

Bromelain : A new promise to remove smear layer : A Review

Dr. Suyog Jadhav¹, Dr. Pratiksha Gaikwad^{2*}, Dr. Priyanka Mantri³, Dr. Aarti Pathak⁴, Dr. Nisha C. Salvi⁵

¹ Assistant Professor (MDS), Department of Conservative Dentistry and Endodontics, Government Dental College and Hospital, Jalgaon. Email: suyogjadhav768@gmail.com

² Assistant Professor (MDS), Department of Periodontology and Oral Implantology, Saraswati Dhanwantari Dental College and Hospital, Parbhani. Email: pratikshagaikwad2112@gmail.com

³ Assistant Professor (MDS), Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College and Hospital, Jalgaon. Email: priyanka.mantri9@gmail.com

⁴ Dental Surgeon, Government Dental College and Hospital, Chhatrapati Sambhajinagar. Email: aartiwangikar09@gmail.com

⁵ Assistant Professor (MDS), Department of Periodontology and Oral Implantology, Government Dental College and Hospital, Jalgaon. Email: nishasalvi291@gmail.com

*Corresponding Author: Dr. Pratiksha Dayanand Gaikwad, Assistant Professor (MDS), Department of Periodontology and Oral Implantology, Saraswati Dhanwantari Dental College and Hospital, Parbhani. Email: pratikshagaikwad2112@gmail.com

Abstract

The success of endodontic treatment depends on effective elimination of micro-organisms and their by-products from the root canal system. Although calcium hydroxide remains the most commonly used intracanal medicament, its limitations against resistant microorganisms such as *Enterococcus faecalis* have prompted the search for alternative therapeutic agents. Bromelain derived from pineapple (*Ananas comosus*) is a proteolytic enzyme complex, has gained attention in dentistry due to its anti-inflammatory, antimicrobial, antioxidant, and tissue-debriding properties. Many newer studies have explored its potential application as an intracanal medicament in endodontics. This review discusses the composition, mechanism of action, biological properties, advantages, limitations, and current evidence regarding the use of bromelain as an intracanal medicament.

Keywords: Bromelain, intracanal medicament, *Enterococcus faecalis*, herbal medicaments, endodontics, root canal therapy.

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Introduction

The main goal of root canal treatment is the elimination of microorganisms and prevention of reinfection within the root canal system. Mechanical instrumentation alone cannot completely eradicate microorganisms because of the complex anatomy of root canals. Henceforth, intracanal medicaments are placed between appointments to intensify disinfection.

Because of its antibacterial activity and ability to induce hard tissue formation, calcium hydroxide has long been considered the gold standard intracanal medicament⁷. However, its efficacy is limited against certain resistant bacterial species, like *Enterococcus faecalis* and *Candida albicans*. Consequently, interest has grown in natural and plant-derived products with antimicrobial and anti-inflammatory properties⁹.

Bromelain, extracted from the stem and fruit of pineapple (*Ananas comosus*), is a mixture of cysteine proteases and non-proteolytic components¹⁵. It has been widely used in medicine for tissue debridement, wound healing, and inflammation control⁹. Its biological activities have led researchers to investigate its role in endodontic disinfection and intracanal medication⁵.

Bromelain: Source and Composition

Bromelain is a proteolytic enzyme complex obtained mainly from the stem and fruit of pineapple (*Ananas comosus*)^{12,13,15}. It contains:

- Peroxidases
- Cysteine proteases
- Glycoproteins
- Phosphatases

- Cellulases
- Carbohydrates

This enzyme exhibits proteolytic activity over a broad pH range and remains biologically active in various physiological environments¹.

Mechanism of Action

Antimicrobial Activity

Bromelain exerts antimicrobial effects through:

- Degradation of bacterial cell wall proteins.
- Disruption of biofilm architecture.
- Inhibition of bacterial adhesion to dentinal surfaces.
- Enhanced penetration into infected tissues due to its proteolytic activity.

Biofilms may cause persistent endodontic infections. By degrading extracellular protein matrices, bromelain may facilitate biofilm disruption and improve microbial elimination^{1,15}.

Anti-inflammatory Action

Bromelain modulates inflammation by:

- Reducing pro-inflammatory cytokines.
- Inhibiting bradykinin production.
- Decreasing edema and tissue swelling.
- Modulating immune responses.

These properties may help reduce postoperative pain and periapical inflammation following endodontic treatment¹⁻⁴.

Tissue-Debridement Effect

Bromelain has proteolytic enzymes that digest necrotic tissue remnants and organic debris¹⁰. This action may contribute to improved canal cleanliness and facilitate disinfection of inaccessible areas¹⁰.

Antioxidant Activity

Bromelain has free radical scavenging activity, reducing oxidative stress and potentially supporting tissue repair processes^{4,11}.

Rationale for Use as an Intracanal Medicament

An ideal intracanal medicament should:

- Be biocompatible
- Possess broad-spectrum antimicrobial activity.
- Eliminate biofilms.
- Promote healing.
- minimal toxicity.

Bromelain exhibits many of these properties:

Desired Property	Bromelain
Antimicrobial activity	Present
Biofilm disruption	Present
Anti-inflammatory effect	Present
Biocompatibility	Favourable
Tissue dissolution	Moderate
Natural origin	Yes

Because of all these properties bromelain may serve as a promising alternative or adjunct to conventional intracanal medicaments¹.

Antimicrobial Efficacy Against Endodontic Pathogens

Enterococcus faecalis

E. faecalis is frequently associated with failed root canal treatments and persistent apical periodontitis^{6,8,11}.

Studies have demonstrated that bromelain can inhibit the growth of *E. faecalis* through:

- Proteolytic degradation of cellular proteins.
- Biofilm disruption.
- Reduction in bacterial adhesion.

Some of the in-vitro investigations have reported antimicrobial activity comparable to conventional medicaments at specific concentrations.

Candida albicans

The antifungal effects of bromelain have also been investigated. Bromelain may reduce fungal colonization within root canals by degrading fungal cell surface proteins and extracellular matrices¹¹.

Effect on Biofilm Removal

Biofilms protect microorganisms from irrigants and medicaments. Proteolytic activity of bromelain enables degradation of biofilm extracellular polymeric substances¹⁴.

Potential benefits include:

- Improved irrigant penetration.

- Enhanced bacterial exposure.
- Reduced microbial resistance.
- Better canal disinfection.

This characteristic is particularly relevant in persistent endodontic infections⁶.

Biocompatibility

An intracanal medicament should be non-toxic to periapical tissues.

Research indicates that bromelain demonstrates:

- Low cytotoxicity.
- Favourable tissue compatibility.
- Reduced inflammatory reactions.

Long history of medical use and Its natural origin support its safety profile, although further clinical studies are necessary².

Comparison with Calcium Hydroxide

Parameter	Bromelain	Calcium Hydroxide
Antimicrobial action	Good	Good
Activity against <i>E. faecalis</i>	Promising	Limited
Anti-inflammatory effect	Strong	Moderate
Biofilm disruption	Effective	Limited
Tissue dissolution	Moderate	Minimal
Natural origin	Yes	No
Clinical evidence	Limited	Extensive

While calcium hydroxide remains the standard medicament, bromelain also offers potential advantages in biofilm disruption and anti-inflammatory activity.

Advantages of Bromelain

1. Natural and biodegradable.
2. Broad-spectrum antimicrobial activity.
3. Effective biofilm disruption.
4. Anti-inflammatory effects.
5. Favourable biocompatibility.

6. Low Potential postoperative discomfort.
7. Minimal risk of antimicrobial resistance.

Limitations

Despite its advantages, bromelain has several limitations:

- Limited clinical evidence.
- Lack of standardised concentration and formulation.
- Enzyme instability during storage.
- Variable extraction and purification methods.
- Need for long-term safety evaluation.

Further laboratory and clinical research is required before routine clinical use can be recommended.

Future Perspectives

Future investigations should focus on:

- Standardise bromelain formulations.
- Evaluate optimal concentrations.
- Assess substantivity within dentinal tubules.
- Compare efficacy with calcium hydroxide and chlorhexidine.
- Conduct randomised clinical trials.
- Explore combinations with other herbal and nanoparticle-based medicaments.

Nanotechnology-based delivery systems may further enhance the antimicrobial effectiveness and stability of bromelain within the root canal environment.

Conclusion

While thinking about promising natural proteolytic enzyme with antimicrobial, anti-inflammatory, and biofilm-disrupting properties that make it a potential intracanal medicament in endodontics bromelain is a valuable alternative. Preliminary evidence suggests effectiveness against resistant microorganisms such as *Enterococcus faecalis* and possible advantages over conventional medicaments in biofilm management. However, current evidence is largely limited to in vitro studies, and further clinical

investigations are necessary to establish its efficacy, safety, and optimal application protocols. In future endodontic practice bromelain may emerge as a valuable adjunct or alternative intracanal medicament.

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