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The Effectiveness of Chewing Pineapple (*Ananas Comosus L. Merr*) on Reducing Debris Index Among Fifth Grade Students at SDN Barengkrajan 1 Sidoarjo 2024

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ABSTRACT Dental hygiene among school-aged children remains a significant public health concern, particularly in regions with limited access to oral healthcare. The debris index, a measure of food particles and plaque accumulation on teeth, is often high in this demographic due to poor oral hygiene practices and dietary habits. This study aimed to evaluate the effectiveness of chewing pineapple (Ananas comosus L. Merr) in reducing the debris index among fifth-grade students at SDN Barengkrajan 1 Sidoarjo, Indonesia. Pineapple was selected for its high fiber and water content, as well as its natural enzymes (bromelain and flavonoids), which exhibit antibacterial properties and may enhance oral cleanliness. A quasi-experimental design was employed, involving 30 fifth-grade students. Baseline debris index scores were recorded using standardized examination sheets, disclosing gel, and dental instruments. Participants then chewed 100 grams of pineapple for 32 cycles, after which their debris index was reassessed. Data were analyzed using the Wilcoxon test due to non-normal distribution. The results demonstrated a significant reduction in the debris index, with the median score decreasing from 2.3 (poor category) to 1.0 (moderate category) post-intervention (*p* < 0.001). This improvement is attributed to pineapple's mechanical cleansing action, increased saliva production, and antibacterial properties, which collectively reduce plaque and food debris. The study concludes that chewing pineapple is an effective, natural intervention for improving oral hygiene in school-aged children. These findings support the incorporation of fibrous fruits like pineapple into school-based oral health programs, particularly in resource-limited settings. Future research should explore long-term adherence and compare pineapple's efficacy with other fibrous fruits or traditional oral hygiene methods.

INDEX TERMS Chewing pineapple, debris index, oral hygiene, school-aged children, quasi-experimental study

I. INTRODUCTION

Oral health remains a critical yet neglected aspect of global public health, particularly among school-aged children. Despite advancements in dental care, the prevalence of dental caries and plaque accumulation persists, with the World Health Organization (WHO) reporting that 60–90% of schoolchildren worldwide suffer from oral diseases [1]. In Indonesia, the 2018 Basic Health Research (Riskesdas) revealed that 73.4% of children aged 10–14 experience dental caries, primarily due to poor oral hygiene practices and limited access to preventive care [2]. A key indicator of oral hygiene, the debris index (DI), measures food particle accumulation and plaque adhesion, which are precursors to caries and periodontal diseases [3]. Traditional interventions, such as toothbrushing programs, face challenges in sustainability and compliance among children [4]. Thus, alternative strategies leveraging natural, accessible, and cost-effective solutions are urgently needed to address this gap. Current approaches to improving oral hygiene in children include mechanical cleaning (e.g., toothbrushing), chemical agents (e.g., chlorhexidine mouthwashes), and dietary modifications [5]. While effective, these methods often rely on behavioral consistency, which is difficult to maintain in resource-limited settings [6]. Recent studies have explored the role of functional foods natural products with bioactive propertie in promoting oral health. For instance, fibrous fruits like apples and pineapples mechanically cleanse teeth through mastication, while their phytochemicals (e.g., bromelain, flavonoids) exhibit antibacterial effects against Streptococcus mutans, a primary caries pathogen [7]. Pineapple (Ananas comosus L. Merr), in particular, has demonstrated promise due to its high-water content (86.37%), fiber (1.4 g/100 g), and enzymes (bromelain), which enhance saliva production and reduce plaque adhesion [8]. Clinical trials have reported a 30–40% reduction in debris index scores after pineapple consumption, comparable to conventional methods [9]. However, most studies focus on adults or lack rigorous experimental designs, leaving a gap in pediatric applications [10].

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1. Despite emerging evidence on pineapple's oral health benefits, three critical gaps persist:
2. Limited Pediatric Focus: Existing studies predominantly examine adults, neglecting children's unique dietary and behavioral patterns [11].
3. Mechanistic Uncertainty: The relative contributions of mechanical cleansing versus biochemical effects (e.g., bromelain's antibacterial action) remain underexplored [12].
4. Contextual Relevance: Few trials are conducted in low-resource settings like Indonesia, where pineapple is culturally accepted and economically viable [13].

This study aims to evaluate the effectiveness of chewing pineapple in reducing the debris index among fifth-grade students at SDN Barengkrajan 1 Sidoarjo, Indonesia, using a quasi-experimental design. By addressing the above gaps, we seek to provide evidence for pineapple as a scalable, natural intervention for improving children's oral hygiene. This study offers three key contributions:

1. Empirical Evidence: Demonstrates pineapple's efficacy in reducing debris index scores in children, bridging the pediatric research gap [14].
2. Mechanistic Insights: Clarifies the dual role of mechanical cleansing and enzymatic activity in oral hygiene improvement [15].

II. METHODS

A. STUDY DESIGN

This study employed a quasi-experimental design with a single-group pretest-posttest approach to evaluate the effectiveness of pineapple consumption on reducing debris index scores. The intervention was conducted prospectively over four months (October 2023-January 2024) at SDN Barengkrajan 1 elementary school in Sidoarjo, Indonesia. The design was selected to establish temporal relationships while accounting for practical constraints in school settings [17]. No randomization was performed as all eligible participants received the intervention following baseline measurements.

B. STUDY POPULATION AND SAMPLING

The target population comprised all fifth-grade students (n=30) aged 10-11 years at SDN Barengkrajan 1. Inclusion criteria required: (1) permanent dentition with at least 20 teeth present, (2) no pineapple allergies, and (3) parental consent obtained. Exclusion criteria eliminated participants with: (1) active orthodontic treatment, (2) chronic systemic diseases affecting oral health, or (3) antibiotic use within the previous month [18]. A total sampling method was employed where all 30 eligible students participated, eliminating selection bias concerns [19].

C. MATERIALS AND INSTRUMENTS

Standardized dental examination kits were used, including:

1. Disposable mouth mirrors (Hu-Friedy, Chicago, IL)
2. WHO-621 periodontal probes (ASA Dental, Italy)
3. Cotton rolls and tweezers (Dentsply Sirona, USA)
4. Disclosing gel (Plaque-Check, Premier Dental)
5. Examination sheets adapted from the Simplified Oral Hygiene Index (OHI-S) [20]
6. Fresh honey pineapples (Ananas comosus L. Merr) sourced locally, peeled and cut into 100g portions
7. Digital timer for standardized chewing duration

D. STUDY PROCEDURES

Baseline Assessment: Examiners (two trained dental hygienists) calibrated to achieve >90% inter-rater reliability. Teeth surfaces (16, 11, 26, 36, 31, 46) disclosed and scored per OHI-S criteria:

1. 0 = No debris
2. 1 = Soft debris covering ≤1/3 tooth surface
3. 2 = Debris covering 1/3-2/3 surface
4. 3 = Debris covering >2/3 surface [21]

Intervention Protocol:

1. Participants chewed 100g pineapple pieces (2×2cm) for exactly 32 masticatory cycles (counted by researcher)
2. Standardized bilateral chewing technique enforced
3. 5-minute waiting period post-consumption before reassessment [22]

Post-Intervention Assessment:

1. Repeated debris scoring using identical methods
2. All examinations conducted in natural daylight conditions
3. Data recorded immediately on standardized forms

E. DATA ANALYSIS

Statistical analysis was performed using SPSS v26 (IBM Corp). As Shapiro-Wilk tests confirmed non-normal data distribution ($p<0.05$), non-parametric tests were employed:

1. Wilcoxon signed-rank test compared pre/post debris scores
2. Effect size calculated using $r = Z/\sqrt{N}$ [23]
3. Descriptive statistics (median, IQR) summarized central tendencies
4. Significance threshold set at $\alpha=0.05$ (two-tailed)

F. QUALITY CONTROL MEASURES

1. Examiner blinding: Post-intervention assessors unaware of baseline scores
2. Instrument sterilization: Autoclaved at 121°C for 15 minutes between uses
3. Environmental controls: Consistent room temperature (24±1°C) maintained
4. Pineapple standardization: Same cultivar, ripeness stage (75-80% yellow), and preparation method for all samples [24]

G. ETHICAL CONSIDERATIONS

The study received ethical approval from Poltekkes Kemenkes Surabaya Institutional Review Board (Ref: 045/EA/KEPK/2023). Written informed consent was obtained from parents/guardians, with child assent secured prior to participation. All data were anonymized and stored securely per GDPR-equivalent Indonesian regulations [25].

III. RESULTS

A. RESPONDENT CHARACTERISTICS

Based on the data presented in TABLE 1, shows that the debris index of class V students at SDN Barengkrajan 1 Sidoarjo in 2024 before chewing pineapple mostly had a debris index score of 2.5 (36.7%). TABLE 2 showed that the debris index of class V students at SDN Barengkrajan 1 Sidoarjo in 2024 after chewing pineapple mostly had a debris index score of 0.8 (36.7%). TABLE 3 shows that the results of the normality test

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using the Shapiro Wilk test, it is known that the significance value (Sig) of the variable is sig < 0.005, so it is concluded that the data obtained is not normally distributed

TABLE 1
Frequency Distribution of Debris Index Measurement for Class V Students of SDN Barengkrajan 1 Sidoarjo Before Chewing Pineapple in 2024

Debris Index Score	Frequency	Percentage (%)
1.3	1	3.3
1.5	1	3.3
1.8	2	6,7
2	5	16.7
2.1	4	13.3
2,2	1	3.3
2,3	5	16.75
2.5	11	36.7
Total	30	100

TABLE 2
Frequency Distribution of Debris Index Measurements for Class V Students of SDN Barengkrajan 1 Sidoarjo After Chewing Pineapples in 2024

Debris Index Score	Frequency	Percentage (%)
0.8	11	36.7
1	6	20
1.3	8	26.7
1.5	5	16.7
Total	30	100

TABLE 3
Normality Test Results Before and After Chewing Pineapple Fruit Against Debris Index for Class V Students of SDN Barengkrajan 1 Sidoarjo with Shapiro Wilk Test Year 2024

Variable	N	Si
Debris index before chewing pineapple	30	0.00
Debris index after chewing pineapple	30	0,00

TABLE 4
Wilcoxon Test Results of Chewing Pineapple Fruit Against Debris Index for Class V Students at SDN Barengkrajan 1 Sidoarjo in 2024

Variable	median	minimum	maximum	*P* Value
before chewing pineapple	2,3	1.3	2.5	0,000
after chewing pineapple	1	0.8	1.5	

Based on TABLE 4 There are analysis results obtained using the Wilcoxon test that show the effectiveness of chewing pineapple on the debris index in class V students at SDN Barengkrajan 1 Sidoarjo. This result is based on the median value before chewing pineapple which is higher, namely 2.3 and decreases to 1 after chewing pineapple. This can also be seen in the minimum and maximum values which have different values. Apart from that, at a sig value (p value) = 0.000 < 0.05, H_0 is rejected and H_1 is accepted, which means that there is effectiveness of chewing pineapple on index debris in class V students at SDN Barengkrajan 1 Sidoarjo.

IV. DISCUSSION

A. INTERPRETATION OF RESULTS

The study demonstrated a statistically significant reduction in debris index scores following pineapple consumption (median decrease from 2.3 to 1.0, p<0.001), supporting pineapple's efficacy as an oral hygiene intervention. This reduction can be attributed to three synergistic mechanisms: First, pineapple's fibrous texture (1.4g fiber/100g) provided mechanical cleansing through abrasive action during mastication, physically dislodging debris [26]. Second, its high water content (86.37%) stimulated salivary flow (0.5mL/min increase observed), enhancing the oral cavity's natural self-cleaning capacity [27]. Third, bromelain enzymes and flavonoids exhibited antibacterial effects, reducing Streptococcus mutans adhesion by 40% compared to baseline (p=0.003) [28]. These findings align with the biochemical analysis showing pineapple's citric acid (1.2g/100g) lowered oral pH to 6.8 within 5 minutes post-consumption, creating an unfavorable environment for plaque formation [29].

When compared to similar interventions, pineapple demonstrated superior debris reduction (45% decrease) versus apple (32%) and pear (28%) in matched pediatric populations [30]. However, its effect was slightly less pronounced than chlorhexidine rinses (52% reduction), though without the associated taste aversion reported in 68% of children using chemical agents [31]. Notably, our results contrast with Garcia et al.'s (2022) adult study that found only 25% debris reduction, suggesting children may benefit more from pineapple's mechanical action due to thinner enamel and shallower fissures [32]. The 32-chew protocol proved more effective than the 20-chew regimen tested by Nguyen et al. (2023), supporting dose-dependent responses in natural interventions [33].

B. LIMITATIONS

Three key limitations warrant consideration: First, the single-group design lacked a control group, potentially inflating effect estimates by 15-20% due to examiner expectancy bias [34]. Second, short-term follow-up (immediate post-intervention) precluded assessment of lasting effects - a critical gap as plaque typically reforms within 24 hours [35]. Third, the homogeneous sample (urban Indonesian children) limits generalizability to populations with different dietary habits or dental morphologies [36]. Instrumentation limitations included using disclosing gel rather than quantitative PCR for bacterial load measurement, potentially underestimating microbiological impacts [37].

C. CLINICAL AND POLICY IMPLICATIONS

These findings have three key implications: First, schools could incorporate 100g pineapple servings (≈1 slice) into weekly meal programs as a cost-effective (≈$0.20/serving) adjunct to brushing [38]. Second, dental professionals might recommend pineapple chewing for children with brushing difficulties, particularly those with developmental disabilities showing 3.2× higher compliance than with flossing [39]. Third, public health campaigns should emphasize pineapple's dual nutritional-oral health benefits, as combined messaging increases parental adoption by 40% versus hygiene-only approaches [40]. Future research should investigate optimal frequency (current data suggest 3-5×/week) and compare different pineapple cultivars' efficacy [41].

V. CONCLUSION

This study aimed to evaluate the effectiveness of pineapple (Ananas comosus L. Merr) consumption in reducing the debris index among fifth-grade students at SDN Barengkrajan 1

Sidoarjo, Indonesia. The results demonstrated a statistically significant reduction in debris index scores, with the median score decreasing from 2.3 (indicating poor oral hygiene) to 1.0 (moderate hygiene) following pineapple consumption (*p* < 0.001). This improvement, representing a 56.5% reduction in debris accumulation, can be attributed to pineapple's mechanical cleansing properties, salivary stimulation (86.37% water content), and antibacterial activity from bromelain enzymes and flavonoids. These findings align with previous research on fibrous fruits as adjuncts to oral hygiene, while uniquely demonstrating pineapple's efficacy in a pediatric population a critical gap in existing literature. The study's quasi-experimental design, though limited by the absence of a control group, provides robust preliminary evidence for incorporating pineapple into school-based oral health programs, particularly in resource-limited settings where traditional dental care access is constrained. Future research should address three key areas: (1) longitudinal studies to assess sustained effects beyond immediate post-intervention measurements, (2) comparative trials evaluating pineapple against established interventions (e.g., fluoride rinses or xylitol gum) using randomized controlled designs, and (3) investigations into optimal dosing protocols, including frequency (e.g., daily vs. weekly consumption) and preparation methods (e.g., fresh vs. processed pineapple). Additionally, mechanistic studies quantifying pineapple's impact on specific oral microbiota through genomic analyses would strengthen the biological plausibility of these findings. The practical implications support integrating pineapple into public health strategies as a low-cost ($0.20/serving), culturally acceptable intervention that synergizes nutritional and oral health benefits. Policymakers should consider pilot programs pairing pineapple distribution with oral health education in elementary schools, while dental professionals might recommend it as a supplemental hygiene measure for high-risk pediatric patients.

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DATA AVAILABILITY

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request

AUTHOR CONTRIBUTIONS

Arnita Dwi Meilani led the conceptualization and design of the study, developed the methodology, and supervised the investigation and data collection. She also performed the formal data analysis, wrote the original draft of the manuscript, and managed the overall project administration. Sri Hidayati contributed to the methodological framework, validated the research approach, provided critical resources, and participated in manuscript review and editing. Silvia Prasetyowati assisted in data collection and curation, contributed to visualization, and helped refine the manuscript through review and editing. I Gusti Ayu Kusuma Astuti N. P played a key role in data validation and formal analysis, provided expert supervision, and contributed to the critical revision of the manuscript. All authors reviewed and approved the final version of the paper.

DECLARATIONS

ETHICAL APPROVAL

This study was approved by the Institutional Review Board of Poltekkes Kemenkes Surabaya (Ref: 045/EA/KEPK/2023). Written informed consent was obtained from the parents/guardians of all participants, and assent was secured from the children prior to their involvement. All procedures adhered to the ethical standards of the 1964 Helsinki Declaration and its later amendments.

CONSENT FOR PUBLICATION PARTICIPANTS.

Participants were informed that the data collected would be used for academic and publication purposes. Written consent for publication of anonymized data was obtained from all respondents or their legal guardians.

COMPETING INTERESTS

The authors declare no conflicts of interest, financial or otherwise, related to this work.

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