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# Antibacterial Effects of Turmeric Extract on Oral *Streptococcus* Infections and Gingivitis

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**Annotation:** This study investigates the antibacterial and anti-inflammatory effects of turmeric extract on oral Streptococcus infections and gingivitis, highlighting its potential as a natural therapeutic agent for oral health. The findings demonstrate that turmeric extract, rich in curcumin, exhibits significant antibacterial activity against key pathogens such as Streptococcus mutans and Streptococcus sobrinus , which are primary contributors to dental caries. Using the disk diffusion method, turmeric extract showed dose-dependent growth inhibition, with zones of inhibition increasing from 12 mm at 100 μg/mL to 25 mm at 300 μg/mL . The Minimum Inhibitory Concentration (MIC) was determined to be 200 μg/mL for S. mutans and 250 μg/mL for S. sobrinus, indicating its potency even at relatively low concentrations.

In addition to its antibacterial properties, turmeric extract significantly reduced inflammatory markers associated with gingivitis. Level of interleukin-6 (IL-6)

and necrosis of tumor necrosis factor-alpha (TNF-$\alpha$) decreased by 55.5% and 60% respectively. After two weeks of treatment. These results underscore curcumin's ability to modulate inflammatory pathways by inhibiting NF-κB and neutralizing reactive oxygen species (ROS) as supported by existing literature.

The profile of turmeric extract also favorable with only mild dry mouth reported in 6.6% of participants while the majority experienced no side effects. Clinically, 66.7% of patients showed significant improvement in gingival health and 26.7% demonstrated moderate improvement reflecting its efficacy in managing gingivitis.

Also the study provides robust evidence for the dual antibacterial and anti-inflammatory properties of turmeric extract, making it a promising natural alternative for preventing and treating oral infections and gum disease. Its safety, tolerability and ease of incorporation into daily oral care routines further enhance its practical utility. Future research should focus on optimizing formulations exploring synergistic combinations and conducting large scale clinical trials to validate these findings and expand its applications in preventive dentistry.

## Introduction

Oral health cornerstone of overly wellbeing yet oral diseases such as dental caries and gingivitis remain prevalent worldwide. Dental caries primarily caused by bacterial species like Streptococcus mutans and Streptococcus Sobrino's results from the fermentation of dietary sugars into acids that demineralize tooth enamel (Selwitz *et al.*,2007).

Gingivitis are the other hand arises from the accumulation of bacterial plaque along the gumline triggering inflammatory response characterized by redness swelling and bleeding of the gums (Kinane *et al.,* 2017). If left untreated, gingivitis can progress to periodontitis a severe condition leading to tissue destruction and tooth loss.

At last years has been growing interest in natural remedies alternatives to conventional treatments for oral diseases, This shift is driven by concerns about antibiotic resistance the high cost of synthetic medications and the potential side effects associated chemical-based therapies (Wang *et al.,* 2019).Among natural compounds gaining attention turmeric (Curcuma longa) have emerged as a promising candidate due to its active ingredient curcumin.Curcumin was a polyphenolic compound with well documented antibacterial,anti inflammatory, and antioxidant properties (Gupta *et al.,* 2013).Traditionlly used in Ayurvedic and Chinese medicine, curcumin is now being explored scientifically for its therapeutic potential in modern dentistry.

The aim of study are evaluate the antibacterial efficacy of turmeric extract against oral streptococcus species and its ability to reduce gingival inflammation.By integrating experimental data with insights from existing literature this research seeks to establish turmeric extract as a safe effective, and natural alternative for managing oral infections and gum disease.

**Keywords:** Turmeric extract, Curcumin, Antibacterial activity, Oral Streptococcus infections, Gingivitis, Streptococcus mutans.

## Methodology

The methodology of this study was designed to systematically evaluate the antibacterial and anti-inflammatory effects of turmeric extract on oral *Streptococcus* infections and gingivitis.The experimental approach included in vitro testing clinical evaluations and statistical analyses to ensure robust and reproducible

### 1. Materials and Samples

### 1.1. Plant Extract Preparation

Turmeric Extract:High-purity turmeric extract containing 95% curcumin (purchased from a reputable supplier) which used as the primary material.The extract was dissolved in dimethyl sulfoxide (DMSO) to prepare stock solutions at concentrations of 100 µg/mL, 200 µg/mL, and 300 µg/mL.These concentrations were chosen based on preliminary studies indicating their efficacy and safety (Moghadam *et al.,* 2018).Curcumin's solubility in DMSO ensures stability and bioavailability during experiments (Gupta et al., 2013).

**Control Solutions** :A negative control (sterile saline) and a positive control (0.2% chlorhexidine gluconate, a standard antibacterial agent)were included for comparison. Chlorhexidine is widely regarded as the "gold standard" for oral antimicrobial therapy due to its broad-spectrum activity (Jones, 1997).

### 1.2. Target Bacteria

Standard strains of *Streptococcus mutans* (ATCC 25175) and *Streptococcus sobrinus* (ATCC 33478) were obtained from a certified microbial repository. These strains are widely recognized as key pathogens in dental caries and were used to assess the antibacterial efficacy of turmeric extract (Loesche, 1986).

Bacterial cultures were maintained in Brain Heart Infusion (BHI) broth at 37°C under anaerobic conditions using an anaerobic jar with gas packs. This method mimics the natural environment of the oral cavity, where these bacteria thrive (Marsh & Martin, 2009).

### 1.3. Gingival Samples

Gingival crevicular fluid (GCF) samples were collected from 30 patients diagnosed with chronic gingivitis. Participants were recruited from a local dental clinic after obtaining informed consent.

Exclusion criteria included systemic diseases, pregnancy, antibiotic use within the past three months, or any ongoing periodontal treatment (Kinane et al., 2017).

GCF was collected using sterile paper points inserted into the gingival sulcus for 30 seconds. Samples were stored at -80°C until analysis. This method is widely accepted for quantifying inflammatory markers in periodontal research (Lamster et al., 2003).

## 2. Methods

### 2.1. Antibacterial Activity Testing

To evaluate the antibacterial efficacy of turmeric extract two complementary methods were employed

#### 2.1.1. Disk Diffusion Method

Sterile filter paper disk 6 mm diameter was impregnated with 20 µL of turmeric extract at concentrations of 100 µg/mL,200 µg/mL and 300 µg/mL. Disk impregnated with sterile saline and 0.2% chlorhexidine served as negative and positive controls respectively. Agar plate was prepared using Mueller-Hinton agar and inoculated with a standardized suspension of *Streptococcus mutans* or *Streptococcus sobrinus* 0.5 McFarland turbidity. Impregnated disk was placed on the agar surface and plates were incubated at 37 °C for 24 H under anaerobic conditions (Bauer *et al*., 1966).

Zones of inhibition were measured in millimeters using digital caliper. Each experiment were performed in triplicate to ensure accuracy. This methods are a well-established technique for assessing the antibacterial activity of plant extracts (Teow *et al.,* 2016).

#### 2.1.2. Broth Microdilution Method

Serial dilutions of turmeric extract was prepared in Mueller Hinton broth which determine the minimum inhibitory concentration(MIC).A bacterial suspension ($1 \times 10^6$ CFU/mL) was added to each well of a 96 well microtiter plate containing varying concentrations of turmeric extract.

Plate was incubated at 37 °C for 24 H and bacterial growth assessed spectrophotometrically at 600 nm. The MIC was defined as the lowest concentration that completely inhibited visible bacterial growth. This method is considered the gold standard for determining the antibacterial potency of compounds (Wiegand *et al.,* 2008).

### 2.2. Anti-Inflammatory Analysis

Level of pro inflammatory cytokines IL-6 and TNF-α in GCF sample was quantified using enzyme linked immunosorbent assays (ELISA). Commercial ELISA kits (BioLegend, USA) which used according to the manufacturer's instructions. IL-6 and TNF-α are key biomarker of inflammation in periodontal disease and have been extensively studied in gingivitis research (Kinane *et al*., 2017).

### 2.3. Clinical Evaluations

Gingival health was assessed using the Gingival Inde GI Plaque Index P as described by Loe and Silness (1963).These indices which widely used in periodontal research to quantify gingival inflammation and plaque accumulation.Participant was instructed to rinse their mouth with 10 mL of the turmeric extract solution for 30 seconds twice daily. Compliance was monitored through self-reported log. Oral rinses have been shown to effectively deliver active compounds to the oral cavity making them a practical delivery method (Petersen & Scheie, 2002).

### 2.4. Side Effects Monitoring

Participants was asked to report any adverse effects experienced during the study period Common side effects such as dry mouth, altered taste, or irritation were documented. Safety assessments are critical in evaluating the feasibility of natural products for long-term use (Lao *et al*., 2006).

### 3. Statistical Analysis

Data were analyzed using SPSS software (version 25.0). Descriptive statistics were used to summarize demographic and clinical characteristics of participants.Paired t-tests were performed to compare pre- and post-treatment values for inflammatory markers (IL-6 and TNF-α) and clinical indices (GI and PI).One-way ANOVA was used to compare zones of inhibition across different concentrations of turmeric extract.Statistical significance was set at $p < 0.05$. These statistical methods are standard in biomedical research and ensure the reliability of findings (Norman & Streiner, 2014).

### 4. Ethical Considerations

The study protocol was approved by the Institutional Review Board (IRB) of the participating institution. Written informed consent was obtained from all participants prior to enrollment. Participants were informed of their right to withdraw from the study at any time without penalty. Ethical guidelines for human research were followed in accordance with the Declaration of Helsinki

## Results and Discussion

The findings of this study provide compelling evidence for the antibacterial and anti-inflammatory efficacy of turmeric extract in combating oral *Streptococcus* infections and gingivitis. Below, we present a detailed discussion of the results derived from the experimental data, supported by references to the tables and insights from existing literature.

### 1. Antibacterial Activity of Turmeric Extract

The antibacterial potential of turmeric extract was assessed using the disk diffusion method, and the results are summarized in Table 1 . As shown, turmeric extract exhibited dose-dependent antibacterial activity against both *Streptococcus mutans* and *Streptococcus sobrinus* . At a concentration of 100 µg/mL, the zone of inhibition measured 12 mm, which increased significantly to 18 mm at 200 µg/mL and reached 25 mm at 300 µg/mL. These finding indicate that higher concentrations of turmeric extract result in greater bacterial growth inhibition.

This dose-response relationship aligns with previous studie highlighting curcumin ability to disrupt bacterial cell membranes and inhibit biofilm formation.For instance according to Moghadam *et al.* (2018),curcumin interferes with quorum sensing communication mechanism used by bacteria to coordinate virulence factor thereby reducing their pathogenicity.Similarly Nagpal and Sood (2013)demonstrated that curcumin inhibits the production of glucosyltransferase enzymes, which are critical for *S. mutans* biofilm formation.The observed zones of inhibition in our study suggest that turmeric extract could serve as an effective natural alternative to conventional antibacterial agents.

### 2. Reduction in Inflammatory Markers

To evaluate the anti inflammatory effects of turmeric extract levels of IL-6 and TNF-α were measured before and after treatment.The results, presented in Table 2 reveal a significant reduction in both inflammatory markers. Specifically, IL-6 levels decreased from 45 pg/mL to 20 pg/mL (a 55.5% improvement), while TNF-α levels dropped from 30 pg/mL to 12 pg/mL (a 60% improvement).These reductions underscore the potent anti-inflammatory properties of turmeric extract.

Curcumin anti inflammatory action is well documented in the literature.According to Gupta et al. (2013)curcumin modulates inflammatory pathways by inhibiting nuclear factor-kappa B (NF-κB), a key regulator of pro-inflammatory cytokines such as IL-6 and TNF-α.This mechanism likely explains the marked decrease in inflammatory markers observed in our study. Furthermore Chainani Wu (2003) noted that curcumin antioxidant properties contribute to its anti inflammatory effects by neutralizing reactive oxygen species (ROS) that exacerbate tissue damage during

inflammation.Taken together, these findings highlight turmeric extract's dual role as both an antibacterial and anti-inflammatory agent.

### 3. Minimum Inhibitory Concentration (MIC)

The MIC values for turmeric extract against *Streptococcus mutans* and *Streptococcus sobrinus* are presented in Table 3 .The MIC for *S. mutans* was determined to be 200 µg/mL, while for *S. sobrinus.* it was slightly higher at 250 µg/mL.These results indicate that turmeric extract effectively inhibits bacterial growth even at relatively low concentrations.

The effectiveness of turmeric extract at low MIC values can be attributed to curcumin multifaceted antibacterial mechanisms.As reported by Teow et al. (2016) curcumin not only disrupts bacterial cell membranes but also interferes with essential metabolic processes, including DNA replication and protein synthesis. Additionally, curcumin has been shown to enhance the efficacy of other antimicrobial agents when used in combination, suggesting its potential for synergistic applications in oral care products (Hewlings & Kalman, 2017).

### 4. Safety Profile and Side Effects

The safety profile of turmeric extract were evaluated by documenting any adverse effects experienced by participants.As shown in Table 4 only two participants (6.6%) reported mild dry mouth, while the remaining 28 participants (93.4%) experienced no side effects.This favorable safety profile underscores the suitability of turmeric extract for long-term use in oral health management.

Turmeric safety has been extensively studied, with numerous reviews confirming its non-toxic nature even at high doses. For example,Lao et al. (2006) conducted a clinical trial involving daily consumption of up to 8 grams of curcumin over three months and found no significant adverse effects. Similarly, Gupta et al.(2013) emphasized that curcumin's low toxicity makes it an ideal candidate for therapeutic applications particularly in sensitive populations such as children and pregnant women. The minimal side effects observed in our study further validate turmeric extract's potential as a safe and natural alternative to synthetic medications.

### 5. Clinical Improvements in Gingival Health

Finally the impact of turmeric extract on gingival health were assessed through clinical evaluations. The results, summarized in Table 5 indicate that 20 participants (66.7%) experienced significant improvements,while 8 participants (26.7%)showed moderate improvement. Only 2 participants (6.6%) reported no improvement. These outcomes reflect the overall efficacy of turmeric extract in managing gingivitis.

The clinical improvements observed in this study consistent with prior research on curcumin's role in periodontal health. A randomized controlled trial by Pradeep et al. (2016) demonstrated that curcumin-based gel significantly reduced gingival bleeding and plaque indices compared to placebo. Similarly a meta-analysis by Zeng et al. (2019) concluded that curcumin-containing formulations are effective in reducing inflammatory markers and improving clinical parameters in patients with chronic periodontitis. These findings reinforce the therapeutic potential of turmeric extract as a complementary treatment for gum disease.

## Conclusion

In conclusion, the results of this study provide robust evidence for the antibacterial and anti-inflammatory effects of turmeric extract on oral *Streptococcus* infections and gingivitis. The findings, supported by quantitative data and referenced literature, position turmeric extract as a safe, effective, and natural alternative for managing oral health conditions. Future research should focus on optimizing formulations, exploring synergistic combinations, and conducting large-scale clinical trials to further validate these promising results.

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