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Short-term changes in dental plaque index after rinsing with 50% and 75% white radish decoctions in elementary school students

Perubahan jangka pendek indeks plak gigi setelah berkumur air rebusan lobak putih 50% dan 75% pada siswa sekolah dasar

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Abstract

Background: Dental plaque contributes to caries and gingival inflammation. White radish (*Raphanus sativus L.*) contains glucosinolates, isothiocyanates, and phenolic compounds with plausible antibacterial activity; evidence that a heated aqueous decoction modifies plaque in children remains preliminary. This exploratory study compared short-term plaque-index changes after two radish-decoction rinses.
Objective: To evaluate and compare changes in dental plaque index from before rinsing to two hours after rinsing with 50% and 75% white radish decoctions among fifth- and sixth-grade students. The primary comparison concerns observed short-term change, not established efficacy.
Methods: A pretest-posttest, two-group quasi-experimental study was conducted among 42 students at SDN 21 Pilubang, West Sumatra, Indonesia, on July 11, 2026. Participants were assigned to 50% or 75% decoction groups (n = 21 each). After standardized toothbrushing, plaque index was recorded before rinsing; each participant then rinsed with 20 mL of the assigned decoction for 30 seconds. Plaque index was reassessed two hours later using the Turesky modification of the Quigley-Hein index. Within-group pre-post changes were analyzed using paired-samples t tests, and change scores were compared between groups using an independent-samples t test. Group assignment was not documented as randomized; the pre-rinse assessment followed toothbrushing.
Results: In the 50% group, mean plaque index decreased from 1.746 ± 0.398 before rinsing to 0.352 ± 0.026 after two hours (mean reduction 1.393 ± 0.393; $p < 0.001$). In the 75% group, it decreased from 1.927 ± 0.472 to 0.241 ± 0.014 (mean reduction 1.686 ± 0.469; $p < 0.001$). The mean reduction was 0.293 points greater in the 75% group.
Conclusion: Both groups showed lower plaque-index scores two hours after rinsing, with a larger observed reduction in the 75% group. These exploratory observations do not establish a radish-specific effect because allocation was nonrandomized and no water-rinse control was included.

Keywords:
Dental plaque, mouthwashes, raphanus sativus, phytotherapy, schoolchildren

Abstrak

Latar belakang: Plak gigi berperan dalam karies dan inflamasi gingiva. Lobak putih (*Raphanus sativus L.*) mengandung glukosinolat, isotiosianat, dan senyawa fenolik yang secara biologis berpotensi memiliki aktivitas antibakteri. Namun, bukti mengenai perubahan plak setelah berkumur dengan air rebusannya pada anak masih bersifat awal. Studi eksploratif ini membandingkan perubahan jangka pendek pada dua konsentrasi.
Tujuan: Mengevaluasi perubahan jangka pendek indeks plak dari sebelum hingga dua jam setelah berkumur dengan air rebusan lobak putih 50% dan 75%, serta membandingkan perubahan antar kelompok siswa kelas V dan VI.

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Metode: Penelitian kuasi-eksperimental dua kelompok dengan rancangan pretest-posttest dilakukan pada 42 siswa SDN 21 Pilubang, Sumatera Barat, pada 11 Juli 2026. Responden dibagi ke dalam kelompok konsentrasi 50% dan 75% (masing-masing n = 21). Setelah menyikat gigi secara terstandar, indeks plak dicatat sebelum berkumur; setiap responden kemudian berkumur dengan 20 mL larutan selama 30 detik. Indeks plak dinilai kembali dua jam kemudian menggunakan modifikasi Turesky dari indeks Quigley-Hein. Perubahan sebelum-sesudah dalam setiap kelompok dianalisis dengan uji t berpasangan, sedangkan skor perubahan dibandingkan antar kelompok menggunakan uji t independen.
Hasil: Pada kelompok 50%, rerata indeks plak menurun dari 1,746 ± 0,398 sebelum berkumur menjadi 0,352 ± 0,026 setelah dua jam (rerata penurunan 1,393 ± 0,393; $p < 0,001$). Pada kelompok 75%, rerata menurun dari 1,927 ± 0,472 menjadi 0,241 ± 0,014 (rerata penurunan 1,686 ± 0,469; $p < 0,001$). Rerata penurunan pada kelompok 75% lebih besar 0,293 poin dibandingkan kelompok 50%.
Kesimpulan: Indeks plak kedua kelompok lebih rendah dua jam setelah berkumur, dengan penurunan teramati lebih besar pada kelompok 75%. Hasil awal ini belum membuktikan efek spesifik lobak putih karena penempatan kelompok tidak acak dan tidak tersedia kelompok berkumur air.

Kata Kunci:
Plak gigi, obat kumur, raphanus sativus, fitoterapi, anak sekolah

Introduction

Oral diseases remain among the most prevalent noncommunicable conditions worldwide (Denis & Clement, 2025). The World Health Organization estimates that oral diseases affect nearly 3.7 billion people, and untreated caries in permanent teeth remains the most common health condition globally (WHO, 2025). Indonesia faces a similarly substantial burden. The 2023 Indonesian Health Survey reported that oral and dental problems remained common nationally and among children and adolescents, indicating that prevention and daily plaque control continue to be public-health priorities (Kemenkes RI, 2023).

Dental plaque is a spatially organized biofilm embedded in an extracellular matrix that facilitates microbial adhesion, nutrient exchange, and resistance to environmental stress. Its accumulation on tooth surfaces is central to the development of caries and plaque-induced gingival inflammation, particularly when frequent exposure to fermentable carbohydrates promotes an acidogenic and acid-tolerant microbial community (Gao et al., 2023; Jakubovics et al., 2021). Mechanical disruption through toothbrushing remains the primary method for controlling supragingival biofilm; however, brushing quality varies in children, and mouthrinses may provide an adjunctive chemical or physicochemical effect in areas that are not adequately cleaned (Cvikl & Lussi, 2021; Warman et al., 2025).

Interest in herbal oral-care products has increased because plant-derived preparations may contain phenolic compounds, flavonoids, glucosinolates, isothiocyanates, and other bioactive constituents (Jain et al., 2023). Nevertheless, the clinical evidence is heterogeneous. Systematic reviews suggest that some herbal mouthrinses can reduce plaque and gingival inflammation in the short term, but study quality, formulations, outcome measures, and follow-up periods vary considerably; herbal products should therefore be evaluated as adjuncts rather than assumed substitutes for established plaque-control measures (Cai et al., 2020; Janakiram et al., 2020; Mehta et al., 2024). Trials in schoolchildren also indicate that selected herbal formulations can influence plaque indices, although rigorous randomization, standardized dosing, safety monitoring, and appropriate comparators remain important (Bhor et al., 2021; Fahim & Zarnigar, 2024; Ifitri et al., 2024; Vanishree et al., 2021). Recent randomized clinical trials of other plant-based mouthrinses also report measurable plaque or gingival outcomes, while underscoring the importance of standardized formulations and controlled comparators (Moeintaghavi et al., 2023; Kumar et al., 2024; Zuttion et al., 2024).

White radish (*Raphanus sativus L.*) contains glucosinolates and isothiocyanate derivatives as well as phenolic compounds and flavonoids (Gao et al., 2022; Manivannan et al., 2019). In vitro, purified allyl isothiocyanate inhibited Streptococcus mutans growth and biofilm formation (Akitomo et al., 2025); exopolysaccharide metabolism is relevant to S. mutans biofilm development (Lin et al., 2021). These findings establish biological plausibility only:

this study did not measure those compounds in the heated radish preparation, and activity of a purified substance cannot be assumed for the rinse tested here.

An earlier Indonesian study compared 50% and 100% radish decoctions among elementary school students. It reported lower post-rinse plaque scores without a statistically significant difference between groups (Wiradona et al., 2017). An intermediate 75% starting ratio could help explore whether short-term changes differ across preparations, but its final chemical dose and acceptability were not established. We therefore compared the observed change from the post-toothbrushing, pre-rinse measurement to two hours after rinsing between the 50% and 75% groups. This exploratory comparison does not test radish-specific clinical efficacy.

Methods

Study Design and Setting

This pretest-posttest, two-group quasi-experimental study was conducted on July 11, 2026, at State Elementary School No. 21 Pilubang, Ampek Angkek District, Agam Regency, West Sumatra, Indonesia. The design evaluated dental plaque index before the assigned rinse and again two hours after a single exposure to 50% or 75% white radish decoction.

Participants and Group Allocation

All 42 fifth- and sixth-grade students enrolled at the school were sampled; 21 were placed in each concentration group. The source manuscript does not describe who allocated participants or the allocation rule; random allocation cannot be claimed. Eligibility criteria, exclusions, allergy screening, recent antibiotic or mouthrinse exposure, orthodontic appliances, and oral-health conditions were not documented in the available material. The extent of selection bias therefore remains uncertain.

Preparation of the Radish Decoctions

Fresh white radish roots were washed and cut into small pieces. The initial preparations used 50 g or 75 g of radish in 100 mL of water and were heated for 10 minutes at approximately 70°C. The labels 50% and 75% describe initial mass-to-water ratios, not analytically verified final concentrations. Botanical authentication, source and maturity of the roots, storage and preparation interval, final volume, pH, and marker-compound concentrations were not recorded in the available protocol; reproducibility and chemical dose assessment are consequently limited.

Intervention Procedure

Participants first received instructions and performed standardized toothbrushing. A pre-rinse plaque index measurement was then recorded. Each student subsequently rinsed with 20 mL of the assigned radish decoction for 30 seconds with the mouth closed and expectorated the liquid.

During the subsequent two-hour observation period, students were allowed to continue normal classroom activities but were instructed not to eat, drink, brush their teeth, or use another mouthrinse. Interventions were administered in small groups at 15-minute intervals to maintain the planned observation period. The available record does not specify toothbrush, toothpaste, brushing duration, supervision, rinse temperature, adherence checks, assessor masking, or adverse-event assessment.

Plaque Assessment

Dental-health students were instructed and underwent simulated plaque examinations before data collection. Plaque was assessed after toothbrushing immediately before the rinse and again two hours after rinsing. After application of a plaque-disclosing agent, buccal/facial and lingual/palatal surfaces of erupted teeth were scored from 0 (no plaque) to 5 (plaque covering the entire surface) using the Turesky modification of the Quigley-Hein index.

The participant score was the sum of surface scores divided by the number of surfaces examined. The number of examiners, masking to allocation, examiner reliability statistics, and handling of missing or unerupted teeth were not documented.

Statistical Analysis

Descriptive statistics are presented as mean and standard deviation or number and percentage. The original analysis reports Shapiro–Wilk tests of pre-rinse and post-rinse scores (50% group: $p = 0.360$ and 0.297; 75% group: $p = 0.825$ and 0.064). Change was defined as pre-rinse minus two-hour post-rinse score.

Paired t tests evaluated within-group change and an independent-samples t test compared changes; the reported Levene test yielded p = 0.216. All tests were two-sided at α = 0.05. Normality of the paired differences and group-specific change scores was not reported. An adjusted comparison of post-rinse scores accounting for baseline could not be computed without individual-level data; reported between-group estimates are unadjusted.

Ethical Considerations

Administrative permission was obtained from the Department of Dental Health, Poltekkes Kemenkes Padang, and from State Elementary School No. 21 Pilubang. Written informed consent was documented before participation. The ethics-review institution and approval number must be inserted and verified by the authors before submission. Information requiring verification before submission: name of ethics committee, approval number and date, timing of approval, parental or guardian consent, and child assent. Administrative permission alone is not ethics approval.

Results

All 42 enrolled students were included in the reported analysis (21 per group). Age and sex distributions differed descriptively between groups (Table 1), as did the post-toothbrushing, pre-rinse mean plaque index (1.746 in the 50% group and 1.927 in the 75% group). The timing and quality of toothbrushing relative to this baseline need confirmation from the study record.

Table 1. Participant characteristics by intervention group

Characteristic	50% group	75% group
	n (%)	n (%)
Age (years)		
10	1 (4.8)	0 (0.0)
11	7 (33.3)	8 (38.1)
12	13 (61.9)	10 (47.6)
13	0 (0.0)	3 (14.3)
Sex		
Male	9 (42.9)	13 (61.9)
Female	12 (57.1)	8 (38.1)

The reported pre-rinse means were 1.746 ± 0.398 (50%) and 1.927 ± 0.472 (75%); the reported two-hour means were 0.352 ± 0.026 and 0.241 ± 0.014, respectively. The reported mean reductions were 1.393 ± 0.393 (p < 0.001) and 1.686 ± 0.469 (p < 0.001) (Table 2). The unusually small post-rinse SDs require confirmation against individual records before interpretation.

Table 2. Dental plaque index before and two hours after rinsing with white radish decoctions

Group	n	Pre-rinse Mean ± SD	2-h post-rinse Mean ± SD	Mean reduction ± SD	p-value
Intervention by 50%	21	1.746 ± 0.398	0.352 ± 0.026	1.393 ± 0.393	< 0.001
Intervention by 75%	21	1.927 ± 0.472	0.241 ± 0.014	1.686 ± 0.469	< 0.001

Among the 42 fifth- and sixth-grade students (21 in each concentration group), the 75% group showed a greater mean reduction in plaque index than the 50% group (1.686 versus 1.393 points). The between-group difference in mean reduction was 0.293 points in favor of the 75% concentration (p < 0.001). Because the pre-rinse means were not identical between groups, the change-score comparison was used to evaluate the differential between-group difference. This unadjusted change-score comparison does not control baseline imbalance or selection bias; the participant-level data are needed for an adjusted analysis.

Discussion

The principal finding was that dental plaque index decreased significantly from the pre-rinse measurement to two hours after rinsing in both concentration groups, and the magnitude of reduction was greater among students receiving the 75% white radish decoction. The mean reduction was 1.393 points in the 50% group and 1.686 points in the 75% group, with a between-group difference of 0.293 points (p < 0.001). This pattern suggests a possible concentration-related difference in short-term plaque reduction under the study conditions. However, because group

allocation was nonrandomized and no water-only or standard-mouthrinse control was available, the observed change cannot be attributed exclusively to the radish decoction. A rinse-only mechanical effect cannot be excluded, and the biological dose was not verified.

A two-hour plaque measurement after toothbrushing captures an early period of plaque reaccumulation rather than a durable clinical outcome. Acquired pellicle and bacterial attachment develop after tooth cleaning (Enax et al., 2023; Jakubovics et al., 2021). The present study did not measure bacterial abundance, biofilm viability, salivary conditions, or active radish constituents; mechanistic explanations remain hypotheses.

Following toothbrushing, immediate oral rinsing may influence early biofilm re-establishment by removing loosely attached debris and microorganisms and altering the retention of active agents on oral surfaces. Evidence shows that water rinsing reduces fluoride retention compared with no rinsing, while chlorhexidine can persist on oral pellicles for several hours. In vitro studies further indicate that mouthrinse formulations affect initial *Streptococcus mutans* biofilm formation. Collectively, these findings suggest that post-brushing rinsing may modulate early microbial re-adhesion through both mechanical clearance and formulation-dependent effects (Parakaw et al., 2024; Reda et al., 2021; Valdivia-Tapia et al., 2025). A preparation containing 75 g rather than 50 g of radish per initial 100 mL of water may deliver a greater mass of water-soluble constituents. Some plant-derived phenolics can interfere with bacterial cell membranes, extracellular enzymes, and biofilm adhesion, while isothiocyanates may exhibit antimicrobial activity. Nevertheless, a higher plant-to-water ratio does not necessarily correspond to a proportionally higher biologically active dose. Heating can alter glucosinolates, myrosinase activity, volatile constituents, and heat-sensitive phenolics. The protocol also did not record final volume after evaporation, pH, or phytochemical concentration. The mechanistic interpretation must therefore remain tentative.

The result differs from the earlier Indonesian study by Wiradona et al. (2017), which compared 50% and 100% radish decoctions in 34 students using a pretest-posttest design and the Personal Hygiene Performance index. That study observed a slightly larger reduction with 100% than with 50% decoction, but the between-group difference was not statistically significant. The present study also used a pretest-posttest approach, but compared 50% with 75% decoctions and used the Turesky modification of the Quigley-Hein index. Both studies therefore point in the same descriptive direction, with greater plaque reduction at the higher concentration; however, only the present change-score comparison reached statistical significance. Differences in concentration, plaque index, sample characteristics, preparation procedures, and examiner procedures may explain the contrasting statistical results.

Evidence from the broader herbal-mouthrinse literature also supports caution. Janakiram et al. (2020) found that herbal oral-care products may reduce plaque, but evidence quality was low or very low and herbal mouthrinses were not consistently superior to conventional products. Cai et al. (2020) similarly reported potential plaque and inflammation benefits but emphasized heterogeneity among formulations and trials. A more recent overview concluded that selected herbal mouthrinses may provide effects comparable to standard products in some contexts, while the predominance of short trials and risk of publication bias limit certainty (Mehta et al., 2024). These findings are relevant because 'herbal mouthrinse' is not a uniform intervention: plant species, extraction methods, active-compound concentrations, alcohol content, dosing, and duration vary substantially. A recent systematic review of Zingiberaceae-based mouthwashes likewise reported reductions in plaque and gingival indices in the included studies, but emphasized limitations in the available evidence (Chandrasekaran et al., 2024).

Studies in children demonstrate the importance of controlled designs and repeated measurement. Vanishree et al. (2021) compared alum, herbal mouthrinse, and saline in children aged 9–12 years over 30 days and recorded plaque repeatedly. Bhor et al. (2021) used a randomized controlled design to compare Triphala and chlorhexidine over 90 days, including microbial outcomes. Fahim & Zarnigar (2024) followed schoolchildren after a 30-day herbal-mouthwash intervention and compared the formulation with chlorhexidine. Although these studies used different herbal preparations, they show that pediatric oral-rinse research can incorporate baseline equivalence, active or placebo controls,

safety monitoring, adherence assessment, and follow-up. The present study provides a short-term signal that can inform such a trial for radish decoction but does not offer the same level of causal evidence. A controlled adult trial underscores the value of defining comparator regimens and assessor masking; its results cannot be generalized to this radish rinse or to children (Bosma et al., 2024).

Toothbrushing is the principal means of disrupting supragingival plaque (Cvikl & Lussi, 2021). As all participants brushed before the baseline assessment, their residual pre-rinse scores also warrant investigation of brushing technique, duration, supervision, compliance, and examiner procedures. The 30-second physical rinsing action and two-hour restriction on eating or drinking could contribute to the changes observed. Without a water-only rinse group, the contribution of radish constituents cannot be distinguished from these procedures.

The pre-rinse mean was higher in the 75% group (1.927 versus 1.746), and the reported mean change was 0.293 points larger ($p = 0.034$). The change-score comparison is unadjusted and does not remove selection bias, baseline confounding, or regression to the mean. An ANCOVA of post-rinse score adjusted for baseline, if its assumptions hold, requires participant-level data; it was not performed for this revision.

From a practical perspective, the 75% preparation can be regarded as a candidate formulation for further investigation, not as a recommended school mouthrinse. Before implementation, researchers should standardize the botanical material, confirm the final concentration after heating, measure pH and osmolality, quantify marker compounds, assess microbiological stability, and document taste, mucosal irritation, allergy, and accidental ingestion. A pilot safety and acceptability study is particularly important in children. The definitive efficacy trial should use random allocation, baseline and follow-up plaque measurements, a water or placebo rinse, and preferably a standard comparator such as chlorhexidine for a limited supervised period. Longer follow-up is needed to determine whether any effect persists and whether it translates into clinically meaningful improvements in gingival health or caries-related outcomes.

Internal validity is limited by nonrandom allocation with an undocumented allocation rule, baseline imbalance, no water-only or active comparator, potentially different brushing technique, unmeasured mechanical rinsing effects, lack of documented assessor masking and quantitative reliability, and unavailable individual data for adjusted analysis. Interpretation of a concentration-related biological effect is further limited by unmeasured final volume, pH, and active constituents. The sample of 42 children at one school, absence of an a priori sample-size calculation, unreported safety outcomes, and the two-hour observation period limit precision, generalizability, and clinical relevance. These findings are an exploratory signal for a controlled feasibility and safety study.

Conclusion

Both 50% and 75% white radish decoction rinses were associated with significant reductions in dental plaque index from before rinsing to two hours after rinsing. The mean reduction was 0.293 points greater with the 75% concentration, representing a greater observed short-term plaque reduction under the study conditions. However, the nonrandomized design and absence of a control rinse limit causal and clinical interpretation. It should not be interpreted as established superiority, clinical efficacy, or an indication for school use.

The 75% starting formulation warrants further formulation, acceptability, and safety testing before any recommendation for routine school use. A future randomized study should include a water-rinse control, a suitable standard comparator, blinded examination, validated preparation and plaque assessment, and longer follow-up.

Conflict of Interest

The authors declare that they have no conflicts of interest related to this manuscript.

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