



Antibacterial effects of silver diamine fluoride, potassium iodide and nanosilver fluoride on dual-species biofilm

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<https://doi.org/10.1016/j.jdent.2024.105097> 

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Abstract

Objectives

This study aims to evaluate antibacterial effects of silver diamine fluoride (SDF), SDF/potassium iodide (KI), and nanosilver fluoride (NSF).

Methods

Antimicrobial activity of sterile saline, 5% sodium hypochlorite (NaOCl), 2% chlorhexidine (CHX), SDF, SDF/KI, NSF, and KI solutions against *Streptococcus mutans* and *Lactobacillus casei* was assessed through disc diffusion tests. A dual-species biofilm of *S. mutans*-*L. casei* was formed on 48 enamel samples, divided into six groups ($n = 8$). Group 1 was treated with sterile saline, Group 2 with 5% NaOCl, Group 3 with 2% CHX, Group 4 with SDF, Group 5 with SDF/KI, and Group 6 with NSF. The samples were analysed using confocal laser scanning microscopy (CLSM) and scanning electron microscopy (SEM). Statistical analysis utilized Shapiro-Wilk and Kruskal-Wallis tests and multiple comparisons were conducted using Dunn test.

Results

SDF, SDF/KI, and NaOCl displayed significantly higher antibacterial activity against dual-species biofilm compared to NSF and CHX ($p < 0.050$).

Conclusions

In conclusion, SDF and SDF/KI demonstrated greater antibacterial activity than NSF. SDF's antibacterial activity was unaffected by KI. Further research is needed to determine the appropriate content and concentration for achieving effective antibacterial activity with NSF.

Clinical significance

The use of silver-containing materials is increasing in popularity within pediatric dentistry. In this study, an endeavor has been made to assist pediatric dentists in determining which solution might be more advantageous for preventing caries.

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Introduction

Silver diamine fluoride (SDF) is a caries-arresting agent that was initially introduced in Japan in 1969 [1]. Its chemical formula is $\text{Ag}(\text{NH}_3)_2\text{F}$, and it is an odorless and colorless alkaline ($\text{pH} \approx 10$) solution that resembles water and contains silver, fluoride, and ammonium ions [1,2]. The ammonium ions within the solution function as stabilizers, the silver ions contribute to antimicrobial activity, and fluoride aids in the remineralization process [3]. The clinical application of SDF received approval from the United States Food and Drug Administration (FDA) in 2014 [4]. The American Academy of Pediatric Dentistry (AAPD) recommends its use as an integral component of comprehensive treatment to arrest caries in primary teeth. The World Health Organization (WHO) endorsed the application of SDF to prevent early childhood caries (ECC) in 2017 and subsequently added it to the list of essential medications for both pediatric and adult populations in 2021 [3,5]. The American Dental Association (ADA) has endorsed the use of SDF [6].

The primary disadvantage of SDF is that it induces black discoloration in dental tissues [7]. Several studies have demonstrated that this discoloration effect can be reduced or even prevented by employing SDF in conjunction with potassium iodide (KI). This phenomenon is attributed to the binding of KI to ionized silver, which facilitates the removal of silver ions from the surroundings, and thus preventing discoloration [8]. This interaction results in the formation of silver iodide (AgI), a creamy white precipitate [9]. Some studies have reported that although AgI mitigates the discoloration effect, it may compromise the caries-arresting and antibacterial efficacy of SDF [8]. There are also studies suggesting that it may not be sufficiently effective in preventing discoloration, underscoring the need for further research [9].

Recently, the idea of using materials containing nanosilver particles as an alternative to SDF to potentially reduce the discoloration disadvantage of SDF has emerged. Nanoparticles exhibit antibacterial activity by penetrating the bacterial matrix [10]. Nanosilver fluoride (NSF) solutions formulated for this purpose consist of silver nanoparticles (AgNPs), chitosan, and fluoride compounds, exhibit non-toxic characteristics, and can serve as an effective caries-arresting agents [11]. NSF solutions are yellowish in color and maintain stability for up to three years following production [12]. Furthermore, they display both bactericidal and bacteriostatic properties [13]. The nanoparticles are spherical in shape and have a size of 3.2 ± 1.2 nm, which enhances their contact surface area with bacteria [12]. As the size of AgNPs decreases, their antibacterial activity increases [13]. Notably, nanoparticles larger than 50 nm are unable to penetrate the biofilms, and this penetration ability decreases exponentially with the square of nanoparticle diameter [14].

The aim of this study was to assess and compare the antibacterial effects of SDF, SDF/KI, and NSF solutions against a dual-species biofilm consisting of *Streptococcus mutans* and *Lactobacillus casei*, developed on enamel samples taken from primary molars. Known for its potent antibacterial activity, 2% chlorhexidine (CHX) and 5% of sodium hypochlorite (NaOCl) solutions were included in the study as positive controls.

Section snippets

Null hypothesis

The hypothesis posed that there would be no significant difference in the antibacterial effects between the negative control group treated with sterile saline and the groups treated with SDF, SDF/KI and NSF....

Materials and methods

This *in vitro* experimental study was approved from Clinical Research Ethical Board of Faculty of Dentistry which we are affiliated (No: 2022/21) and funded by Scientific Research Projects Coordination Unit of our affiliated university [Grant number: 38,769]. Signed informed consent forms were obtained from authorized parents to collect non-carious primary molars and saliva sample. The study has been conducted in accordance with the latest version of the Helsinki Declaration.

All experiments...

Disc diffusion test results

Table 2 illustrates the antibacterial effects of sterile saline, 5% NaOCl, 2% CHX, SDF, SDF/KI, NSF, and KI solutions against *S. mutans* ATCC 25,175 and *L. casei* ATCC 4646 strains.

A statistically significant disparity was observed among the medians of inhibition zones against *S. mutans* ATCC 25,175 bacteria as influenced by the various solutions ($p < 0.001$). It was found that SDF and SDF/KI solutions were associated with the most substantial inhibition zones against *S. mutans*, and no...

Discussion

Numerous studies have explored the antibacterial effect of SDF and SDF/KI [8,16,17,18]. However, the number of studies comparing the antibacterial effect of SDF, SDF/KI, and NSF is quite limited in the literature. This study was conducted to address this gap by evaluating and comparing the antibacterial efficacy of these current materials in pediatric dentistry, aiming to contribute to the literature.

Cariogenic bacteria such as *S. mutans*, *S. sobrinus*, and *Lactobacillus*, are present within...

Conclusions

Based on the findings of this study, it can be concluded that SDF and SDF combined with KI exhibit superior antibacterial activity compared to NSF. The combined use of SDF/KI did not significantly affect the antibacterial efficacy of SDF....

CRedit authorship contribution statement

Büşra Karaduran: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sibel Çelik:** Methodology, Data curation. **Merve Yıldırım Üçüncü:** Methodology, Data

curation. **Nursen Topçuoğlu:** Methodology, Data curation. **Mehmet Koray Gök:** Methodology, Data curation. **Mine Koruyucu:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Funding acquisition, Data curation,...

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper....

Financial support

The present study was funded by Scientific Research Projects Coordination Unit of Istanbul University. Project number: 38769....

Ethical approval statement

Approval for this *in vitro* study was obtained from the Clinical Research Ethical Board of Faculty of Dentistry, Istanbul University, İstanbul, Türkiye (No: 2022/21). Signed informed consent forms were obtained from authorized parents to collect non-carious primary molars and saliva sample. The study has been conducted in accordance with the latest version of the Helsinki Declaration....

Acknowledgments

We extend our gratitude to the Scientific Research Projects Coordination Unit of Istanbul University for financial support in conducting this present study....

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References (30)

W.T. Huang *et al.*

[Applications of silver diamine fluoride in management of dental caries](#)

Adv. Dental Biomater. (2019)

I.G. Yan *et al.*

[Ion Concentration of Silver Diamine Fluoride Solutions](#)

Int. Dent. J. (2022)

F.M. Zheng *et al.*

Silver diamine fluoride therapy for dental care

Jpn. Dent. Sci. Rev. (2022)

V.T. Noronha *et al.*

Silver nanoparticles in dentistry

Dent. Mater. (2017)

A. Kurt *et al.*

Effect of different polishing techniques for composite resin materials on surface properties and bacterial biofilm formation

J. Dent. (2019)

W.K. Seow

Early childhood caries

Pediatr. Clin. North. Am. (2018)

A.C.MÇ Reis *et al.*

Quantification and gene expression of Lactobacillus casei group species associated with dentinal lesions in early childhood caries

Saudi. Dent. J. (2021)

M. Sayed *et al.*

Effect of silver-containing agents on the ultra-structural morphology of dentinal collagen

Dent. Mater. (2020)

N. Seifo *et al.*

The use of silver diamine fluoride (SDF) in dental practice

Br. Dent. J. (2020)

L. Timms *et al.*

Everyone else is using it, so why isn't the UK? Silver diamine fluoride for children and young people

Community Dent. Health. (2020)

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