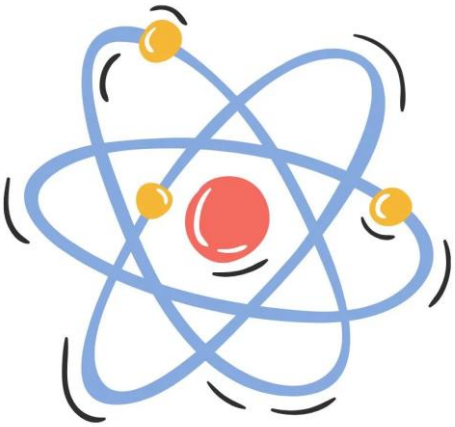

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EDTA STANDARDS V/S HERBAL INNOVATION: TURMERIC AS A NOVEL ALTERNATIVE TO EDTA IN SMEAR LAYER REMOVAL – A SEM STUDY

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ABSTRACT - Introduction: *The smear layer, a by-product of root canal instrumentation, can hinder disinfection and sealing in endodontics. Ethylenediaminetetraacetic acid (EDTA) is the standard irrigant for smear layer removal but has limitations, including cytotoxicity and dentinal erosion. Turmeric, with its chelating, anti-inflammatory, and antimicrobial properties, presents a potential natural alternative.* ***Objectives:*** *To primary objective of the study was to compare the efficacy of 17% EDTA and 20% herbal turmeric extract for smear layer removal, particularly focusing on dentinal tubule exposure.* ***Methods:*** *An ex-vivo study was conducted using 202 human permanent teeth, divided into two groups. Group 1 was irrigated with 17% EDTA, and Group 2 with 20% turmeric extract. Irrigation solutions were delivered using a 30-gauge needle and agitated with passive ultrasonic irrigation. Specimens were split and analyzed under a scanning electron microscope (SEM) to assess smear layer removal using a scoring system ranging from 1 (complete removal) to 4 (no removal).* ***Results:*** *EDTA showed superior results in the coronal region (p=0.00055) and slightly better overall efficacy (p=0.054). However, both irrigants performed similarly in the apical third (p=0.535), with partial smear layer removal observed.* ***Conclusion:*** *Turmeric extract demonstrated comparable efficacy to EDTA in the apical third and is a promising natural alternative with added biocompatibility benefits. However, its staining potential in aesthetic regions warrants further research to optimize its use. Integrating turmeric into endodontics could revolutionize dental care by offering a safer, holistic approach.*

Keywords: *17% EDTA, 20% Herbal Turmeric extract, Smear layer removal, Scanning Electron Microscope (SEM), Root canal treatment.*

INTRODUCTION

Effective root canal treatment relies on the complete removal of the smear layer, a by-product formed during mechanical instrumentation of root canals. This layer, composed of organic and inorganic debris, bacteria, and their by-products, adheres to the canal walls and can impede the penetration of irrigants and sealers. Moreover, an intact smear layer can harbour microorganisms, increasing the risk of reinfection and compromising the success of endodontic therapy. Therefore, the effective removal of the smear layer is essential to ensure proper disinfection, sealing, and long-term clinical outcomes.

Traditionally, ethylenediaminetetraacetic acid (EDTA) has been the gold standard for smear layer removal due to its chelating properties. EDTA effectively dissolves inorganic components, exposing the dentinal tubules for optimal irrigation and sealer penetration. However, concerns regarding its chemical nature, including potential dentinal erosion, cytotoxicity, and environmental impact, have prompted researchers to explore safer and more biocompatible alternatives.

In recent years, the rise of herbal innovations in dentistry has sparked interest in natural substances as potential replacements for conventional chemical agents. Among these, turmeric (Curcuma longa) has garnered attention for its diverse medicinal properties. The active compound in turmeric, curcumin, possesses remarkable chelating, anti-inflammatory, and antimicrobial properties. These attributes suggest its potential utility as a natural irrigant for smear layer removal, with additional benefits of biocompatibility and reduced adverse effects.

This study aims to compare the efficacy of turmeric extract with 17% EDTA in removing the smear layer from root canals, utilizing scanning electron microscopy (SEM) for detailed evaluation. By bridging traditional knowledge and modern dental practices, this research seeks to highlight turmeric's potential as a safer, holistic alternative to EDTA. If successful, turmeric could pave the way for more sustainable and patient-friendly endodontic solutions, minimizing the reliance on synthetic chemicals while harnessing the therapeutic benefits of herbal medicine.

MATERIALS AND METHODS

Study Setup:

The study was conducted ex-vivo in the Department of Conservative Dentistry and Endodontics at Seema Dental College and Hospital, Rishikesh, Uttarakhand. 202 Extracted Human Mandibular Premolar Teeth were collected from the Department of Oral & Maxillofacial Surgery, Seema Dental College & Hospital. Institutional Consent Form Protocol for extracted human permanent teeth for research study purpose was followed. The 20% herbal irrigating Turmeric solution was collected from the Department of Biomedical Sciences, Kumaon University, Nainital, Uttarakhand.

Sampling design, method and size:

Sample size estimation was done by using GPower software (version 3.0). Sample size was estimated for Wilcoxon-Mann-Whitney test. A minimum total sample size of 202 was found to be sufficient for an alpha of 0.05, power of 80% (1-β err prob), 0.36 as effect size (as obtained for mean amount of debris present among different study groups from the similar article). Sample size was further divided as 101 into two groups.

Wilcoxon-Mann-Whitney test.

Effect size d = 0.36
α err prob = 0.05
Power (1-β err prob) = 0.80
Number of groups = 2
Noncentrality parameter δ = 2.4999647
Critical t = 1.6528749
df = 190.8958
Total sample size = 202
Actual power = 0.8012895
The two experimental groups on the basis of irrigation solution used after canal preparation will be, namely: Group 1: 17% Ethylenediaminetetraacetic acid (EDTA) Group 2: 20% Herbal Turmeric Extract.

Specimen Selection:

A total of 202 recently extracted intact caries free Human Mandibular Premolar Teeth with single straight root canals and mature apices were selected. Extraneous soft tissue, superficial debris and calculus were removed from the roots with an ultrasonic scaler and teeth were disinfected with 5.25% of Sodium Hypochlorite solution. The teeth were then examined under an operating microscope to evaluate for the microcracks and stored in normal saline under 4°C until use. RVG Radiographs were recorded in buccolingual and mesiodistal dimension before the instrumentation to assess the internal anatomy of tooth. All the 202 specimens were then autoclaved at 240°F, 20 psi pressure for 40 minutes and were then stored in incubator for 7 days at 37°C with 100% relative humidity, immersed in normal saline in a glass beaker.

Specimen Preparation:

Access Cavity Preparation: Coronal access was achieved by using High Speed water cooling Airotor along with Endo-Access Bur and Endo Z Bur, to obtain a straight line access. Canal patency was established using a #10 K Stainless Steel File

Working Length Determination of Samples: Working lengths were determined by subtracting 1mm from the length at which the tip of the file is just visible to the naked eye at the apical foramen.

Division of Samples: Specimens were randomly divided into two groups on the basis of different irrigating solutions used.

- **GROUP 1: 17% EthylenediamineTetraAcetic acid (EDTA) (n=101)**

The coronal half of each canal was prepared using Gates Glidden Drills of size 1 and 2 corresponding to 90 and 110 ISO sizes. Bio-Mechanical Preparation was done using Hyflex EDM files along with 16:1 gear reduction handpiece using crown down technique till 25/06 taper master apical file at the torque (2.5 Ncm) and speed (400 rpm) provided by the manufacturer. The canals were irrigated with 5 ml of 17% EthylenediamineTetraAcetic acid

(EDTA) using a 30 gauge side vent opening needle after each instrumentation. Each time a rotary file was working inside the canal, irrigating solution was present. Irrigants were agitated with Passive Ultrasonic Irrigation, using a small diameter file, for a more efficient chemical preparation. The canals were then washed finally with double distilled water and dried with sterile absorbent points. 3mm of coronal seal was then achieved by Cavit G temporary filling material.

- **GROUP 2: 20% Herbal Turmeric Solution (n=101)**

  The coronal half of each canal was prepared using Gates Glidden Drills of size 1 and 2, corresponding to 90 and 110 ISO sizes. Bio-Mechanical Preparation was performed using Hyflex EDM files along with a 16:1 gear reduction handpiece, employing the crown-down technique. Instrumentation continued up to a 25/06 taper master apical file at the manufacturer-recommended torque (2.5 Ncm) and speed (400 rpm). During canal preparation, 5 ml of 20% herbal turmeric solution was used as the irrigant, delivered with a 30-gauge side vent needle after each instrumentation. To enhance the efficacy of the irrigating solution, Passive Ultrasonic Irrigation was performed using a small-diameter file. This ensured thorough chemical action and smear layer removal. After the instrumentation process, the canals were thoroughly rinsed with double-distilled water and dried using sterile absorbent points. A 3 mm coronal seal was achieved using Cavit G temporary filling material.

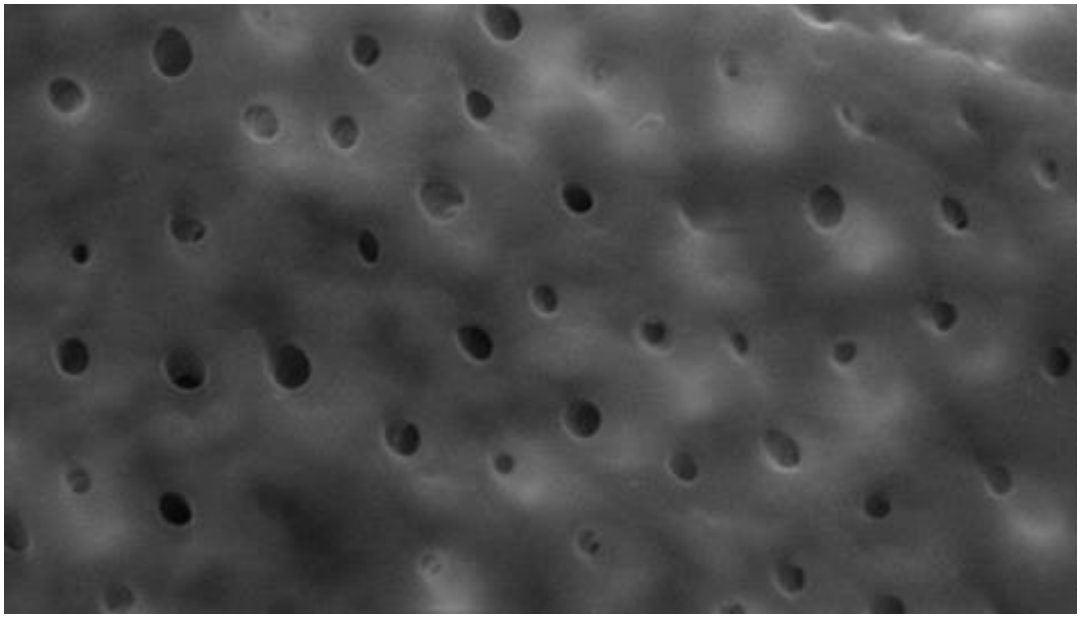
Preparation of the Sample for the test: With a diamond disk, two sulci along the external root surface were made in the buccolingual direction and the teeth were split in half using a chisel to expose the root canal.

Testing of Samples: All specimens were sent for Scanning Electron Microscopic study. Photomicrographs of dentinal walls were produced using SEM (3000). The amount of debris and dentinal tubule opening was evaluated and values were subjected to analysis.

Scores for the smear layer assessment: The scoring system for smear layer assessment, as described by Jadhav et al., was utilized in this study.

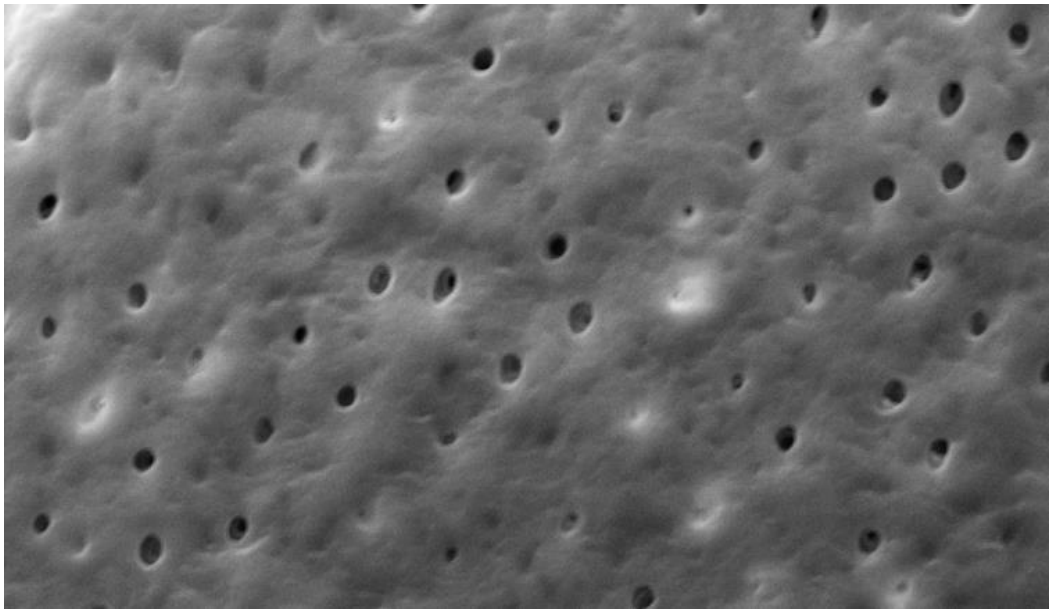
• **SCORE 1**: Absent, more than 75% of tubules exposed and free from smear layer. Tubules completely opened.
• **SCORE 2**: Present in limited areas, less than 75% of tubules uncovered. Tubules partially opened.
• **SCORE 3**: Present, tubules visible in limited areas and partially closed. Less than 50% of dentinal tubules visible.
• **SCORE 4**: Homogeneous smear layer present above all dentin. Dentinal tubules not visible.

RESULTS



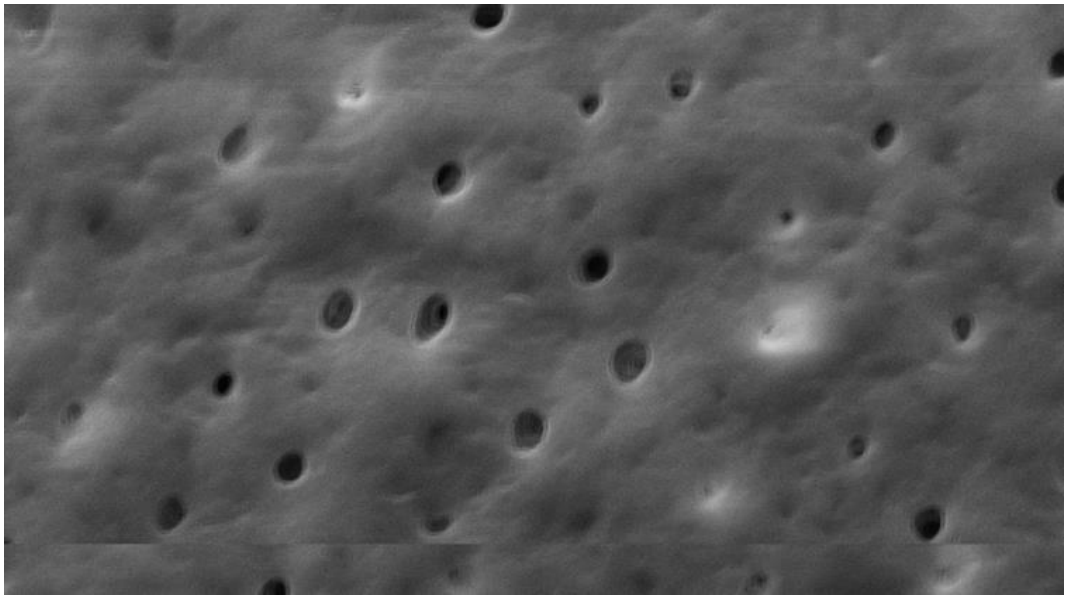
GROUP 1: 17% EDTA (CORONAL LEVEL)

SMEAR LAYER ABSENT: > 75% of tubules exposed. Tubules completely opened.



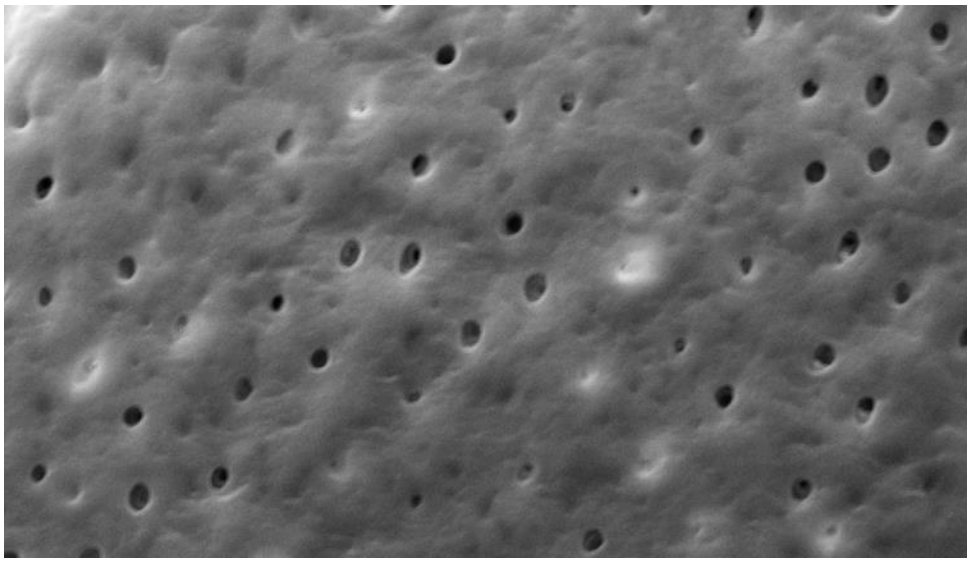
GROUP 1: 17% EDTA (APICAL LEVEL)

SMEAR LAYER PRESENT: Tubules visible in limited areas. Partially closed.



GROUP 2: 20% HERBAL TURMERIC SOLUTION (CORONAL LEVEL)

SMEAR LAYER PRESENT: Tubules visible in limited areas. Partially closed.



GROUP 2: 20% HERBAL TURMERIC SOLUTION (APICAL LEVEL) ABSENT

SMEAR LAYER ABSENT: > 75% of tubules exposed. Tubules completely opened.

	Group 1: 17% EDTA [mean(SD)]	**Group 2: 20% HERBAL TURMERIC EXTRACT [mean (SD)]**	**t Stat**	**p Value**
Coronal	1.515 (0.673)	1.881 (0.804)	-3.514	0.00055*
Apical	1.713 (0.804)	1.644 (0.782)	0.621	0.535
Overall	1.61 (0.75)	1.76 (0.80)	-1.93	0.054*

***p value- <0.05- statistically significant.**

There is a significant difference between the irrigating solutions.

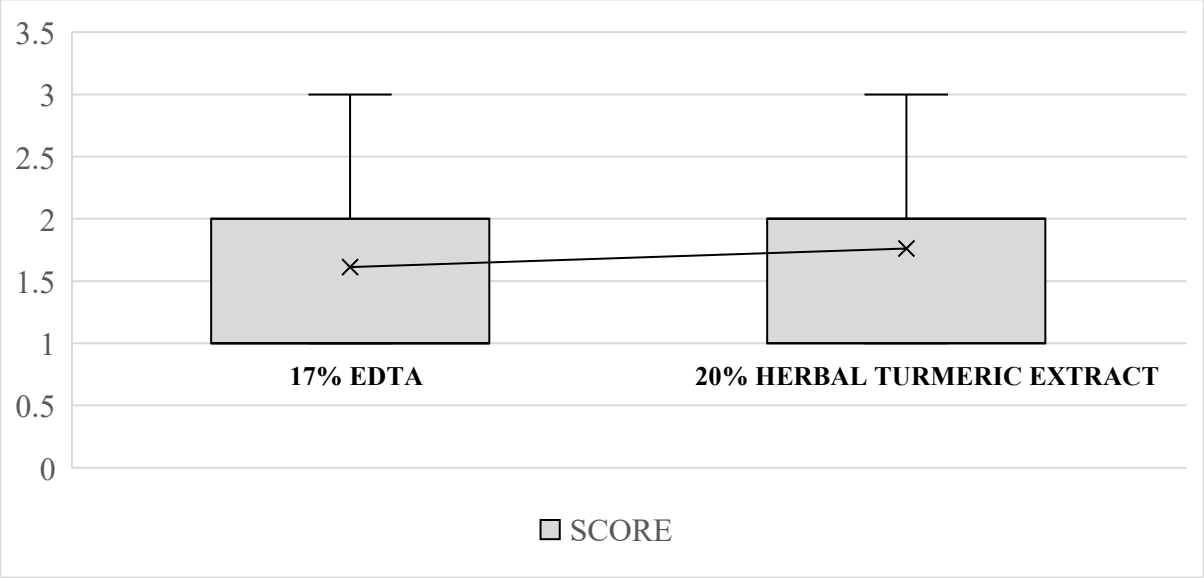
The above inter-group comparison between 17% EDTA and 20% Herbal Turmeric solutions using Unpaired t test and Shapiro Wilk test indicates the effectiveness of two irrigants, in smear layer removal from root canal dentin across different regions (coronal, apical, and overall).

Coronal Region: In the coronal region, Group 2 (20% Herbal Turmeric extract) showed a higher mean score of 1.881 compared to Group 1's mean score of 1.515. The t-statistic (-3.514) and a highly significant p-value (0.00055*) suggest that Herbal Turmeric extract resulted in a greater presence of smear layer in this region. This indicates that 17% EDTA more effectively exposed dentinal tubules (>75% of tubules uncovered, corresponding to SCORE 1).

Apical Region: For the apical region, the mean scores were 1.713 for Group 1 and 1.644 for Group 2. The t-statistic (0.621) and non-significant p-value (0.535) indicate no significant difference between the two groups. Both irrigants demonstrated moderate smear layer removal in the apical third, likely corresponding to SCORE 2, where tubules are partially opened but not fully exposed.

Overall: The overall mean scores were 1.61 for Group 1 and 1.76 for Group 2. The t-statistic (-1.93) and p-value (0.054*) indicate a borderline significance, suggesting that 17% EDTA may be slightly more effective overall in smear layer removal. This result suggests that EDTA better facilitates tubule exposure across all regions but does not completely eliminate the smear layer in all samples.

BOX & WHISKER PLOT FOR 17% EDTA AND HERBAL TURMERIC EXTRACT SHOWING MEAN SCORES



Observation Based on Scoring System:

SCORE 1: Achieved predominantly in the coronal region with 17% EDTA, indicating tubules were completely opened.

SCORE 2: Seen in both irrigants in the apical region, reflecting partial removal of the smear layer and limited tubule exposure.

SCORE 3 and 4: Not strongly observed, as most regions showed tubule exposure to varying degrees.

In conclusion, 17% EDTA proved superior to 20% Herbal Turmeric extract in the coronal and overall regions, achieving greater smear layer removal and tubule exposure. Both irrigants performed similarly in the apical region, reflecting the challenges of effective cleaning in this anatomically narrow area.

DISCUSSION

The results of this study highlight the potential of turmeric extract as a novel alternative to EDTA for smear layer removal in endodontic treatments. While EDTA demonstrated higher efficacy in the coronal and middle thirds of the root canal system, turmeric extract exhibited comparable results in the apical third, a critical zone often associated with persistent debris and microbial contamination. These findings are significant as they demonstrate that turmeric, a natural agent, can achieve similar outcomes in areas traditionally challenging to clean.

The chelating properties of curcumin, the active component of turmeric, play a crucial role in its performance. *Curcumin's* ability to bind with calcium ions facilitates the dissolution of inorganic debris, effectively exposing dentinal tubules. Additionally, turmeric's inherent anti-inflammatory and antimicrobial properties may offer an added advantage by reducing the risk of postoperative complications and reinfection. Unlike EDTA, which has been associated with dentinal erosion and cytotoxic effects, turmeric offers a more biocompatible profile, potentially making it safer for long-term clinical use.

Despite these promising results, there are limitations to consider. The study's ex-vivo nature limits its ability to simulate the complexities of the oral environment, such as variations in pH, fluid dynamics, and microbial biofilms. Further in-vivo research is essential to confirm these findings and evaluate the long-term implications of turmeric's use in endodontics.

This study underscores the importance of integrating traditional herbal remedies into modern dental practices. The ability of turmeric to serve as a natural alternative aligns with the growing emphasis on biocompatibility and sustainability in healthcare.

CONCLUSION

This study highlights turmeric extract as a promising alternative to EDTA for smear layer removal, demonstrating comparable efficacy, particularly in the apical third of the root canal. Turmeric's chelating, anti-inflammatory, and antimicrobial properties, along with its superior biocompatibility, make it an attractive choice for safer and more natural endodontic treatments. While EDTA remains a dependable standard, turmeric offers a viable option for clinicians aiming to reduce the adverse effects of chemical agents. However, a noted drawback of turmeric is its tendency to discolor dental tissues, which can be a significant concern, especially in anterior teeth.

To address this issue, additional steps may be necessary when using turmeric solutions in aesthetic regions. This includes thorough rinsing with alternative irrigants, such as saline or chlorhexidine, following turmeric irrigation to minimize surface staining. Application of whitening agents or polishing techniques may also be explored to restore the natural appearance of the tooth. Future clinical studies should not only validate turmeric’s efficacy as an irrigant but also investigate protocols to counteract its staining potential, ensuring it can be effectively integrated into treatments involving anterior teeth. The successful incorporation of turmeric into endodontic practice could revolutionize care, aligning it with holistic, sustainable, and patient-friendly approaches.

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