potential application in mouthwashes or local drug delivery systems for targeting periodontal biofilm.[8]

It is compared with well-known herbal LDD of *Curcuma longa* (Curcumin) and tetracycline LDD in this study. Tetracycline was the first local drug delivery agent introduced for use in periodontal pockets, as reported by Goodson *et al.* in 1979.[9] Subsequently, several studies have highlighted the benefits of curcumin as an LDD agent. For instance, Chaturvedi Aditi *et al.* (2024) demonstrated that 1% curcumin gel was more effective than chitosan chips against *Porphyromonas gingivalis*. *Curcuma longa* is particularly noteworthy due to its wide range of pharmacological properties, including antioxidant, antimicrobial, anti-inflammatory, antiseptic, immunostimulant, hepatoprotective, and antimutagenic activities.[10]

In this study, gels of *Quercus infectoria* and *Curcuma longa* were prepared, and tetracycline fibers (Periodontal AB Plus) were used in periodontal pockets measuring 5–7 mm. Coe-Pak was placed in both the *Quercus infectoria* and *Curcuma longa* groups. Clinical parameters- including probing pocket depth (PPD), clinical attachment level (CAL), papillary bleeding index (PBI), and plaque index (PI)- were recorded at baseline and one month after LDD placement. The colony count of *P. gingivalis* was also assessed at baseline and one month postoperatively. To the best of our knowledge, this is the first in vivo study to evaluate the potential of *Quercus infectoria* as a local drug delivery agent.

II. Materials and Methods:

2.1 Study sample and selection criteria:

This study was conducted in the Department of Periodontics, College of Dental Sciences, Davangere, from January 2025 to March 2025. A total of 30 subjects (both males and females) aged between 25 and 50 years were randomly selected from the outpatient department. Participants presented with localized chronic periodontitis and periodontal pockets measuring 5–7 mm. Subjects were excluded if they were smokers, pregnant, had systemic diseases, a history of drug allergy, had undergone periodontal therapy within the previous three months, had received antibiotic treatment within one month prior to the study, were undergoing orthodontic treatment during the study period, or had teeth with severe caries or extensive restorations in the selected sites. The study was approved by ethics committee no. CODS/IEC/19/2024-25. Informed consent was taken from the subjects prior to the start of the study.

2.2 Study design:

This was a randomized clinico-microbiological study conducted over a period of two months. Periodontal parameters, including probing pocket depth (PPD), clinical attachment level (CAL), papillary bleeding index (PBI), and plaque index (PI), were recorded at baseline and one month postoperatively. To evaluate the efficacy of the local drug delivery agents against *P. gingivalis*, subgingival plaque samples were collected in Reduced Transport Fluid (RTF) medium at baseline and after one month and sent to Maratha Mandal Central Research Laboratory, Belgavi, Karnataka for microbial evaluation. These samples were cultured on blood agar, and the number of colony-forming units (CFUs) was analyzed.

Sample size was calculated using formula: $n=Z^2PQ/e^2$

Where, n=number of subjects in each group

Z=critical value at 95% confidence level

P=prevalence of chronic periodontitis with type 2 diabetes

q=prevalence of non-prevalence

e=instrumental error

Total sample size was 30 with localized chronic periodontitis patients with pockets 5-7mm.

Group I: Group treated with *Quercus infectoria* gel

Group II: Group treated with *Curcuma longa* gel

Group III: Group treated with Tetracycline

2.3 Preparation of Local Drug Delivery agents:

Herbal gels were prepared in Bapuji Pharmacy College, Davangere and the procedure is as follows:

Quercus infectoria gel: Thirty milliliters of distilled water were measured and transferred to a 250 mL beaker. HPMC powder was slowly sprinkled over the distilled water and dissolved by continuous stirring with a magnetic bead at 20 rpm on a magnetic stirrer. Subsequently, 200 mg of carbopol was gradually added to the solution and allowed to hydrate overnight. After 24 hours, the mixture was stirred again using a magnetic stirrer to ensure uniform dispersion of carbopol. The accurately weighed quantity of drug was dissolved in 10 mL of distilled water, and this drug solution was added dropwise to the polymeric mixture under constant stirring. Finally, 5–10 mL of freshly prepared NaOH solution was added to adjust the pH and convert the preparation into a gel.

Curcumin longa gel: Curcumin gel was prepared by dissolving 100 mg of curcumin in 80 mL of double-distilled water in a beaker. The mixture was then exposed to ambient air at a temperature above 25 °C to allow gel formation.

Tetracycline LDD: Periodontal AB Plus which is readily available is used.

III. Procedure:

Following initial Phase I therapy, sites with probing pocket depths of 5–7 mm were selected for the study. Baseline plaque samples were collected, and clinical parameters were recorded. Clinical attachment level (CAL), probing pocket depth (PPD), and plaque index (PI) were measured at four sites per tooth (buccal, lingual, mesial, and distal) using a calibrated periodontal probe. PPD was defined as the distance between the gingival margin and the base of the pocket, whereas CAL was measured as the distance between the base of the pocket and a fixed reference point on the tooth, such as the cementoenamel junction (CEJ). Gingival inflammation was assessed using the Papillary Bleeding Index (PBI) developed by Saxer and Mühlemann.

Following baseline recordings, local drug delivery was administered. Group I received *Quercus infectoria* gel (Figure 1 demonstrating *Quercus infectoria* gel placement in subgingival pocket), Group II received *Curcuma longa* gel (Figure 2 demonstrating *Quercus infectoria* gel placement in subgingival pocket), and Group 3 received tetracycline fibers. Coe-Pak was placed in Groups I and II to prevent dislodgement. All participants were instructed on proper oral hygiene practices and advised to avoid flossing for 10 days. Patients were recalled after one week to assess for any adverse reactions, and the Coe-Pak was removed for Group I and Group II during this visit. After one month, plaque samples were recollected and clinical parameters were re-evaluated. Plaque samples collected at Baseline and post 1 month post-operatively were sent to Maratha Mandal for microbial count of *P.gingivalis*. (Figure 3 showing growth of *P.gingivalis* on agar medium)

IV. Statistical analysis:

The data collected was entered into Microsoft excel. The data was statistically analysed using SPSS software version 23.0. All the values were expressed in the form of mean, and standard deviation. The parameters were compared between Group I, Group II, and Group III. The results were obtained using ANOVA.

V. Results

Intergroup comparison of probing pocket depth (PPD) among *Quercus infectoria*, *Curcuma longa*, and tetracycline groups revealed a statistically significant difference ($p < 0.001$). The mean PPD in the *Quercus infectoria* group (4.7 ± 2.5) was lower compared to the *Curcuma longa* group (4.75 ± 2.45) and the tetracycline group (4.9 ± 2.35) when assessed at baseline and after one month. (Table 1 depicts the intergroup comparision of PPD).

Similarly, intergroup comparison of clinical attachment level (CAL) demonstrated a statistically significant difference ($p < 0.001$). The mean CAL was lowest in the *Quercus infectoria* group (4.45 ± 2.75), followed by tetracycline (4.6 ± 2.7) and *Curcuma longa* (5.25 ± 2.75). (Table 2 depicts the intergroup comparision of CAL).

For papillary bleeding index (PBI), a significant difference was also observed between groups ($p < 0.001$), with mean PBI scores of 1.51 ± 0.5 for *Quercus infectoria*, 1.46 ± 0.55 for *Curcuma longa*, and 1.35 ± 1.35 for tetracycline. (Table 3 depicts the intergroup comparision of PBI).

Plaque index (PI) comparison showed significant intergroup variation ($p < 0.001$), with mean PI values of 1.58

± 0.35 for *Quercus infectoria*, 1.63 ± 0.35 for *Curcuma longa*, and 1.65 ± 0.4 for tetracycline. (Table 4 depicts the intergroup comparision of PI).

Finally, intergroup comparison of colony-forming units (CFUs) of *P. gingivalis* revealed statistically significant differences ($p < 0.001$). The mean CFU count was lowest in the *Quercus infectoria* group (99 ± 63), followed by *Curcuma longa* (101.5 ± 38.5) and tetracycline (112 ± 28.5), as evaluated at baseline and one month postoperatively. (Table 5 depicts the intergroup comparision of CFUs of *P. gingivalis*).

VI. Discussion

The aim of the present study was to evaluate and compare the clinical effects of *Quercus infectoria* local drug delivery (LDD) with *Curcuma longa* LDD and tetracycline LDD, as well as to assess their antimicrobial activity against *P. gingivalis*. The study was conducted in the Department of Periodontics, College of Dental Sciences, Davangere, on 30 randomly selected subjects of both genders presenting with periodontal pockets measuring 5–7 mm. Informed consent was obtained from all participants before initiating the study. Periodontal status was assessed using Plaque Index (PI), Papillary Bleeding Index (PBI), Clinical Attachment Level (CAL), and Probing Pocket Depth (PPD). The study aimed to determine the clinical efficacy of natural LDD agents, such as *Curcuma longa* and *Quercus infectoria*, in comparison to a well-established allopathic agent, tetracycline.

The concept of local drug delivery in periodontics was first introduced by Dr. Max Goodson in 1979, with the development of tetracycline-filled cellulose acetate hollow fibers placed within the gingival sulcus. This approach demonstrated significant benefits in reducing periodontal pathogens and improving clinical outcomes while using less than 1/1000th of the systemic tetracycline dose. LDD overcame several limitations of systemic antibiotic therapy, including low drug bioavailability, the need for frequent dosing, gastrointestinal side effects, dysbiosis, drug resistance, and interactions with other systemically administered medications.[9] In the present study, the tetracycline group demonstrated significant improvement in clinical parameters and a reduction in *P. gingivalis* counts, findings consistent with those reported by Vijayalakshmi R *et al.* (2013), who observed that tetracycline, when delivered from type I collagen fibers with a controlled release profile, effectively inhibited *P. gingivalis* growth and served as a useful adjunct to mechanical therapy in the management of chronic

periodontitis.[11] Tetracycline, owing to its antimicrobial properties have contributed to the reduction of *P. gingivalis* counts, while collagen serves both as a carrier for the drug and as a scaffold that supports soft tissue regeneration, thereby enhancing clinical parameters.

Curcuma longa (turmeric) is a well-known herbal remedy that has gained considerable importance in periodontics due to its antibacterial, anti-inflammatory, antioxidant, antiviral, and anticancer properties. Its bioactive constituents include three major curcuminoids—demethoxycurcumin, bisdemethoxycurcumin, and curcumin—along with volatile oils such as turmerone, atlantone, and zingiberene, as well as sugars, proteins, and resins. In the present study, the *Curcuma longa* group demonstrated improvement in clinical parameters, which is consistent with the findings of Siddharth *et al.* (2020), who reported statistically significant improvement in clinical parameters when curcumin gel was compared with chlorhexidine gel.[16] Furthermore, a reduction in *P. gingivalis* counts was observed one month after gel placement, corroborating the results of M. Nagasri *et al.* (2015), who showed that curcumin gel was effective against *P. gingivalis* and improved clinical outcomes when used as an adjunct to scaling and root planing (SRP).[12] These beneficial effects are likely attributed to curcumin's ability to inhibit the production of pro-inflammatory cytokines, downregulate the activity of key enzymes such as cyclooxygenase-2, lipoxygenase, and nitric oxide synthase, and suppress the biosynthesis of inflammatory prostaglandins. Additionally, curcumin enhances neutrophil function during inflammation, which may contribute to improved periodontal attachment and a reduction in subgingival biofilm accumulation.

Quercus infectoria is primarily composed of gallotannic acid, gallic acid, ellagic acid, starch, and sugars. In Malay traditional medicine, it has been used to restore postpartum uterine elasticity and stimulate vaginal muscle contraction.[13] In Indian traditional medicine, it is commonly incorporated into tooth powders and toothpastes for the management of gingival and oral cavity diseases.[14] Extracts from the galls of *Q. infectoria* exhibit strong antibacterial activity against oral pathogens such as *Streptococcus mutans*, *Streptococcus salivarius*, *Porphyromonas gingivalis*, and *Fusobacterium nucleatum*. This activity is attributed to the presence of tannins, which exert antimicrobial effects by forming complexes with microbial enzymes (e.g., cellulase) and cell membranes, causing iron deprivation through precipitation, and disrupting bacterial metabolism by inhibiting oxidative phosphorylation.[7] Alhamadani *et al.* (2020) demonstrated that *Q. infectoria* extract could be effectively used as an oral powder with anti-plaque and anti-gingivitis properties. Similarly, Noori *et al.* (2023) evaluated the antibacterial effect of the hydroalcoholic extract of *Q. infectoria* galls on *Aggregatibacter actinomycetemcomitans* in vitro and recommended its potential application in mouthrinses and local drug delivery systems.[8]

VII. Figures and tables

Fig 1: demonstrating *Quercus infectoria* gel placement in subgingival pocket

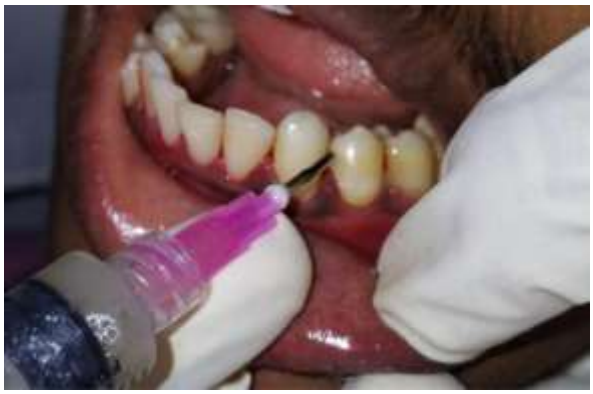

Fig 2: demonstrating *Curcuma longa* gel placement in subgingival pocket

Fig 3:

TABLE 1: Intergroup comparison of Probing Pocket Depth scores of three groups at baseline and a month

Group	N	Mean	Std. deviation	p-value
Quercus infectoria	10	4.7	2.5	0.001
Curcumin longa	10	4.75	2.45	
Tetracycline	10	4.9	2.35	

TABLE 2: Intergroup comparison of Clinical attachment level scores of three groups at baseline and a month

Group	N	Mean	Std. deviation	p-value
Quercus infectoria	10	4.45	2.75	0.002

Curcumin longa	10	5.25	2.75	
Tetracycline	10	4.6	2.7	

TABLE 3: Intergroup comparison of Papillary Bleeding Index scores of three groups at baseline and a month

Group	N	Mean	Std. deviation	p-value
Quercus infectoria	10	1.51	0.5	0.001
Curcumin longa	10	1.46	0.55	
Tetracycline	10	1.35	1.35	

TABLE 4: Intergroup comparison of Plaque Index scores of three groups at baseline and a month

Group	N	Mean	Std. deviation	p-value
Quercus infectoria	10	1.58	0.35	0.002
Curcumin longa	10	1.63	0.35	
Tetracycline	10	1.65	0.4	

TABLE 5: Intergroup comparison of Colony Forming Units scores of three groups at baseline and a month

Group	N	Mean	Std. deviation	p-value
Quercus infectoria	10	99	63	0.004
Curcumin longa	10	101.5	38.5	
Tetracycline	10	112	28.5	

VIII. Conclusion:

This study aimed at studying the efficacy of extract of Quercus infectoria as LDD, and also to compare its efficacy to curcumin longa and tetracycline. This study showed better improvement in clinical parameters in tetracycline group than Curcuma longa group followed by Quercus infectoria group. Whereas, P.gingivalis colony forming units reduction was more in tetracycline followed by Curcuma longa and Quercus infectoria.

Limitation of study being the smaller sample size, results might vary with larger sample size.

Local drug delivery systems seem reliable option in the geriatric patients where surgery is usually avoided or in the patients with systemic illness where surgery is not usually indicated.

References:

[1] Amato M, Santonocito S, Polizzi A, Tartaglia GM, Ronsivalle V, Viglianisi G, Grippaudo C, Isola G. Local Delivery and Controlled Release Drugs Systems: A New Approach for the Clinical Treatment of Periodontitis Therapy. Pharmaceutics. 2023 Apr 21;15(4):1312. doi: 10.3390/pharmaceutics15041312. PMID: 37111796; PMCID: PMC10143241.

[2] Babu Dhanikula, Ramesh Panchagnula, Localized paclitaxel delivery, International Journal of Pharmaceutics, Volume 183, Issue 2, 1999, Pages 85-100, ISSN 0378-5173, https://doi.org/10.1016/S0378-5173(99)00087-3.

[3] Sanz M., Herrera D., Kebschull M., Chapple I., Jepsen S., Beglundh T., Sculean A., Tonetti M.S. Treatment of stage I-III periodontitis-The EFP S3 level clinical practice guideline. J. Clin. Periodontol.

[1] 2020;47((Suppl. 22)):4–60. doi: 10.1111/jcpe.13290. [DOI] [PMC free article] [PubMed] [Google Scholar]

[2] Herrera D., Sanz M., Kebschull M., Jepsen S., Sculean A., Berglundh T., Papapanou P.N., Chapple I., Tonetti M.S. Treatment of stage IV periodontitis: The EFP S3 level clinical practice guideline. J. Clin. Periodontol. 2022;49((Suppl. 24)):4–71. doi: 10.1111/jcpe.13639. [DOI] [PubMed] [Google Scholar]

[3] Karale, Akanksha Mohan; Waghmare, Pramod; Dodwad, Vidya M.; Kaur, Avneet. Herbal Local Drug Delivery: A Narrative Review. Indian Journal of Dental Sciences 16(3):p 147-152, Jul–Sep 2024. | DOI: 10.4103/ijds.ijds_75_23

[4] Anil Kumar Vadaga, Sai Shashank Gudla, Suchitra Poritigadda, Dipayan Debnath, Sri Latha Hanumanthu, Venkata Harini Gudala, Jyothi Doddipatla, Phytochemical composition and pharmacological benefits of Majuphal, Pharmacological Research - Natural Products, Volume 8, 2025, 100342, ISSN 2950-1997, https://doi.org/10.1016/j.prenap.2025.100342.

[5] Basri DF, Tan LS, Shafiei Z, Zin NM. In Vitro Antibacterial Activity of Galls of Quercus infectoria Olivier against Oral Pathogens. Evid Based Complement Alternat Med. 2012;2012:632796. doi: 10.1155/2012/632796. Epub 2011 Nov 17. PMID: 22203875; PMCID: PMC3235900.

[6] Tabibzadeh Noori Z, Tabatabaei Rad M, Hakemi Vala M, Karimi M, Esmaeil Nejad A. Evaluation of the antibacterial effect of hydroalcoholic extract of the galls of Quercus infectoria on Aggregatibacter actinomycetemcomitans. J Adv Periodontol Implant Dent. 2023 Apr 5;15(1):35-41. doi: 10.34172/japid.2023.006. PMID: 37645555; PMCID: PMC10460781.

[7] Goodson JM, Haffajee A, Socransky SS. Periodontal therapy by local delivery of tetracycline. J Clin Periodontol. 1979 Apr;6(2):83-92. doi: 10.1111/j.1600-051x.1979.tb02186.x. PMID: 379050.

[8] Chaturvedi A, Sheokand V, Bhardwaj A, Wadhwa V. Comparative Evaluation of Local Drug Delivery Using Chitosan Chip and 1% Curcumin Gel on Porphyromonas Gingivalis: A Clinico-microbiological Study. World J Dent 2024; 15 (8):702-708.

[9] Vijayalashmi R, Ravindranath SM, Jayakumar ND, Padmalatha, Vargheese SH, Kumaraswamy KL. Kinetics of drug release from a biodegradable local drug delivery system and its effect on Porphyromonas gingivalis isolates: An in vitro study. J Indian Soc Periodontol. 2013 Jul;17(4):429-34. doi: 10.4103/0972-124X.118311. PMID: 24174719; PMCID: PMC3800402.

[10] Nagasri M, Madhulatha M, Musalaiah SV, Kumar PA, Krishna CH, Kumar PM. Efficacy of curcumin as an adjunct to scaling and root planning in chronic periodontitis patients: A clinical and microbiological study. J Pharm Bioallied Sci. 2015 Aug;7(Suppl 2):S554-8. doi: 10.4103/0975-7406.163537. PMID: 26538916; PMCID: PMC4606658.

[11] Muhamad Z, Mustafa AM. Traditional Malay Medicinal Plants, Penerbit Fajar Bakti Sdn. Bhd., Kuala Lumpur, Malaysia. 1994.

[12] Khare CP. Indian medicinal plants: an illustrated dictionary. Springer Science & Business Media; 2008 Apr 22.

[13] Clinical study on the therapeutic effects of Quercus infectoria galls as oral powder in gingivitis and

[14] plaque patients . (2020). *Indian Journal of ForensicMedicine & Toxicology*, *14*(4), 744-

[15] https://doi.org/10.37506/ijfmt.v14i4.11576

[16] Siddharth M, Singh P, Gupta R, Sinha A, Shree S, Sharma K. A Comparative Evaluation of Subgingivally Delivered 2% Curcumin and 0.2% Chlorhexidine Gel Adjunctive to Scaling and Root Planing in Chronic Periodontitis. J Contemp Dent Pract. 2020 May 1;21(5):494-499. PMID: 32690830.