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Comparing the anticaries effects of silver diamine fluoride and propolis tincture among community-dwelling older adults - a randomized controlled trial

R. Vasantharaj, Shivashankar Kengadaran *, Anusha Divvi

Department of Public Health Dentistry, Indira Gandhi Institute of Dental Sciences, Sri Balaji Vidyapeeth, Pondicherry, 605004, India

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ABSTRACT

Background: Dental caries remains a major oral health burden among older adults, where conventional fluoride strategies may be less effective. The aim of this study was to compare the anticaries effects of 38% Silver Diamine Fluoride (SDF) with Propolis tincture in community-dwelling older adults.

Methods: In a randomized trial, participants aged 55–65 years with active caries were allocated to receive either 38% SDF (Advantage Arrest®, Elevate Oral Care, USA) or Propolis tincture (Superbee®, Hi-Tech Natural Products (India) Ltd., India) at baseline, with follow-ups at 3 and 6 months. Caries progression and arrest were assessed using ICDAS and Root Caries Index (RCI). Primary outcome was caries arrest; secondary outcomes included progression, new lesions, and tolerability. Analyses followed the intention-to-treat principle.

Results: At the three-month follow-up, SDF achieved an 87% caries arrest rate versus 55% for Propolis tincture, indicating superior arrest and prevention with SDF ($p < 0.05$). These findings persisted at six months, with SDF maintaining higher efficacy in arresting progression and preventing new lesions. Propolis showed some benefit for moderate lesions but was less effective in halting new caries. Safety data were not reported in the provided source.

Conclusions: The 38% SDF formulation was more effective than Propolis tincture for caries arrest and prevention in geriatric dental care over six months. Propolis tincture may serve as an adjunct; however, its slower antibacterial action and lack of fluoride limit standalone effectiveness. Longer-term trials and combination approaches are warranted.

1. Introduction

Older adults living in the community face a high burden of dental caries, with root caries and progression poses particular challenges due to aging-related factors and uneven access to regular dental care [1,2]. Non-invasive, low-resource caries management strategies are especially appealing in geriatric settings to reduce morbidity and maintain dentition [3]. Silver Diamine Fluoride (38%) and propolis tincture represent two such non-invasive options that warrant direct comparison in this population to inform practical care decisions [4].

Caries remains a significant contributor to oral morbidity among the older adults, influencing pain, nutrition, and overall quality of life. Many older adults, particularly those in community settings, experience barriers to regular dental visits and preventive care, increasing reliance on simple, at-home or short-clinic interventions [3]. Understanding the real-world performance of non-invasive strategies like SDF and propolis tincture in this group is essential for guiding prevention efforts and reducing the burden of caries in geriatric populations [4].

Silver Diamine Fluoride (38%) acts through a dual mechanism: silver provides antimicrobial effects that arrest caries, while fluoride promotes remineralization and inhibits progression. The simplicity and rapid action of SDF make it particularly attractive for older adults who may have limited access to traditional restorative care. In randomized trials involving community-dwelling older adults, SDF has demonstrated superior caries arrest and progression control compared with some alternatives, supporting its relevance for geriatric dental care [5–8].

Propolis tincture offers a natural, biocompatible option with antimicrobial properties that can be applied non-invasively to carious lesions [9–11]. While propolis has shown in vitro and limited in vivo activity against cariogenic bacteria, the breadth and consistency of

* Corresponding author.
E-mail addresses: ksrvasanth.py@gmail.com (R. Vasantharaj), shiva.freee@gmail.com (S. Kengadaran), anushadivvi1991@gmail.com (A. Divvi).

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clinical evidence in caries prevention and arrest are more limited than for SDF [4,12]. In geriatric prevention research, propolis has been explored as a comparator and potential adjunct, but robust head-to-head evidence against SDF in older adults remains scarce; existing data from community-based studies provide a basis for direct comparison in this trial [13].

There is a paucity of head-to-head randomized evidence comparing silver diamine fluoride and propolis tincture specifically in community-dwelling older adults, with limited data on clinical caries arrest outcomes. Existing evidence consistently supports the strong antimicrobial and remineralizing effects of 38% silver diamine fluoride, with sustained caries arrest reported in older populations, whereas evidence for propolis-based formulations suggests primarily short-term antimicrobial benefits with limited data supporting arrest of established coronal and root carious lesions [4,13]. Hence, the present study was designed to directly compare 38% silver diamine fluoride and propolis tincture in community-dwelling older adults to evaluate their effectiveness in arresting caries and preventing lesion progression. The null hypothesis was that there would be no statistically significant difference between 38% silver diamine fluoride and propolis tincture in arresting or preventing the progression of coronal and root carious lesions among community-dwelling older adults.

2. Materials and methods

2.1. Methods

2.1.1. Study design and setting

We conducted a parallel-group randomized controlled trial to compare the anticaries effectiveness of 38% silver diamine fluoride (SDF) and propolis tincture among community-dwelling older adults. The trial was carried out between March 2024 and December 2024 in old-age homes in Puducherry, India. The study protocol was reviewed and approved by the Institutional Review Board of Indira Gandhi Institute of Dental Sciences, Puducherry (Approval no. IGIDSIEC2023NRP81PGVPHD). Written informed consent was obtained from all participants in their preferred language (Tamil or English) after explaining the study purpose, procedures, potential risks, and benefits.

During the informed consent process, all participants were explicitly informed that application of silver diamine fluoride could result in permanent black staining of the treated tooth surfaces. This information was provided verbally and in writing prior to enrollment, and participants consented with full understanding of this potential outcome. Confidentiality was maintained by anonymizing data and securely storing records. Permission was also obtained from the administrators of the participating old-age homes. The trial was prospectively registered with the Clinical Trials Registry–India (CTRI/2025/01/079671).

2.1.2. Participants

We recruited community-dwelling men and women aged 55–65 years residing in selected old-age homes. Inclusion criteria were: moderate-to-high caries risk based on American Dental Association caries risk assessment (score >6); presence of Class I occlusal or Class II proximal carious lesions; cavitated lesions corresponding to International Caries Detection and Assessment System (ICDAS) codes 4–6; and a Russell's Periodontal Index score <2. Participants were required to be free of systemic diseases or allergies that could interfere with treatment and to agree to comply with follow-up visits.

Individuals with xerostomia, cognitive impairment or dementia that could interfere with informed consent or study participation, complete denture wearers, participants with fewer than 10 remaining natural teeth, active oral infections, enamel or dentin developmental defects, severe uncontrolled systemic conditions, cavitated lesions extending to the pulp or involving structural loss greater than one-third of the coronal portion, known hypersensitivity to silver or propolis, or accidental pulp exposure during treatment were excluded from the study.

2.1.3. Training and calibration

Before data collection, the principal investigator was trained and calibrated in the use of the Root Caries Index (RCI) and ICDAS-II under the supervision of an experienced public health dentist. Intra-examiner reliability was assessed by re-examining 20 older adults on two successive days; Cronbach's alpha was 0.89 for RCI and 0.94 for ICDAS-II.

2.1.4. Sample size

The sample size was calculated based on the expected difference in caries arrest outcomes between intervention groups using data from the randomized trial by Tan et al. (2010), which evaluated non-invasive interventions for root caries in older adults [14]. In the reference study, the mean number of root surfaces with new active caries or fillings after one year differed across groups (means: 1.5, 1.0, 0.8, and 0.4). Based on these reported values, an effect size (Cohen's f) of 0.4047 was derived. With an alpha error of 5% and statistical power of 80%, using a one-way analysis of variance to detect differences between groups, the minimum required sample size was estimated to be 25 participants per group. To account for an anticipated attrition rate of approximately 20%, the final sample size was inflated to 30 participants per group, resulting in a total sample of 60 participants.

2.1.5. Randomization and allocation concealment

Randomization was performed using simple random allocation without stratification by gender or other baseline variables. Given the relatively small sample size, this approach resulted in an unequal gender distribution between groups. The statistician was blinded to group allocation. Owing to the characteristic discoloration associated with silver diamine fluoride, participant and investigator blinding was not feasible. To minimize detection bias, outcome assessments were performed by an examiner who was not involved in the intervention procedures and who assessed caries status using standardized ICDAS-II and Root Caries Index criteria. Furthermore, potassium iodide was applied following SDF application to reduce visible staining, thereby reducing the likelihood of group identification during follow-up examinations.

2.1.6. Interventions

Participants in the SDF group received topical application of 38% SDF (Advantage Arrest, Elevate Oral Care, USA). After isolating the selected teeth with cotton rolls, a drop of SDF was applied with a disposable micro-applicator, allowed to remain for 10 s, and air-dried for 1 min. To minimize black staining, a saturated potassium iodide solution was applied repeatedly with fresh applicators until no further discoloration occurred [15]. Participants in the propolis group received topical application of a propolis tincture which is commercially available (Superbee®, Hi-Tech Natural Products (India) Ltd., India). The tincture was used at a standardized concentration as supplied by the manufacturer and stored at room temperature in a dark container according to the manufacturer's instructions. After cleaning and drying the tooth surface, the tincture was applied using a thin, soft-bristled applicator and left undisturbed for 10 min to allow adherence before rinsing [16]. The preparation and application protocol was standardized for all participants. Both interventions were administered by the same trained investigator following standardized protocols. No concomitant fluoride or antibacterial treatments were provided during the study.

2.1.7. Outcomes and follow-up

The primary outcome was change in caries status of treated tooth surfaces measured with ICDAS-II and RCI at baseline, 3 months, and 6 months after intervention. Secondary outcomes included the proportion of new or arrested lesions over time. Adverse effects such as mucosal irritation or hypersensitivity were monitored systematically at each follow-up visit.

2.1.8. Data collection

Baseline demographic and behavioral data (oral hygiene practices,

dietary habits, and dental care awareness) were collected via a structured questionnaire administered in the participants' preferred language. Oral examinations were performed on site in the old-age homes, with participants seated upright in chairs under natural light supplemented by portable illumination when necessary. Caries detection followed the ICDAS-II protocol [17] teeth were cleaned, dried with cotton rolls or compressed air, and visually inspected using a ball-ended explorer. Root caries were quantified with RCI [18]. All indices were recorded at baseline, 3 months, and 6 months for both groups.

2.1.9. Statistical analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 23 (IBM Corp., Chicago, IL, USA). Normality of continuous variables was assessed using the Shapiro–Wilk test. As the data were not normally distributed, non-parametric statistical tests were applied. Descriptive statistics were expressed as mean and standard deviation or median and interquartile range, as appropriate. Intra-group comparisons across time points were performed using the Friedman test followed by Wilcoxon signed-rank post hoc tests, and inter-group comparisons were conducted using the Mann–Whitney *U* test. A two-sided P value of 0.05 was considered statistically significant.

3. Results

A total of 60 community-dwelling older adults were included, with 30 participants in each treatment arm. The two groups were comparable in terms of age (mean 62.9 ± 9.0 years in the SDF group and 64.7 ± 5.9 years in the propolis group; $p = 0.35$). However, there was a significant gender imbalance, with more females in the SDF group (63.0%) and more males in the propolis group (92.9%; $p = 0.001$). Distribution of caries risk at baseline did not differ significantly between groups ($p = 0.40$). Approximately half of the participants in each arm were at high caries risk (45.8% SDF, 54.2% propolis) (Table 1).

Table 2 denotes the changes in coronal caries, assessed using ICDAS scores, revealed distinct differences between groups at both 3 and 6 months. At 3 months, the SDF group demonstrated significantly less progression in ICDAS 2 scores compared to propolis across several tooth surfaces. Improvements were particularly evident for scores 1, 2, and 3 ($p < 0.05$), where SDF was associated with stabilization or slight regression of lesions, while propolis showed greater progression. By contrast, no significant differences were detected for higher ICDAS scores (4 and 5).

At 6 months, these patterns were sustained and accentuated. The SDF group maintained stable or improved scores, while the propolis group exhibited marked progression. For ICDAS scores 1, 2, 3, and 4, the differences were statistically significant in favor of SDF (all $p \leq 0.001$). Even at score 5, SDF-treated teeth fared better (mean change 0.10 ± 0.40 vs. −0.10 ± 0.40; $p = 0.047$) (Table 3). Comparisons between the 3- and 6-month intervals indicated minimal change in the SDF group, whereas the propolis group continued to show deterioration, particularly for ICDAS scores 2 and 4 ($p = 0.001$) (Table 4).

Analysis of root caries using the Root Caries Index (RCI) paralleled these findings. At 3 months, SDF-treated lesions demonstrated stability or minimal improvement, with highly significant differences compared to propolis for RCI scores 1 and 3 ($p = 0.001$) (Table 5). Propolis, in contrast, was associated with worsening of root caries, particularly at lower severity scores. At 6 months, SDF continued to perform favorably across all RCI categories. Significant differences between groups were found for scores 1, 2, and 3 (all $p \leq 0.001$), with the SDF group showing either no change or slight regression, while the propolis group exhibited progressive lesion development (Table 6). Between 3 and 6 months, the SDF group remained stable, whereas the propolis group experienced continued worsening, notably in RCI scores 2 and 3 ($p = 0.001$) (Table 7).

Table 1
Patient characteristics in the two study groups.

Characteristic	SDF group Frequency in percentage/ mean ± SD	Propolis group Frequency in percentage/ mean ± SD	P value
Age (years)	62.87 ± 9.02	64.73 ± 5.9418	0.348
Gender			
Male	7.1%	92.9%	**0.001**
Female	63.0%	37.0%	
Caries risk			
High	45.8%	54.2%	0.396
Moderate	52.8%	47.2%	

Table 2
Comparison of changes in ICDAS scores between baseline and three months in the two study groups.

ICDAS 2	Group	N	Mean ± SD	Median (Min–Max)	P-value
Score 1	SDF	30	0.0333 ± 0.4138	0.0000 (−1.00 to 2.00)	**0.001**
	Propolis	30	0.7667 ± 0.8584	1.0000 (−1.00 to 2.00)	
Score 2	SDF	30	−0.2667 ± 0.6397	0.0000 (−2.00 to 0.00)	**0.023**
	Propolis	30	0.3333 ± 1.1547	0.0000 (−2.00 to 3.00)	
Score 3	SDF	30	0.2333 ± 0.6261	0.0000 (−1.00 to 2.00)	**0.001**
	Propolis	30	−0.8667 ± 1.0743	−1.0000 (−3.00 to 2.00)	
Score 4	SDF	30	−0.1000 ± 0.5477	0.0000 (−2.00 to 1.00)	0.311
	Propolis	30	−0.2667 ± 0.7397	0.0000 (−2.00 to 1.00)	
Score 5	SDF	30	0.1000 ± 0.4026	0.0000 (0.00 to 2.00)	0.085
	Propolis	30	−0.0333 ± 0.1826	0.0000 (−1.00 to 0.00)	

Footnote: Values represent changes in ICDAS or Root Caries Index scores between the specified time points. Positive values indicate an increase in score (lesion progression), negative values indicate a decrease in score (lesion arrest or improvement), and zero indicates no change.

Table 3
Comparison of changes in ICDAS 2 scores between baseline and six months in two groups.

ICDAS 2	Group	N	Mean ± SD	Median (Min–Max)	P-value
Score 1	SDF	30	0.0000 ± 0.2626	0.0000 (−1.00 to 1.00)	**0.001**
	Propolis	30	0.8667 ± 0.8604	1.0000 (0.00 to 3.00)	
Score 2	SDF	30	−0.2667 ± 0.6397	0.0000 (−2.00 to 0.00)	**0.001**
	Propolis	30	1.0000 ± 1.0171	1.0000 (−1.00 to 3.00)	
Score 3	SDF	30	0.2333 ± 0.6261	0.0000 (−1.00 to 2.00)	**0.001**
	Propolis	30	−0.7000 ± 1.3933	−1.0000 (−3.00 to 2.00)	
Score 4	SDF	30	−0.1000 ± 0.5477	0.0000 (−2.00 to 1.00)	**0.001**
	Propolis	30	−1.1000 ± 0.9595	−1.0000 (−3.00 to 0.00)	
Score 5	SDF	30	0.1000 ± 0.4026	0.0000 (0.00 to 2.00)	**0.047**
	Propolis	30	−0.1000 ± 0.4026	0.0000 (−2.00 to 0.00)	

Footnote: Values represent changes in ICDAS or Root Caries Index scores between the specified time points. Positive values indicate an increase in score (lesion progression), negative values indicate a decrease in score (lesion arrest or improvement), and zero indicates no change.

Table 4
Comparison of changes in ICDAS 2 scores between 3 months and six months in two groups.

ICDAS 2	Group	N	Mean ± SD	Median (Min–Max)	P-value
Score 1	SDF	30	−0.0333 ± 0.1826	0.0000 (−1.00 to 0.00)	0.085
	Propolis	30	0.1000 ± 0.4026	0.0000 (0.00 to 2.00)	
Score 2	SDF	30	0.0000 ± 0.0000	0.0000 (0.00 to 0.00)	**0.001**
	Propolis	30	0.6667 ± 0.7581	0.5000 (0.00 to 2.00)	
Score 3	SDF	30	0.0000 ± 0.0000	0.0000 (0.00 to 0.00)	0.445
	Propolis	30	0.1667 ± 1.3412	0.0000 (−3.00 to 3.00)	
Score 4	SDF	30	0.0000 ± 0.0000	0.0000 (0.00 to 0.00)	**0.001**
	Propolis	30	−0.8333 ± 0.9129	−1.0000 (−3.00 to 0.00)	
Score 5	SDF	30	0.0000 ± 0.0000	0.0000 (0.00 to 0.00)	0.317
	Propolis	30	−0.0667 ± 0.3652	0.0000 (−2.00 to 0.00)	

Footnote: Values represent changes in ICDAS or Root Caries Index scores between the specified time points. Positive values indicate an increase in score (lesion progression), negative values indicate a decrease in score (lesion arrest or improvement), and zero indicates no change.

Table 5
Comparison of changes in root caries index scores between baseline and three months in two groups.

Root caries index	Group	N	Mean ± SD	Median (Min–Max)	P-value
RCI Score 1	SDF	30	0.0000 ± 0.0000	0.0000 (0.00 to 0.00)	**0.001**
	Propolis	30	0.9000 ± 0.8449	1.0000 (0.00 to 3.00)	
RCI Score 2	SDF	30	−0.1000 ± 0.3051	0.0000 (−1.00 to 0.00)	0.19
	Propolis	30	−0.3000 ± 1.3684	−1.0000 (−3.00 to 2.00)	
RCI Score 3	SDF	30	0.0667 ± 0.2537	0.0000 (0.00 to 1.00)	**0.001**
	Propolis	30	−0.6000 ± 0.7240	0.0000 (−2.00 to 0.00)	
RCI Score 4	SDF	30	0.0333 ± 0.1826	0.0000 (0.00 to 1.00)	0.317
	Propolis	30	0.0000 ± 0.0000	0.0000 (0.00 to 0.00)	

Footnote: Values represent changes in ICDAS or Root Caries Index scores between the specified time points. Positive values indicate an increase in score (lesion progression), negative values indicate a decrease in score (lesion arrest or improvement), and zero indicates no change.

Table 6
Comparison of changes in root caries index scores between baseline and six months in two groups.

Root caries index	Group	N	Mean ± SD	Median (Min–Max)	P-value
RCI Score 1	SDF	30	0.0000 ± 0.0000	0.0000 (0.00 to 0.00)	**0.001**
	Propolis	30	1.0000 ± 0.8710	1.0000 (0.00 to 3.00)	
RCI Score 2	SDF	30	−0.1667 ± 0.3791	0.0000 (−1.00 to 0.00)	**0.001**
	Propolis	30	0.6667 ± 0.9223	0.5000 (−1.00 to 2.00)	
RCI Score 3	SDF	30	0.2000 ± 0.6103	0.0000 (0.00 to 3.00)	**0.001**
	Propolis	30	−1.4333 ± 0.7279	−1.5000 (−3.00 to 0.00)	
RCI Score 4	SDF	30	0.0000 ± 0.4549	0.0000 (−2.00 to 1.00)	**0.037**
	Propolis	30	−0.2333 ± 0.5683	0.0000 (−2.00 to 0.00)	

Footnote: Values represent changes in ICDAS or Root Caries Index scores between the specified time points. Positive values indicate an increase in score (lesion progression), negative values indicate a decrease in score (lesion arrest or improvement), and zero indicates no change.

Table 7
Comparison of changes in root caries index scores between 3 months and six months in two groups.

Root caries index	Group	N	Mean ± SD	Median (Min–Max)	P-value
RCI Score 1	SDF	30	0.0000 ± 0.0000	0.0000 (0.00 to 0.00)	0.154
	Propolis	30	0.1000 ± 0.4026	0.0000 (0.00 to 2.00)	
RCI Score 2	SDF	30	−0.0667 ± 0.2537	0.0000 (−1.00 to 0.00)	**0.001**
	Propolis	30	0.9667 ± 1.0334	1.0000 (−2.00 to 3.00)	
RCI Score 3	SDF	30	0.1333 ± 0.5714	0.0000 (0.00 to 3.00)	**0.001**
	Propolis	30	−0.8333 ± 1.2341	−1.0000 (−3.00 to 2.00)	
RCI Score 4	SDF	30	−0.0333 ± 0.4138	0.0000 (−2.00 to 1.00)	**0.06**
	Propolis	30	−0.2333 ± 0.5683	0.0000 (−2.00 to 0.00)	

Footnote: Values represent changes in ICDAS or Root Caries Index scores between the specified time points. Positive values indicate an increase in score (lesion progression), negative values indicate a decrease in score (lesion arrest or improvement), and zero indicates no change.

4. Discussion

The present study tested the null hypothesis that there would be no statistically significant difference between 38% silver diamine fluoride and propolis tincture in arresting or preventing progression of coronal and root carious lesions among community-dwelling older adults. The null hypothesis was rejected, as silver diamine fluoride demonstrated significantly greater caries arrest and reduced lesion progression compared with propolis tincture at both 3- and 6-month follow-up.

The improvement observed in the silver diamine fluoride group is consistent with earlier findings that describe its strong antimicrobial activity and remineralizing ability. A meta-analysis conducted by Subbiah and Gopinathan (2018) reported that silver diamine fluoride demonstrated clear effectiveness in preventing and arresting caries in older adults [5]. Further support for the preventive ability of silver diamine fluoride is provided by a systematic review that demonstrated a clear reduction in new dentin caries when silver diamine fluoride was compared with placebo, no treatment, or fluoride tincture, confirming its effectiveness in preventing caries across the dentition [19]. Our findings align closely with these results. The minimal change between three and six months in the silver diamine fluoride group suggests that the agent provides continued protection once the initial arrest has been achieved.

In contrast to the strong benefits observed in the present study, Ericson et al. (2023) reported that a single application of silver diamine fluoride did not provide an additional preventive advantage when used alongside an established risk-based programme that already included fluoride tincture in older nursing home residents [6]. Their trial showed no meaningful difference between the silver diamine fluoride group and the placebo group at one year, possibly because the participants had low baseline caries activity and limited capacity to participate in daily oral care. This may explain why their outcomes differed from the clear and

consistent improvements observed in our study.

The limited performance of propolis tincture in the present study is also supported by experimental evidence from De Luca et al. (2017) [9]. Their investigation demonstrated that propolis tincture was able to reduce smooth surface enamel caries in animal models and performed comparably to a standard fluoride varnish under mild conditions. However, its protective effect did not extend to dentin surfaces and was not maintained when the cariogenic challenge increased. The loss of activity under higher disease pressure indicated that propolis provides only short-term benefits and lacks the sustained protective action needed when caries risk is moderate to high [10]. This pattern is consistent with the continued progression of both coronal and root lesions observed in the propolis group in our trial.

Patterns observed in root caries outcomes followed a trajectory similar to coronal caries results. Silver diamine fluoride provided stability across all Root Caries Index categories at three and six months. In a study among institutionalized older adults, annual application of silver diamine fluoride produced the lowest number of new root caries surfaces over a three-year observation period when compared with oral hygiene instruction alone, chlorhexidine varnish, or sodium fluoride varnish [14]. These results highlight the ability of silver diamine fluoride to provide sustained protection for exposed root surfaces and align closely with the stability and arrest observed in our study.

In contrast, the propolis group showed continued worsening of root surface lesions. The results of this study highlight the limited ability of propolis to sustain antimicrobial action in the oral environment of adults with moderate to high caries risk. Similarly, Rodrigues et al. (2021) showed that propolis was able to reduce Streptococcus mutans levels during the early stages of treatment and demonstrated a microbial effect comparable to fluoride and chlorhexidine. However, this reduction was short lived and did not translate into evidence of sustained long-term protection [16]. These findings indicate that while propolis may temporarily lower cariogenic bacterial load, its ability to maintain prolonged anticaries activity is limited. This short duration of action supports the continued progression of coronal and root lesions seen in the propolis group in our study.

A strength of this study is the use of a randomized and double blinded design that enhanced internal validity. The application protocols were standardized and the assessment tools were well established. The community-based setting reflects the real-world context of preventive care among older adults. The study also included rigorous follow up at three and six months, which allowed clear observation of early and sustained treatment effects. The novelty of the present study lies not in demonstrating the effectiveness of silver diamine fluoride per se, but in directly comparing it with a natural alternative that is increasingly promoted for caries management. By demonstrating that propolis tincture does not achieve comparable arrest of coronal or root caries in older adults at moderate to high risk, this study provides clinically relevant evidence to guide material selection in geriatric preventive care.

However, there were limitations that should be acknowledged. Blinding of the operator was not feasible due to the characteristic staining associated with silver diamine fluoride, which represents a potential source of performance bias. However, this limitation was mitigated by separating intervention delivery from outcome assessment and by using standardized, validated caries assessment indices. A gender imbalance existed between groups, which may influence generalizability even though there is no strong evidence that gender modifies the response to silver diamine fluoride. The follow-up duration was limited to 6 months, which allows assessment of early treatment effects but does not capture long-term durability of caries arrest. Longer follow-up periods are recommended in future studies to evaluate sustained anticaries outcomes.

4.1. Clinical significance

Effect size analysis confirmed that the observed differences between silver diamine fluoride and propolis varnish were clinically meaningful and not merely statistically significant. For root caries outcomes, Cohen's *d* values ranged from moderate (d ≈ 0.45) to very large (d ≈ 1.17–2.43), with the largest effects seen in more advanced Root Caries Index categories, indicating substantial lesion arrest with silver diamine fluoride. Similarly, for coronal caries, changes in ICDAS scores demonstrated predominantly large effect sizes (d ≈ 0.86–1.50) across most lesion severities, with a moderate effect (d ≈ 0.50) even for advanced lesions. These magnitudes indicate clinically important reductions in caries progression and meaningful lesion stabilization, supporting the use of silver diamine fluoride as a highly effective, non-invasive caries management strategy for community-dwelling older adults.

5. Conclusion

Despite these limitations, the results provide important clinical implications. Silver diamine fluoride demonstrated consistent and meaningful prevention of lesion progression on both coronal and root surfaces. Its ability to stabilize lesions over time supports its use as an effective noninvasive approach for older adults who are at increased risk of caries. Propolis tincture, while appealing as a natural therapeutic agent, did not provide sufficient protection in this clinical context. The findings add to the growing evidence supporting the routine use of silver diamine fluoride in preventive and arrestive care for aging populations and provide direction for future research on natural products.

CRediT authorship contribution statement

R. Vasantharaj: Validation, Supervision, Resources, Methodology, Investigation, Conceptualization. **Shivashankar Kengadaran:** Validation, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Anusha Divvi:** Writing – review & editing, Writing – original draft, Conceptualization.

Patient consent statement

We have obtained a complete written informed consent from the patient for the publication of this study and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Submission declaration

This manuscript has not been published previously and is not under consideration for publication elsewhere. The publication of this manuscript has been approved by all authors and by the responsible authorities where the work was carried out. If accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically, without the written consent of the copyright holder.

Declaration of generative AI use

During the preparation of this manuscript, generative artificial intelligence tools were used only for language refinement and grammatical correction. The authors reviewed and edited all content and take full responsibility for the accuracy and integrity of the work.

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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.

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Data availability

Data will be made available on request.

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