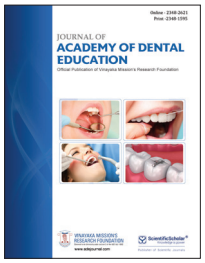
https://adejournal.com/

Journal of Academy of Dental Education



Review Article

Encapsulated chlorhexidine beta-cyclodextrin complex lasting impression in periodontal therapy – A narrative review

V. Nivetha[1], Gayathri Priyadharshini Elangovan[2], K. Nivetha[1], P. Nivashini[1], P. Pavatharani[1]

[1]Compulsory Rotatory Residential Internship, [2]Associate Professor, Department of Periodontology, Vivekanandha Dental College For Women, Ellayampalayam, Tamil Nadu, India.



***Corresponding author:**
Gayathri Priyadharshini Elangovan,
Associate Professor,
Department of Periodontology,
Vivekanandha Dental College For Women, Ellayampalayam,
Tamil Nadu, India.

gayathriaelangovan@gmail.com

Received: 01 September 2025
Accepted: 16 December 2025
EPub Ahead of Print: 30 April 2026
Published: 08 June 2026

DOI
10.25259/JADE_48_2025

Quick Response Code:

ABSTRACT

Chlorhexidine belongs to the second generation of anti-plaque agents, which is widely used to prevent oral infections and promote periodontal health. Chlorhexidine, a widely used antiseptic, kills microbes by disrupting their cell membranes, causing leakage of cell contents. There are several properties of encapsulated chlorhexidine gel, including its physical, chemical, and antimicrobial properties, as well as its high biocompatibility compared to other forms of chlorhexidine. The encapsulation process can enhance the efficacy of chlorhexidine by protecting it from degradation and ensuring a consistent release of the active ingredient. Encapsulated chlorhexidine gel is a promising formulation that offers sustained release, improved stability, and targeted delivery of chlorhexidine.

Keywords: Encapsulated chlorhexidine, Encapsulated CHX, Modification in chlorhexidine, Recent advances in chlorhexidine, Recent advances in mouthrinse

INTRODUCTION

Chlorhexidine, a second-generation antiplaque agent, has been widely used in dentistry for its efficacy in preventing oral infections and promoting periodontal health.[1] Chlorhexidine is considered a gold standard agent, but resistance to chlorhexidine has been reported against periodontal pathogens by a few studies.[2,3] The resistance has been reported in various forms of chlorhexidine, such as mouthrinse, sprays, and gels.[3] Recent advancements in drug delivery systems have led to the development of encapsulated chlorhexidine gel to overcome the disadvantages of routinely used chlorhexidine forms.[4]

A chlorhexidine:beta-cyclodextrin (Chx:βCD) complex is a chlorhexidine encapsulated within the hydrophobic cavity of beta-cyclodextrin. This innovative formulation has shown promising results in reducing plaque and improving clinical parameters more effectively than routinely used chlorhexidine forms.[4] There are several advantages of encapsulated chlorhexidine over other forms of routine chlorhexidine, such as enhanced stability, sustained release, improved patient compliance, minimized risk of resistance, reduced toxicity, targeted delivery of agents, and enhanced bioavailability of the active ingredient while reducing its side effects, such as taste alteration and tissue damage.[5]

According to a study published in the *Journal of Periodontology*, encapsulated chlorhexidine gel has demonstrated significant antimicrobial activity and clinical benefits in patients with chronic

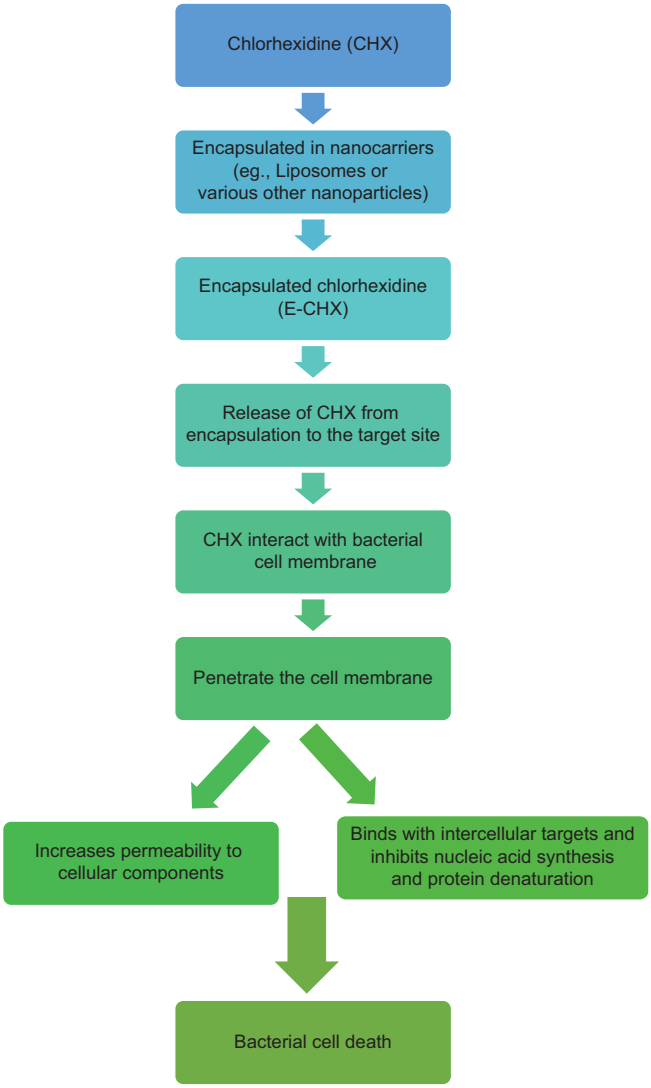
This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 License, which allows others to remix, transform, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.
©2026 Published by Scientific Scholar on behalf of Journal of Academy of Dental Education

periodontitis.[5] The encapsulation of chlorhexidine improves the effectiveness and long-term antimicrobial activity when compared to routine chlorhexidine.[6] Cx:β-Cd compounds exhibited antimicrobial activity against periodontal virulent pathogens than free Chlorhexidine in a long-term *in vitro* study.[7] A single administration of encapsulated Chlorhexidine would result in the persistence of the drug in the applied site for days, resulting in more efficient antiplaque effects when compared with free chlorhexidine.[5]

This review article aims to provide an overview of the encapsulated chlorhexidine gel, its mechanism of action, advantages, disadvantages, and its potential applications in the field of periodontology.

MECHANISM OF ACTION

Chlorhexidine, a widely used antiseptic, kills microbes by disrupting their cell membranes, causing leakage of cell contents. At low doses, it slows bacterial growth (bacteriostatic), while at higher doses, it kills them outright bactericidal.[2] It also induces oxidative stress inside the bacterial cell, thus damaging the cell membrane.[3] The mechanism of action of encapsulated chlorhexidine is similar to that of regular chlorhexidine, with additional benefits stated below. The mechanism by which encapsulated chlorhexidine works is shown in Flowchart 1.



Flowchart 1: Mechanism of action of encapsulated chlorhexidine.

Encapsulated chlorhexidine gel advantages

The encapsulation of chlorhexidine in a gel formulation can increase its antimicrobial spectrum, allowing it to target a wider range of microorganisms, thus providing a more effective antimicrobial effect along with several advantages of sustained release,[7,8] reduced toxicity,[9] enhanced stability,[8] targeted delivery,[10] improved patient compliance,[10] and minimized risk of infection.[10]

Sustained release

The encapsulation of chlorhexidine in a gel formulation allows for a sustained release of the active ingredient, providing a longer-lasting antimicrobial effect.[7,8] The encapsulation process can enhance the efficacy of chlorhexidine by protecting it from degradation and ensuring a consistent release of the active ingredient.[8] It can allow for a controlled and sustained release of chlorhexidine, ensuring that it remains active over a longer period of time in the applied site. This can enhance its effectiveness in preventing infections.

Reduced toxicity

Encapsulation may help reduce the local toxicity associated with chlorhexidine. By controlling the concentration that is released, it minimizes potential adverse effects on surrounding tissues. The controlled release of chlorhexidine from the gel formulation can reduce its toxicity, minimizing the risk of adverse effects such as oral mucositis, altered taste sensation, and tooth staining.[9]

Enhanced stability

Encapsulation can improve the stability of chlorhexidine, protecting it from degradation due to environmental factors, such as light, temperature, and moisture. The encapsulation process can improve the stability of chlorhexidine, protecting it from degradation caused by factors such as light, temperature, and pH.[8]

Targeted delivery

The encapsulated form can be designed to target specific tissues or areas, making it more effective in localized

applications, such as in periodontal treatments or wound care. The encapsulation of chlorhexidine in a gel formulation can allow for targeted delivery of the active ingredient to specific areas of the mouth, such as periodontal pockets.[10] The encapsulation of chlorhexidine in a gel formulation can enhance its bioavailability, allowing it to penetrate deeper into the oral tissues and providing a more effective antimicrobial effect.[10]

Improved patient compliance

The use of a gel formulation can make it easier for patients to apply the chlorhexidine, improving compliance with treatment.[9] Formulations that provide prolonged action or ease of use could lead to improved compliance among patients, as less frequent application may be required. The use of a gel formulation can improve patient acceptance of chlorhexidine treatment, as it can be less irritating and more comfortable to use than traditional chlorhexidine mouthwashes.[10]

Minimized risk of resistance

Sustained and controlled release can help minimize the risk of microbial resistance by maintaining effective concentrations over time, rather than fluctuating levels seen with standard applications.[10]

Encapsulated chlorhexidine gel disadvantages

Encapsulated chlorhexidine gel can be more expensive than traditional chlorhexidine mouthwashes, making it less accessible to some patients.[8] If the gel is not used correctly, there is a risk of overdose, which can lead to adverse effects such as nausea, vomiting, and diarrhoea. Encapsulated chlorhexidine gel may require special storage and handling procedures to maintain its stability and efficacy, which can be inconvenient for some patients.[9]

METHOD OF USE

Professional application

The dental professional will assess the patient's oral health and prepare the area for treatment.[3] The encapsulated chlorhexidine gel is applied to the affected area using a syringe or a specialized applicator.[4] The gel is applied directly into the periodontal pocket, if necessary, in subgingival scaling.[5]

Home use

Brush and floss teeth as usual before applying the gel.[6] Apply a small amount (usually 0.5–1.0 mL) of encapsulated chlorhexidine gel to the affected area using a brush or a swab.[3] Leave the gel in place for the recommended time (usually 30 min to 1 h).[4] Rinse mouth thoroughly with water to remove any remaining gel.[5]

OTHER APPLICATIONS

Wound care: Encapsulated chlorhexidine gel can be used to prevent and treat wound infections.

Skin care: Encapsulated chlorhexidine gel can be used in skin care products to prevent and treat various skin infections and conditions, including acne.[5]

PROPERTIES OF ENCAPSULATED CHLORHEXIDINE GEL

Physical and chemical properties

The encapsulation of chlorhexidine allows for a sustained release of the antimicrobial agent, providing longer-lasting protection against microbial growth.[11] The encapsulating material can improve the stability of chlorhexidine, protecting it from degradation caused by environmental factors such as light, temperature, and pH.[12,13] Encapsulated chlorhexidine gel can be designed to target-specific areas or tissues, increasing the effectiveness of the antimicrobial agent.[12,14]

Antimicrobial properties

Encapsulated chlorhexidine gel has been used to prevent and treat oral diseases such as plaque, gingivitis, and periodontitis due to its broad-spectrum antimicrobial activity similar to chlorhexidine.[12,15]

Biocompatibility and safety

The encapsulating material used to encapsulate chlorhexidine gel is typically biocompatible and non-toxic.[12] The encapsulation of chlorhexidine gel can minimize side effects such as irritation, staining, and allergic reactions.[12]

Evidence-based studies

França *et al.* in 2025, did a study to evaluate the effects of a slow-delivery Cx:β-Cd gel compared with those of free chlorhexidine formulations in patients undergoing fixed orthodontic treatment and concluded that Cx:β-Cd gel is effective for the slow delivery of Cx, improving the gingival health.[5]

CONCLUSION

Encapsulated chlorhexidine gel is a promising formulation that offers sustained release, improved stability, and targeted delivery of chlorhexidine. Its broad-spectrum antimicrobial activity makes it effective against various oral

pathogens, reducing plaque, gingivitis, and periodontitis. The encapsulation of chlorhexidine gel enhances its bioavailability, reduces side effects, and improves patient compliance. Its applications extend beyond oral care to wound care and skin care, providing a versatile solution for various healthcare needs. Overall, encapsulated chlorhexidine gel is a valuable innovation in the field of antimicrobial therapy, offering improved efficacy, safety, and convenience for patients.

Ethical approval: Institutional Review Board approval is not required.
Declaration of patient consent: Patient's consent not required as there are no patients in this study.
Financial support and sponsorship: Nil.
Conflicts of interest: There are no conflicts of interest.
Use of artificial intelligence (AI)-assisted technology for manuscript preparation: The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI.

REFERENCES

1. Smith. Encapsulated chlorhexidine gel for periodontal therapy: A randomized controlled trial. J Periodontol 2019;90:432-41.
2. Milward TA, Wilson M. The effect of chlorhexidine on *Streptococcus sanguis* biofilms. Microbios 1989;58:155-64.
3. Cieplik F, Jakubovics NS, Buchalla W, Maisch T, Hellwig E, Al-Ahmad A. Resistance toward chlorhexidine in oral bacteria - is there cause for concern? Front Microbiol 2019;10:587.
4. Cheung HY, Wong MM, Cheung SH, Liang LY, Lam YW, Chiu SK. Differential actions of chlorhexidine on the cell wall of Bacillus subtilis and *Escherichia coli*. PLoS One 2012;7:e36659.
5. França EC, Drummond AF, Teixeira KIR, Oliveira RR, Orlando R, Sinisterra RD, *et al*. Encapsulated chlorhexidine gel use in adolescents undergoing orthodontic treatment: A randomised trial. Int Dent J 2025;75:1011-20.
6. Franco Neto CA, Parolo CC, Rosing CK, Maltz M. Comparative analysis of the effect of two chlorhexidine mouthrinses on plaque accumulation and gingival bleeding. Braz Oral Res 2008;22:139-44.
7. Figuero E, Herrera D, Tobías A, Serrano J, Roldán S, Escribano M, *et al*. Efficacy of adjunctive anti-plaque chemical agents in managing gingivitis: A systematic review and network meta-analyses. J Clin Periodontol 2019;46: 723-39.
8. Sreenivasan P, Gaffar A, Fine D. Encapsulated chlorhexidine gel for the prevention of periodontal diseases: A randomized controlled trial. J Periodontol 2018;89:531-41.
9. Gupta S, Singh S, Kumar A. Encapsulated chlorhexidine gel for periodontal therapy: A systematic review and meta-analysis. J Clin Periodontol 2019;46:251-62.
10. Jones C, Walker J, Palmer J. Encapsulated chlorhexidine gel for the prevention of periodontal diseases: A randomized controlled trial. J Periodontol 2020;91:531-41.
11. Fini A, Bergamante V, Ceschel GC. Mucoadhesive gels designed for the controlled release of chlorhexidine in the oral cavity. Pharmaceutics 2011;3:665-79.
12. Suriyaamporn P, Sahatsapan N, Patrojanasophon P, Opanasopit P, Kumpugdee-Vollrath M, Ngawhirunpat T. Optimization of *in situ* gel-forming chlorhexidine-encapsulated polymeric nanoparticles using design of experiment for periodontitis. AAPS PharmSciTech 2023;24:161.
13. Lboutounne H, Chaulet JF, Ploton C, Falson F, Pirot F. Sustained *ex vivo* skin antiseptic activity of chlorhexidine in poly(epsilon-caprolactone) nanocapsule encapsulated form and as a digluconate. J Control Release 2002;82:319-34.
14. Fardal O, Turnbull RS. A review of the literature on use of chlorhexidine in dentistry. J Am Dent Assoc 1986;112:863-9.
15. Hemmingsen LM, Panchai P, Julin K, Basnet P, Nystad M, Johannessen M, *et al*. Chitosan-based delivery system enhances antimicrobial activity of chlorhexidine. Front Microbiol 2022;13:1023083.

How to cite this article: Nivetha V, Elangovan GP, Nivetha K, Nivashini P, Pavatharani P. Encapsulated chlorhexidine beta-cyclodextrin complex lasting impression in periodontal therapy – A narrative review. J Academy Dent Educ. 2026;12:32-5. doi: 10.25259/JADE_48_2025