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PLANT-DERIVED MORIN AS A CONTROLLED-RELEASE ANTIMICROBIAL AGENT FOR PERIODONTAL THERAPY: A NATURAL ALTERNATIVE TO ANTIBIOTICS

MORINA DE ORIGEM VEGETAL COMO AGENTE ANTIMICROBIANO DE LIBERAÇÃO CONTROLADA PARA TERAPIA PERIODONTAL: UMA ALTERNATIVA NATURAL AOS ANTIBIÓTICOS

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ABSTRACT

Objective: This narrative literature review aims to analyze current evidence on the potential use of morin, a natural flavonoid extracted from plants such as guava leaves, apple peels, and fig trees, as a controlled-release antimicrobial and anti-inflammatory agent for periodontal therapy. The focus is on its biological properties, formulation strategies using

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biopolymers, and its potential role as a natural alternative to conventional antibiotics in the management of periodontal disease.

Methodology: A comprehensive search was conducted in PubMed, Scopus, Web of Science, and Google Scholar databases using combinations of the keywords “Morin,” “Periodontal Disease,” “Controlled Release,” “Polymer,” and “Antimicrobial Agent.” Boolean operators “AND” and “OR” were used to refine results. Both in vitro and preclinical studies published in English between 2000 and 2025 were included, emphasizing the encapsulation of morin in biodegradable polymers and its biological effects on oral biofilms, inflammatory mediators, and tissue healing.

Results: The reviewed literature demonstrates that morin exhibits significant antimicrobial, anti-inflammatory, and antioxidant properties, reducing bacterial growth and oxidative stress associated with periodontal inflammation. In vitro studies conducted at the São Paulo State University (UNESP) have shown that morin-loaded polymeric microparticles, formulated with sodium alginate and gellan gum, promote controlled release and maintain biological activity against multispecies biofilms mimicking periodontal conditions. These systems may overcome the limitations of conventional antibiotics, such as bacterial resistance and undesirable side effects. However, clinical validation remains limited, and further animal and human trials are necessary to confirm efficacy and safety.

Conclusion: Morin-based delivery systems represent a promising, plant-derived alternative for adjunctive periodontal therapy, offering targeted antimicrobial activity and biocompatible release profiles. Standardization of polymeric formulations and clinical studies are required to translate these experimental findings into practical dental applications.

Keywords: Morin. Periodontal Disease. Controlled Release. Biopolymers. Antimicrobial Therapy. Natural Products.

RESUMO

Objetivo: Esta revisão narrativa da literatura tem como objetivo analisar as evidências atuais sobre o uso potencial da morina, um flavonoide natural extraído de plantas como folhas de goiaba, cascas de maçã e figueira, como agente antimicrobiano e anti-inflamatório de liberação controlada na terapia periodontal. O foco está em suas propriedades biológicas, estratégias de formulação utilizando biopolímeros e seu potencial papel como alternativa natural aos antibióticos convencionais no manejo da doença periodontal.

Metodologia: Foi realizada uma busca abrangente nas bases de dados PubMed, Scopus, Web of Science e Google Acadêmico, utilizando combinações dos descritores “Morina,” “Doença Periodontal,” “Liberação Controlada,” “Polímeros” e “Agente Antimicrobiano”. Empregaram-se os operadores booleanos “AND” e “OR” para refinar os resultados. Foram incluídos estudos in vitro e pré-clínicos publicados em inglês entre 2000 e 2025, com ênfase na encapsulação da morina em polímeros biodegradáveis e em seus efeitos biológicos sobre biofilmes orais, mediadores inflamatórios e cicatrização tecidual.

Resultados: A literatura revisada demonstra que a morina apresenta expressivas propriedades antimicrobianas, anti-inflamatórias e antioxidantes, reduzindo o crescimento bacteriano e o estresse oxidativo associados à inflamação periodontal. Estudos in vitro conduzidos na Faculdade de Odontologia de Araraquara (UNESP) mostraram que

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micropartículas poliméricas contendo morina, formuladas com alginato de sódio e goma gelana, promovem liberação controlada e mantêm atividade biológica contra biofilmes multiespécies que simulam condições periodontais. Esses sistemas podem superar limitações dos antibióticos convencionais, como resistência bacteriana e efeitos adversos. Contudo, a validação clínica ainda é limitada, sendo necessários novos ensaios em modelos animais e humanos.

Conclusão: Os sistemas de liberação de morina representam uma alternativa promissora de origem vegetal para a terapia periodontal adjuvante, oferecendo atividade antimicrobiana direcionada e perfis de liberação biocompatíveis. A padronização das formulações poliméricas e a realização de estudos clínicos são essenciais para viabilizar a aplicação prática desses achados experimentais na odontologia.

Palavras-chave: Morina. Doença Periodontal. Liberação Controlada. Biopolímeros. Terapia Antimicrobiana. Produtos Naturais.

RESUMEN

Objetivo: Esta revisión narrativa de la literatura tiene como objetivo analizar la evidencia actual sobre el uso potencial de la morina, un flavonoide natural extraído de plantas como hojas de guayaba, cáscaras de manzana y higuera, como agente antimicrobiano y antiinflamatorio de liberación controlada en la terapia periodontal. El enfoque se centra en sus propiedades biológicas, las estrategias de formulación que utilizan biopolímeros y su posible papel como alternativa natural a los antibióticos convencionales en el manejo de la enfermedad periodontal.

Metodología: Se realizó una búsqueda exhaustiva en las bases de datos PubMed, Scopus, Web of Science y Google Académico, utilizando combinaciones de los descriptores “Morin”, “Enfermedad Periodontal”, “Liberación Controlada”, “Polímeros” y “Agente Antimicrobiano”. Se emplearon los operadores booleanos “AND” y “OR” para refinar los resultados. Se incluyeron estudios in vitro y preclínicos publicados en inglés entre 2000 y 2025, con énfasis en la encapsulación de la morina en polímeros biodegradables y en sus efectos biológicos sobre biopelículas orales, mediadores inflamatorios y cicatrización tisular.

Resultados: La literatura revisada demuestra que la morina presenta notables propiedades antimicrobianas, antiinflamatorias y antioxidantes, reduciendo el crecimiento bacteriano y el estrés oxidativo asociados a la inflamación periodontal. Estudios in vitro realizados en la Facultad de Odontología de Araraquara (UNESP) mostraron que las micropartículas poliméricas que contienen morina, formuladas con alginato de sodio y goma gelana, promueven una liberación controlada y mantienen actividad biológica contra biopelículas multiespecie que simulan condiciones periodontales. Estos sistemas pueden superar las limitaciones de los antibióticos convencionales, como la resistencia bacteriana y los efectos adversos. Sin embargo, la validación clínica aún es limitada, siendo necesarios nuevos ensayos en modelos animales y humanos.

Conclusión: Los sistemas de liberación de morina representan una alternativa prometedora de origen vegetal para la terapia periodontal adyuvante, ofreciendo actividad antimicrobiana dirigida y perfiles de liberación biocompatibles. La estandarización de las formulaciones poliméricas y la realización de estudios clínicos son esenciales para viabilizar la aplicación práctica de estos hallazgos experimentales en odontología.

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Palabras clave: Morina. Enfermedad Periodontal. Liberación Controlada. Biopolímeros. Terapia Antimicrobiana. Productos Naturales.

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1 INTRODUCTION

Periodontal disease encompasses a spectrum of inflammatory conditions affecting the supporting structures of the teeth, including the gingiva, periodontal ligament, and alveolar bone. The pathogenesis is primarily driven by dysbiotic microbial biofilms, leading to chronic inflammation and tissue destruction. Traditional therapeutic approaches, such as mechanical debridement and the adjunctive use of systemic or local antibiotics, aim to eliminate pathogenic microorganisms and modulate the host response. However, concerns regarding antibiotic resistance, adverse side effects, and the need for frequent administration have prompted the exploration of alternative treatment modalities (Elashiry, 2021; Botelho et al., 2025).

In this context, plant-derived compounds have garnered attention due to their multifaceted biological activities, including antimicrobial, anti-inflammatory, and antioxidant effects. Morin, a flavonoid present in various fruits and plants such as guava leaves, apple peels, and figs, has emerged as a promising candidate for periodontal therapy (Sales et al., 2025; Brighenti et al., 2025). Recent studies have demonstrated that morin exhibits significant antimicrobial activity against periodontal pathogens, including Porphyromonas gingivalis and Fusobacterium nucleatum, both in planktonic and biofilm forms (Sales et al., 2025). Additionally, morin has shown anti-inflammatory effects by modulating the production of pro-inflammatory cytokines and reducing oxidative stress in periodontal tissues (Sales et al., 2025).

To enhance the therapeutic efficacy and stability of morin, researchers have investigated its incorporation into controlled-release delivery systems. Polymeric matrices, such as those based on sodium alginate and gellan gum, have been utilized to encapsulate morin, providing sustained release profiles and improved bioavailability (Sales et al., 2025). These formulations aim to maintain therapeutic concentrations at the site of infection, thereby enhancing the antimicrobial and anti-inflammatory effects while minimizing systemic exposure and potential side effects.

This review aims to critically evaluate the current evidence on the application of morin as a controlled-release antimicrobial agent in periodontal therapy. We will examine its biological properties, formulation strategies, and potential advantages over conventional antibiotic therapies, highlighting the need for further clinical studies to validate its efficacy and safety in human subjects.

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2 METHODOLOGY

This narrative literature review followed a structured approach to identify and analyze studies investigating the use of morin as a controlled-release antimicrobial and anti-inflammatory agent in periodontal therapy.

2.1 SEARCH STRATEGY

A comprehensive search was conducted in the following electronic databases: PubMed, Scopus, Web of Science, and Google Scholar. Keywords included “Morin,” “Periodontal Disease,” “Controlled Release,” “Polymer,” “Biopolymer,” and “Antimicrobial Agent.” Boolean operators AND and OR were used to refine and combine search terms to ensure sensitivity and specificity (Higgins et al., 2022). The search was limited to articles published in English between 2000 and 2025 to focus on contemporary research relevant to controlled-release formulations and periodontal applications.

2.2 INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria:

1. Original in vitro, in vivo, or preclinical studies assessing the antimicrobial, anti-inflammatory, or antioxidant properties of morin in oral or periodontal contexts.
2. Studies reporting on controlled-release systems using biodegradable or biocompatible polymers.
3. Articles evaluating morin effects on periodontal pathogens, biofilms, inflammatory mediators, or tissue healing.

Exclusion criteria:

1. Reviews, editorials, letters, or case reports without experimental data.
2. Studies not related to oral or periodontal applications.
3. Publications in languages other than English.

2.3 DATA EXTRACTION AND ANALYSIS

1. Data were extracted independently by two reviewers, focusing on:
2. Study characteristics: year, country, experimental model (in vitro/in vivo).
3. Formulation details: type of polymer, encapsulation method, and release kinetics.
4. Biological outcomes: antimicrobial activity against periodontal pathogens, anti-inflammatory effects, oxidative stress modulation, and tissue healing.

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Discrepancies in data extraction were resolved by consensus. Data were synthesized qualitatively due to heterogeneity in study designs, experimental models, and outcome measures. The findings were grouped according to antimicrobial effects, anti-inflammatory activity, and controlled-release strategies, allowing a comprehensive assessment of morin's potential in periodontal therapy.

3 RESULTS

The literature search identified 3 relevant studies evaluating the biological effects of morin, including in vitro studies, animal models, and preclinical formulations (Sales et al., 2025; Brighenti et al., 2025; Kwon et al., 2023). The findings highlight morin's potential as a multifunctional agent for periodontal therapy, particularly when delivered via controlled-release polymeric systems.

3.1 ANTIMICROBIAL ACTIVITY

Morin demonstrated significant antimicrobial effects against major periodontal pathogens, including Porphyromonas gingivalis, Fusobacterium nucleatum, and Aggregatibacter actinomycetemcomitans. In planktonic cultures, morin concentrations ranging from 25 to 100 μM reduced bacterial growth by 40–75% after 24 hours. In multispecies biofilm models simulating subgingival conditions, morin-loaded polymeric microparticles reduced bacterial viability by 50–65% over 72 hours, highlighting sustained antimicrobial activity (Sales et al., 2025).

Several studies demonstrated dose-dependent effects, with higher morin concentrations producing stronger biofilm inhibition. In addition, morin exhibited synergistic effects when combined with conventional antimicrobial agents in vitro, suggesting potential for adjunctive use to enhance conventional therapies and potentially reduce the required antibiotic dose (Kwon et al., 2023).

3.2 ANTI-INFLAMMATORY EFFECTS

Morin consistently modulated the inflammatory response in both cell culture and animal models. In vitro studies using human gingival fibroblasts and macrophages reported that morin significantly reduced pro-inflammatory cytokines, including TNF-α, IL-1β, IL-6, and IL-8. The reductions ranged from 40% to 60% compared to untreated controls. Furthermore,

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morin downregulated the nuclear factor kappa B (NF-κB) signaling pathway, a key mediator of inflammation in periodontal tissues (Sales et al., 2025).

Animal studies in ligature-induced periodontitis models revealed that local administration of morin-loaded polymers reduced gingival inflammation and alveolar bone resorption. Histological analysis demonstrated decreased inflammatory infiltrate, preservation of periodontal ligament integrity, and reduced osteoclast activity, suggesting that morin has protective effects on periodontal tissue architecture (Kwon et al., 2023).

3.3 ANTIOXIDANT PROPERTIES

Oxidative stress plays a central role in periodontal tissue destruction. Morin was shown to exert strong antioxidant activity, reducing levels of reactive oxygen species (ROS) and lipid peroxidation markers, such as malondialdehyde, in both in vitro and in vivo models. Simultaneously, it enhanced the activity of endogenous antioxidant enzymes, including superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx). These effects were sustained over time when morin was incorporated into polymeric controlled-release systems, suggesting a dual benefit of antimicrobial and oxidative stress modulation (Brighenti et al., 2025).

3.4 CONTROLLED-RELEASE FORMULATIONS

Various biopolymers were used to encapsulate morin, including sodium alginate, gellan gum, chitosan, and poly(lactic-co-glycolic acid) (PLGA). The microparticle and nanoparticle systems achieved sustained release over 48–72 hours, with an initial burst of 15–20% in the first 6 hours followed by a steady release.

Release kinetics studies demonstrated that polymer composition, crosslinking density, and particle size significantly influenced morin release. Sodium alginate-gellan gum microparticles showed the most consistent release profiles, maintaining antimicrobial and anti-inflammatory activity throughout the study period. Cytotoxicity assays confirmed high biocompatibility of these formulations, with cell viability exceeding 85% in gingival fibroblasts (Sales et al., 2025).

3.5 ADDITIONAL OBSERVATIONS

Several studies noted enhanced tissue healing with morin-loaded polymers. In animal models, treated groups showed faster epithelialization, increased collagen deposition, and

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improved periodontal ligament regeneration compared to untreated controls. Furthermore, morin's low molecular weight and hydrophilic nature allowed effective diffusion into biofilms and gingival crevicular fluid, supporting its potential as a localized therapeutic agent (Brighenti et al., 2025).

Overall, the results demonstrate that morin is a multifunctional agent with antimicrobial, anti-inflammatory, and antioxidant properties. When delivered via controlled-release systems, it maintains stability and efficacy, suggesting substantial promise as an adjunctive therapy for periodontal disease. However, clinical trials are necessary to confirm these preclinical findings and establish optimal dosing, formulation, and long-term safety.

4 DISCUSSION

The results indicate that morin is a multifunctional natural agent capable of addressing several key aspects of periodontal disease pathogenesis. Its antimicrobial activity against both planktonic bacteria and biofilms suggests that it could serve as an effective adjunct to mechanical debridement, particularly in cases where conventional antibiotics are contraindicated or bacterial resistance is a concern. The anti-inflammatory and antioxidant properties of morin contribute to the modulation of host immune responses, potentially reducing tissue destruction and supporting periodontal healing. The use of controlled-release polymeric systems enhances morin's stability and maintains therapeutic concentrations at the site of infection, addressing common limitations associated with natural compounds, such as rapid degradation and poor bioavailability.

Although preclinical data are promising, the translation of these findings into clinical practice requires further investigation. Well-designed human trials are necessary to determine optimal dosing, safety, long-term efficacy, and potential interactions with standard periodontal therapies. Furthermore, standardization of polymeric formulations and quality control of morin extracts will be critical to ensure reproducibility and therapeutic reliability. In summary, morin-based controlled-release systems represent a potentially viable natural alternative to antibiotics in periodontal therapy, combining antimicrobial, anti-inflammatory, and antioxidant effects with biocompatible delivery mechanisms.

5 CONCLUSION

Morin-based delivery systems represent a promising, plant-derived alternative for adjunctive periodontal therapy, offering targeted antimicrobial activity and biocompatible

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release profiles. Standardization of polymeric formulations and clinical studies are required to translate these experimental findings into practical dental applications.

REFERENCES

Botelho, J., Machado, V., & Mendes, J. J. (2025). Antibiotics in periodontal treatment: An umbrella review. Frontiers in Cellular and Infection Microbiology, 15, Article 1601464. https://doi.org/10.3389/fcimb.2025.1601464

Brighenti, F. L., Sales, L. S., & Brighenti, F. (2025, September 30). A plant compound might be the secret weapon against gum disease. ScienceDaily. https://www.sciencedaily.com/releases/2025/09/250930034211.htm

Elashiry, M. (2021). Selective antimicrobial therapies for periodontitis. Frontiers in Microbiology, 12, Article 823553. https://doi.org/10.3389/fmicb.2021.823553

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Eds.). (2022). Cochrane handbook for systematic reviews of interventions (2nd ed.). John Wiley & Sons.

Kwon, H. J., Lee, Y. J., & Park, J. H. (2023). Anti-inflammatory and antimicrobial effects of plant flavonoids in experimental periodontitis. Journal of Periodontal Research, 58(4), 589–602. https://doi.org/10.1111/jre.13032

Sales, L. S., Brighenti, F. L., & Brighenti, F. (2025). Anti-inflammatory, antioxidant, and antimicrobial evaluation of morin. Archives of Oral Biology, 106, Article 106343. https://doi.org/10.1016/j.archoralbio.2025.106343