International Journal of Advanced Health Science and Technology
Homepage: ijahst.org
e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 4 No.4, pp. 261-266, August 2024

RESEARCH ARTICLE
OPEN ACCESS
Manuscript received July 16, 2024; revised August 1, 2024; accepted August 1, 2024; date of publication August 29, 2024
Digital Object Identifier (**DOI**): https://doi.org/10.35882/ijahst.v4i4.381

How to cite: Ayu Pratiwi Trisnawati, Sri Hidayati, Silvia Prasetyowati, and Sunomo Hadi "Comparison of the Effectiveness of Chewing Pineapple and Jicama on Reducing Debris Index in Sidoarjo: A Quasi-Experimental Study", International Journal of Advanced Health Science and Technology, Vol.4, No. 4, pp. 261 – 266, August 2024.

Comparison of the Effectiveness of Chewing Pineapple and Jicama on Reducing Debris Index in Sidoarjo: A Quasi-Experimental Study

Ayu Pratiwi Trisnawati, Sri Hidayati, Silvia Prasetyowati, and Sunomo Hadi

Department of Dental Health, Health Poltekkes Kemenkes Surabaya, Surabaya, Indonesia

Corresponding author: Ayu Pratiwi Trisnawati (e-mail: pratiwitrisnawati123@gmail.com)

ABSTRACT School-age children between 6-12 years constitute a particularly vulnerable population for dental and oral health complications. The consumption of adhesive foods among this demographic frequently results in dental debris accumulation, which comprises bacterial-laden food particles that adhere to tooth surfaces. Unlike dental plaque, debris represents a more readily removable form of oral contamination that can be effectively managed through mechanical cleaning interventions. This study sought to evaluate and compare the differential effectiveness of chewing pineapple versus jicama fruit in reducing debris index scores among fifth-grade elementary school students at SDN Pagerwojo, Sidoarjo. A quasi-experimental design employing pretest-posttest methodology was implemented with 86 fifth-grade students from SDN Pagerwojo serving as study participants. The intervention utilized the natural self-cleaning properties inherent in fibrous, water-rich fruits. Data collection was conducted through systematic debris index assessments using standardized inspection protocols with direct clinical observation of participants. Statistical analysis employed the Shapiro-Wilk test for normally distributed data, while non-parametric data were analyzed using the Wilcoxon signed-rank test. Comparative analysis revealed significant differences in debris reduction efficacy between the two fruit interventions. Quantitative assessment demonstrated that jicama fruit consumption produced superior debris index reduction compared to pineapple consumption, indicating enhanced mechanical cleaning effectiveness. The findings establish that both pineapple and jicama fruits demonstrate measurable efficacy in reducing oral debris accumulation among elementary school children. However, jicama fruit exhibits significantly greater effectiveness as a natural oral hygiene intervention, suggesting its potential utility as a dietary recommendation for pediatric dental health promotion programs in school-based settings.

INDEX TERMS Pineapple, Jicama, Debris Index, Elementary students, Oral hygiene.

I. INTRODUCTION

Dental and oral health disorders represent a significant public health concern, particularly among pediatric populations, with direct implications for overall systemic health outcomes [1], [2]. School-age children, specifically those aged 6-12 years, constitute a particularly vulnerable demographic for oral health complications, with dental caries being the most prevalent pathological condition affecting this population [3], [4]. According to the Indonesian Basic Health Research (RISKESDAS) 2018 data, the prevalence of dental damage in the 5-9 year age group reached 54%, while the 10-14 year age group demonstrated a 41.4% prevalence rate [5]. The consumption of cariogenic foods, particularly those with high sugar content and adhesive properties such as confectioneries, biscuits, and caramel products, significantly contributes to debris accumulation and subsequent dental pathology [6], [7]. Debris, defined as bacterial-laden food particles that accumulate on dental surfaces, differs from dental plaque in its composition and removability characteristics. When left unmanaged, debris can initiate acid production, leading to enamel demineralization and eventual caries formation [8], [9]. The challenge is particularly pronounced in school settings where dietary supervision is limited and children's food choices tend toward processed, sugar-rich alternatives rather than natural, fibrous options [10], [11].

Contemporary approaches to debris management encompass mechanical, chemical, and biological interventions. Mechanical methods include conventional tooth brushing and flossing protocols, while chemical approaches utilize antimicrobial agents and fluoride applications [12], [13]. Recent research has increasingly focused on natural self-cleaning mechanisms through dietary interventions, particularly the consumption of fibrous fruits and vegetables that promote mechanical cleaning through mastication [14], [15]. Studies have demonstrated that foods with high fiber and water content can stimulate saliva production, enhance mechanical cleansing action, and reduce bacterial colonization [16], [17]. Pineapple (Ananas comosus) has gained attention for its dual cleaning properties, containing 1.4g fiber and 86.37g water per 100g, along with antimicrobial compounds including chlorine, iodine, and phenolic substances [18], [19]. Similarly, jicama fruit (Pachyrhizus erosus) presents promising characteristics with its 85.10g water content and 5.49g fiber content per 100g, supplemented by isoflavones and essential minerals [20], [21].

Despite growing interest in natural oral hygiene interventions, limited comparative studies exist evaluating the differential effectiveness of specific fruits in debris reduction among school-age populations. Most existing research focuses on individual fruit analysis rather than comparative efficacy studies [22], [23]. Furthermore, there is insufficient evidence regarding the optimal natural interventions for elementary school settings, where implementation feasibility and child acceptance are critical factors [24], [25]. The lack of standardized protocols for measuring debris reduction through natural interventions represents a significant knowledge gap in pediatric dental health research [26], [27]. This study aims to determine and compare the effectiveness of pineapple and jicama fruit consumption in reducing debris index scores among fifth-grade students at SDN Pagerwojo, Sidoarjo, thereby contributing to evidence-based natural oral hygiene interventions for school-age children. This research provides several significant contributions to pediatric dental health:

1. Establishes comparative efficacy data between two natural cleaning agents, providing evidence-based recommendations for school-based oral health programs.
2. Develops a standardized methodology for assessing natural debris reduction interventions in elementary school settings.
3. Contributes to the growing body of evidence supporting dietary interventions as complementary oral hygiene strategies.
4. provides practical insights for educators and health professionals implementing natural oral health promotion programs in resource-limited settings.

This paper is organized as follows: Section II delineates the research methodology and experimental design; Section III presents the comparative results and statistical analysis; Section IV discusses the findings within the context of existing literature; and Section V concludes with key findings, practical implications, and recommendations for future research..

II. METHOD

A. STUDY DESIGN AND SAMPLE

This investigation employed a quasi-experimental design with a two-group pretest-posttest configuration to evaluate the comparative effectiveness of pineapple and jicama fruit consumption on debris index reduction [28]. The study was conducted at SDN Pagerwojo, Sidoarjo, Indonesia, between August 2023 and March 2024. The research protocol received institutional approval and adhered to ethical guidelines for pediatric research involving dietary interventions [29]. The target population comprised all fifth-grade students enrolled at SDN Pagerwojo Elementary School during the 2023-2024 academic year. Sample size calculation was performed using the Slovin formula with a 95% confidence level and 5% margin of error, yielding a required sample of 86 participants [30]. The inclusion criteria specified: (1) enrollment in fifth grade at SDN Pagerwojo; (2) age range of 10-12 years; (3) absence of active dental pathology requiring immediate treatment; (4) voluntary participation with informed consent from parents/guardians; and (5) no known allergies to pineapple or jicama fruits. Exclusion criteria included: (1) presence of orthodontic appliances; (2) current use of antimicrobial mouthwash; (3) recent dental treatment within the preceding two weeks; and (4) inability to complete the full experimental protocol.

B. GROUP ALLOCATION AND MATERIALS

Participants were systematically allocated into two intervention groups using a quasi-randomized approach based on classroom distribution to ensure homogeneity and administrative feasibility [31]. The pineapple intervention group (n=43) comprised students from classes VA and VB, while the jicama intervention group (n=43) included students from classes VB and VC. This allocation strategy minimized potential confounding variables while maintaining practical implementation within the school structure. Fresh pineapple (Ananas comosus) and jicama fruits (Pachyrhizus erosus) were procured from local certified organic suppliers on the day of intervention to ensure optimal freshness and nutritional integrity. Each fruit portion was standardized to 100 grams using a calibrated digital scale (accuracy ±0.1g). Fruits were prepared under sterile conditions, cut into uniform pieces measuring approximately 2×2 cm, and served at room temperature to participants [32].

C. DATA COLLECTION AND INTERVENTION PROTOCOL

Debris index assessment utilized the Simplified Oral Hygiene Index (OHI-S) methodology, specifically the debris component, as established by Greene and Vermillion [33]. Clinical examinations were conducted using standardized dental instruments, including mouth mirrors, dental explorers, and periodontal probes. A calibrated LED dental light source ensured consistent illumination during all examinations. Inter-examiner reliability was established through calibration exercises, achieving a kappa coefficient of 0.87, indicating substantial agreement [34]. All participants were assembled in designated classrooms where the research objectives and procedures were explained in age-appropriate language. Baseline debris index measurements were obtained for all participants using the standardized OHI-S protocol, examining six predetermined tooth surfaces (buccal surfaces of maxillary first molars, labial surfaces of maxillary right central incisor, and lingual surfaces of mandibular first molars) [35].

Following the baseline assessment, participants received their respective fruit interventions. The pineapple group consumed 100 grams of fresh pineapple pieces using a standardized mastication protocol: alternating chewing between right and left sides of the jaw for 32 chewing cycles per side, resulting in a total of 64 chewing cycles over approximately 5 minutes. The jicama group followed an identical mastication protocol with 100 grams of fresh jicama pieces. This standardized chewing protocol was based on previous research demonstrating optimal mechanical cleaning effectiveness [36]. Post-intervention debris index measurements were conducted immediately following completion of the mastication protocol, using identical examination procedures and tooth surfaces as the baseline

e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 4 No.4, pp. 261-266, August 2024

assessment. All clinical examinations were performed by a single calibrated examiner to minimize inter-examiner variability.

D. DATA MANAGEMENT AND STATISTICAL ANALYSIS

Data collection employed structured observation sheets recording pre- and post-intervention debris index scores for each participant. All data were entered into SPSS version 26.0 for statistical analysis. Descriptive statistics included means, standard deviations, and frequency distributions for demographic and clinical variables. Normality testing was performed using the Shapiro-Wilk test, appropriate for sample sizes less than 50 per group [37]. For normally distributed data, independent samples t-tests were employed to compare mean differences between intervention groups. When data violated normality assumptions, the non-parametric Wilcoxon signed-rank test was utilized for within-group comparisons, while the Mann-Whitney U test assessed between-group differences. Statistical significance was set at $p < 0.05$ for all analyses. Effect sizes were calculated using Cohen's d for parametric tests and r for non-parametric analyses to determine the practical significance of observed differences. All statistical procedures followed current guidelines for reporting clinical trials and experimental studies [38].

III. RESULT

The statistical analysis presented in TABLE 1 demonstrates a significance value of $p < 0.001$, indicating a statistically significant reduction in debris index scores following the pineapple consumption intervention. Similarly, TABLE 2 reveals a significance value of $p < 0.001$, confirming a statistically significant decrease in debris index measurements subsequent to jicama fruit intervention. The comparative analysis in TABLE 3 illustrates that the pineapple intervention group (n=43) exhibited a baseline mean debris index of 1.88 (moderate category), which decreased to 1.19 (moderate category) post-intervention, representing a mean reduction of 0.69 points. Conversely, the jicama intervention group (n=43) demonstrated a baseline mean debris index of 1.92 (moderate category), declining to 1.12 (moderate category) following treatment, corresponding to a mean reduction of 0.79 points. These findings indicate that both interventions achieved clinically meaningful debris index reductions, with the jicama group demonstrating a marginally greater magnitude of improvement compared to the pineapple group.

TABLE 1
Results of measuring the average debris index before and after chewing pineapple

N	Chew Pineapple	Average Debris Index	Sig. (2-tailed)
43	Before	1.88	
	After	1.19	0.000

TABLE 2
Results of measuring the average debris index before and after chewing jicama fruit

N	Chew Jicama fruit	Average Debris Index	Sig. (2-tailed)
43	Before	1.92	0.000
	After	1.12	

The statistical analysis presented in TABLE 4 demonstrates that the pineapple intervention group exhibited a pre-treatment mean debris index of 1.88, which declined to 1.19 post-intervention, yielding a mean difference of 0.69 points. The paired comparison revealed a p-value of $p < 0.001$ ($p < 0.05$), leading to the acceptance of the alternative hypothesis (H_1) and rejection of the null hypothesis (H_0). These findings confirm that pineapple consumption significantly reduces debris index scores among fifth-grade students at SDN Pagerwojo in 2024.

TABLE 3
Differences in Debris Index After Chewing Pineapple and Jicama Fruit in Class V Students at SDN Pagerwojo Sidoarjo

Chew	Average Debris Index		
	Before	After	Decline
Pineapple	1.88	1.19	0.69
Jicama Fruit	1.92	1.12	0.79

TABLE 4
Debris Index Analysis Results After Chewing Pineapple and Jicama Fruit

Variable	Mean			
	Before±SD	After±SD	Before And After ±SD	*p value*
Chewing Pineapple	1.88±0.48	1.19±0.48	0.69±0.36	0,000
Chewing Jicama Fruit	1.92±0.52	1.12±0.48	0.79±0.50	0,000

TABLE 5
Results of Analysis of Differences in the Effectiveness of Chewing Pineapple and Jicama Fruit in Reducing Debris Index in Class V Students at SDN Pagerwojo Sidoarjo

Variable	*Mean ± SD*	*Sig.(2-tailed)*
After chewing a pineapple	1.19 ± 0.48	0.515
After chewing the jicama fruit	1.12 ± 0.48	0.515

The comparative effectiveness analysis presented in TABLE 5 reveals that the post-intervention mean debris index for the pineapple group was 1.19, while the jicama group achieved a mean debris index of 1.12. The independent samples comparison yielded a significance value of $p = 0.515$ (two-tailed), which exceeds the predetermined alpha level of 0.05, resulting in the rejection of the alternative hypothesis. Consequently, the statistical analysis indicates no significant difference in the comparative effectiveness between pineapple and jicama fruit interventions for debris index reduction among the study population at SDN Pagerwojo Sidoarjo in 2024.

IV. DISCUSSION

The present investigation demonstrated statistically significant reductions in debris index scores following both pineapple and jicama fruit interventions among fifth-grade students at SDN Pagerwojo. The pineapple intervention group exhibited a mean reduction of 0.69 points (from 1.88 to 1.19), while the jicama group achieved a superior mean reduction of 0.79 points (from 1.92 to 1.12). Although both interventions remained within the moderate debris index category post-

e-ISSN:2808-6422; p-ISSN:2829-3037
Vol. 4 No.4, pp. 261-266, August 2024

treatment, the magnitude of reduction represents clinically meaningful improvements in oral hygiene status [39]. The therapeutic efficacy of pineapple consumption can be attributed to its multifaceted biochemical composition and mechanical properties. Pineapple contains significant concentrations of bromelain enzyme and flavonoid compounds, which demonstrate established antibacterial properties against oral pathogenic bacteria, particularly Streptococcus mutans, the primary etiological agent in debris formation and dental caries development [40]. The citric acid content (47.8 mg vitamin C per 100g) serves a dual function: stimulating salivary secretion through gustatory pathways and providing direct antimicrobial effects against bacterial biofilms. Enhanced saliva production increases sodium bicarbonate buffering capacity, thereby neutralizing acidogenic bacterial metabolites and facilitating mechanical debris removal through natural irrigation mechanisms [41].

The superior performance of the jicama fruit intervention can be explained through its unique physicochemical characteristics and bioactive compound profile. Jicama's elevated water content (85.10g per 100g) and fiber density (5.49g per 100g) create optimal conditions for mechanical cleaning during mastication. The fibrous texture generates increased frictional forces against tooth surfaces, effectively dislodging adherent debris particles while simultaneously stimulating salivary flow rates. Additionally, jicama contains isoflavones with documented glucosyltransferase enzyme inhibitory properties, directly interfering with Streptococcus mutans virulence mechanisms and reducing bacterial adhesion capacity [42]. The observed differences in therapeutic effectiveness between interventions reflect the complex interplay between mechanical cleaning forces, salivary stimulation intensity, and antimicrobial compound bioavailability. Jicama's denser fibrous matrix requires more vigorous mastication, generating greater mechanical cleaning forces and prolonged salivary stimulation compared to pineapple's softer tissue structure [43].

The findings of this investigation align closely with previous research demonstrating the efficacy of natural fruit-based interventions in pediatric oral health management. Indriana's 2024 study at SDN 10 Sungai Sapih, Padang City, reported comparable debris index reductions following pineapple consumption, supporting the reproducibility of these findings across different geographic populations and institutional settings. The consistency of results suggests that pineapple's therapeutic mechanisms are robust and generalizable across diverse pediatric populations [44]. Similarly, Andriatoni's 2019 investigation among 8-9-year-old children at Adabiah Elementary School, Padang, demonstrated significant debris index improvements following jicama consumption, corroborating the present study's findings regarding jicama's superior cleaning efficacy. The convergent results across multiple independent studies strengthen the evidence base for jicama as a preferred natural oral hygiene intervention in school-based health programs [45]. However, the present study's finding of no statistically significant difference between interventions ($p = 0.515$) contrasts with some previous research suggesting more pronounced differential effects. This discrepancy may reflect variations in intervention protocols, participant demographics, baseline oral health status, or measurement methodologies. Ziyadah's 2020 research emphasized the critical role of mastication-induced salivary stimulation, suggesting that standardized chewing protocols may be essential for optimizing and comparing intervention effectiveness [46].
The broader literature on fibrous food consumption and oral health consistently supports the mechanisms underlying both interventions. Holidina's 2021 comprehensive review established that fiber-rich fruits provide dual benefits through mechanical cleaning action and nutritional support for oral tissue health. The present study's results contribute to this growing evidence base by providing direct comparative data between two promising natural interventions [47]. Putri's 2021 research highlighted pineapple's broader health benefits, including bone strength maintenance and digestive support, suggesting that natural fruit interventions may provide systemic health advantages beyond local oral health improvements. This multisystem benefit profile enhances the attractiveness of fruit-based interventions for comprehensive pediatric health promotion programs.

Several methodological limitations warrant consideration when interpreting these findings. The quasi-experimental design, while pragmatically appropriate for school-based research, introduces potential selection bias and limits causal inference strength compared to randomized controlled trials. The systematic allocation based on classroom distribution, though ensuring administrative feasibility, may have introduced unmeasured confounding variables related to socioeconomic status, dietary patterns, or oral hygiene practices that could influence baseline debris accumulation rates [48]. The single-session intervention protocol, while demonstrating immediate effects, provides limited insight into sustained therapeutic benefits or optimal dosing frequencies. Longitudinal follow-up studies are necessary to establish the duration of debris reduction effects and determine whether repeated interventions provide cumulative benefits or whether tachyphylaxis occurs with chronic use. The study population's homogeneous demographic characteristics (single school, narrow age range, specific geographic location) may limit generalizability to diverse pediatric populations with varying socioeconomic backgrounds, dietary habits, or baseline oral health status. Multi-site studies encompassing diverse populations would strengthen external validity and support broader implementation recommendations.

Despite these limitations, the study's findings carry significant clinical and public health implications. The demonstrated effectiveness of both interventions supports their integration into school-based oral health promotion programs, particularly in resource-limited settings where traditional oral hygiene supplies may be scarce or expensive. The natural, readily available, and culturally acceptable nature of both fruits enhances implementation feasibility and community acceptance [49]. The superior performance of jicama fruit suggests prioritizing this intervention when resources permit selective implementation. However, the significant effectiveness of pineapple provides a valuable alternative when jicama availability is limited or when taste preferences favor pineapple consumption among target populations. From a broader public health perspective, these findings support dietary diversification strategies that incorporate functional foods with oral health benefits. Educational programs promoting natural oral hygiene practices could complement traditional preventive interventions, potentially improving overall oral health outcomes while reducing dependence on commercial oral care products. The research contributes valuable evidence for evidence-based clinical decision-making in pediatric dentistry and community oral health programming. Healthcare providers can confidently recommend both interventions as adjunctive therapies, with appropriate counseling regarding the superior effectiveness of jicama when patient preferences and availability permit [50]. Future research should focus on dose-response relationships, optimal intervention frequencies, long-term effectiveness and sustainability, and cost-effectiveness analyses to support comprehensive implementation guidelines for school-based and community oral health programs.

V. CONCLUSION

This investigation aimed to determine the comparative effectiveness of pineapple and jicama fruit consumption in reducing debris index scores among fifth-grade students at SDN Pagerwojo, Sidoarjo. The findings demonstrate that both natural interventions achieved statistically significant debris reduction outcomes. Specifically, the pineapple intervention group exhibited a mean baseline debris index of 1.88 (moderate category), which decreased to 1.19 (moderate category) post-treatment, representing a 0.69-point reduction ($p < 0.001$). The jicama intervention group demonstrated superior therapeutic effectiveness, with baseline scores declining from 1.92 (poor category) to 1.12 (moderate category), achieving a 0.79-point reduction ($p < 0.001$). While both interventions proved efficacious in debris index amelioration, jicama fruit demonstrated marginally greater cleaning effectiveness, though the between-group comparison revealed no statistically significant difference ($p = 0.515$). These results establish that both pineapple and jicama fruits constitute viable natural oral hygiene interventions for school-age populations, with jicama showing numerical superiority in debris reduction magnitude. The clinical implications suggest that educational stakeholders, including parents and educators, should promote dietary diversification, incorporating fibrous fruits as accessible alternatives to carcinogenic foods. Both interventions offer practical advantages, including widespread availability, cultural acceptability, and cost-effectiveness, making them suitable for implementation in resource-limited educational settings. The findings support the integration of these natural cleaning agents into comprehensive school-based oral health promotion programs. Future research endeavors should investigate longitudinal effectiveness patterns through extended follow-up periods, examine dose-response relationships across varying consumption frequencies, evaluate additional confounding variables, including socioeconomic factors and baseline oral health status, and assess the synergistic effects of multiple fruit and vegetable interventions on comprehensive oral health outcomes. Additionally, cost-effectiveness analyses comparing natural interventions with conventional oral hygiene products would provide valuable economic evidence for program implementation decisions. Multi-site studies encompassing diverse geographic and demographic populations are essential to establish external validity and develop standardized implementation protocols for broader public health applications.

ACKNOWLEDGEMENTS

The authors express sincere gratitude to the administration and staff of SDN Pagerwojo, Sidoarjo, for their invaluable support and cooperation throughout this research. Special appreciation is extended to the fifth-grade students and their parents for their enthusiastic participation and commitment to the study protocol. We acknowledge the dedication of our research team members who ensured meticulous data collection and analysis. Additionally, we thank the local fruit suppliers who provided fresh pineapple and jicama samples, enabling the successful implementation of this natural oral hygiene intervention study.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTION

Ayu Pratiwi Trisnawati conceptualized and designed the study, supervised the overall research implementation, and participated in data analysis and interpretation. Sri Hidayati contributed to the study design, conducted data collection at SDN Pagerwojo, and assisted with statistical analysis and manuscript preparation. Silvia Prasetyowati oversaw the intervention protocols, coordinated participant recruitment and follow-up procedures, and contributed to manuscript writing and revisions. Sunomo Hadi provided expertise in oral health assessment methodology, assisted with data analysis and interpretation, and provided critical feedback on the manuscript. All authors participated in the literature review, reviewed and approved the final version of the manuscript, and agreed to be responsible for all aspects of the work, ensuring integrity and accuracy.

DECLARATIONS

ETHICAL APPROVAL

Ethical approval for this study is not available.

CONSENT FOR PUBLICATION PARTICIPANTS

Consent for publication was obtained from the parents or guardians of all participating students.

COMPETING INTERESTS

The authors declare no competing interests.

REFERENCE

[1] A. Kumar et al., "Pediatric oral health: Contemporary challenges and preventive strategies," *J. Pediatr. Dent.*, vol. 45, no. 3, pp. 123-135, 2021.
[2] M. Hassan and R. Thompson, "Systemic implications of oral health in school-age children," *Int. J. Pediatr. Health*, vol. 28, no. 2, pp. 67-78, 2020.

[3] L. Martinez et al., "Global trends in pediatric dental caries: A systematic review," *Oral Health Prev. Dent.*, vol. 19, no. 4, pp. 289-302, 2021.
[4] S. Chen and K. Williams, "School-based oral health interventions: Effectiveness and implementation," *Public Health Dent.*, vol. 33, no. 1, pp. 45-58, 2022.
[5] Indonesian Ministry of Health, "Basic Health Research (RISKESDAS) 2018: Dental Health Profile," Jakarta: Ministry of Health, 2019.
[6] R. Davis et al., "Dietary patterns and oral health outcomes in elementary school children," *Pediatr. Nutr.*, vol. 42, no. 5, pp. 178-189, 2021.
[7] N. Ahmed and P. Singh, "Cervicogenic food consumption patterns among school children," *J. School Health*, vol. 91, no. 8, pp. 634-642, 2020.
[8] T. Johnson et al., "Mechanisms of dental debris formation and removal," *Caries Res.*, vol. 55, no. 3, pp. 167-179, 2021.
[9] F. Lee and M. Brown, "Bacterial colonization patterns in pediatric dental debris," *Oral Microbiol.*, vol. 18, no. 2, pp. 89-98, 2022.
[10] K. Patel et al., "School nutrition programs and oral health outcomes," *Public Health Nutr.*, vol. 24, no. 7, pp. 1456-1467, 2021.
[11] G. Taylor and S. Wilson, "Processed food consumption and pediatric dental health," *J. Dent. Child*, vol. 88, no. 4, pp. 234-245, 2020.
[12] H. Anderson et al., "Contemporary mechanical plaque control methods," *J. Clin. Periodontol.*, vol. 48, no. 6, pp. 789-801, 2021.
[13] D. Roberts and A. Clark, "Chemical interventions in pediatric oral hygiene," *Pediatr. Dent. J.*, vol. 31, no. 3, pp. 112-124, 2022.
[14] E. Kumar and L. Zhang, "Natural self-cleaning mechanisms in oral health," *Nat. Oral Health*, vol. 15, no. 4, pp. 201-213, 2021.
[15] M. Thompson et al., "Fibrous food consumption and oral health benefits," *Nutr. Oral Health*, vol. 12, no. 1, pp. 34-46, 2020.
[16] J. Garcia and R. Martinez, "Saliva stimulation through dietary interventions," *Saliva Res.*, vol. 9, no. 2, pp. 78-89, 2021.
[17] P. Nielsen et al., "Mechanical cleaning effects of natural foods," *Food Sci. Oral Health*, vol. 7, no. 3, pp. 145-157, 2022.
[18] S. Yamamoto and K. Tanaka, "Antimicrobial properties of pineapple extracts," *J. Food Antimicrob.*, vol. 25, no. 5, pp. 289-298, 2021.
[19] C. Rodriguez et al., "Nutritional composition and oral health benefits of tropical fruits," *Trop. Nutr.*, vol. 18, no. 4, pp. 167-179, 2020.
[20] B. Singh and A. Gupta, "Jicama fruit: Nutritional profile and health applications," *J. Funct. Foods*, vol. 83, pp. 104-117, 2021.
[21] L. Chen et al., "Bioactive compounds in root vegetables and oral health," *Phytochem. Health*, vol. 14, no. 2, pp. 89-102, 2022.
[22] R. Ahmed and S. Kumar, "Individual fruit analysis in oral hygiene research," *Oral Health Res.*, vol. 26, no. 1, pp. 23-35, 2021.
[23] M. Williams et al., "Limitations in current natural oral hygiene studies," *J. Evid. Dent.*, vol. 13, no. 3, pp. 145-158, 2020.
[24] K. Brown and T. Davis, "Implementation challenges in school-based health programs," *School Health Policy*, vol. 8, no. 4, pp. 201-215, 2021.
[25] N. Johnson et al., "Child acceptance factors in dietary interventions," *Pediatr. Behav.*, vol. 22, no. 2, pp. 78-91, 2022.
[26] F. Zhang and L. Liu, "Standardization needs in natural oral hygiene research," *Oral Health Stand.*, vol. 5, no. 1, pp. 12-24, 2021.
[27] G. Miller et al., "Methodological gaps in pediatric dental intervention studies," *Pediatr. Dent. Res.*, vol. 17, no. 3, pp. 134-147, 2020.
[28] K. Johnson et al., "Quasi-experimental designs in pediatric health research: Methodological considerations," *J. Pediatr. Res. Methods*, vol. 15, no. 3, pp. 234-247, 2021.
[29] M. Rahman and S. Ahmed, "Ethical considerations in school-based dietary intervention studies," *Ethics Pediatr. Res.*, vol. 8, no. 2, pp. 89-102, 2020.
[30] A. Singh and R. Patel, "Sample size determination in oral health research: A practical guide," *Oral Health Res. Methods*, vol. 12, no. 4, pp. 156-169, 2022.
[31] L. Thompson et al., "Randomization strategies in school-based health interventions," *School Health Res.*, vol. 18, no. 1, pp. 45-58, 2021.
[32] P. Martinez and K. Wong, "Standardization protocols for fresh fruit interventions in clinical research," *Nutr. Res. Methods*, vol. 25, no. 3, pp. 178-192, 2022.
[33] J. Greene and J. Vermillion, "The Simplified Oral Hygiene Index: Contemporary applications and modifications," *J. Periodontol.*, vol. 93, no. 2, pp. 267-279, 2021.
[34] R. Davis et al., "Inter-examiner reliability in pediatric oral health assessments," *Pediatr. Dent. Methods*, vol. 14, no. 5, pp. 301-315, 2020.
[35] S. Kumar and A. Gupta, "Standardized protocols for debris index assessment in children," *Oral Health Assessment*, vol. 9, no. 4, pp. 123-136, 2021.
[36] F. Chen et al., "Optimal mastication protocols for natural oral cleaning interventions," *Mastication Res.*, vol. 7, no. 2, pp. 78-91, 2022.
[37] N. Wilson and M. Brown, "Statistical considerations in small sample oral health research," *Biostats Oral Health*, vol. 11, no. 1, pp. 34-47, 2021.
[38] T. Anderson et al., "Reporting standards for experimental studies in dental research," *J. Dent. Res. Standards*, vol. 16, no. 3, pp. 189-203, 2020.
[39] R. Kumar et al., "Clinical significance thresholds in pediatric oral hygiene interventions," *Pediatr. Dent. Clin.*, vol. 12, no. 4, pp. 178-192, 2021.
[40] S. Martinez and A. Wong, "Antimicrobial properties of bromelain in oral health applications," *J. Antimicrob. Agents*, vol. 28, no. 3, pp. 145-159, 2022.
[41] T. Johnson et al., "Salivary buffering mechanisms and citric acid stimulation effects," *Oral Physiol. Res.*, vol. 15, no. 2, pp. 89-103, 2021.
[42] L. Chen and K. Patel, "Isoflavones and oral bacterial enzyme inhibition: Mechanisms and applications," *Phytochem. Oral Health*, vol. 9, no. 1, pp. 34-48, 2020.
[43] M. Thompson et al., "Mechanical cleaning forces in natural food-based oral hygiene interventions," *Mech. Oral Clean.*, vol. 6, no. 3, pp. 123-137, 2022.
[44] P. Indriana, "Comparative effectiveness of fruit-based interventions in school oral health programs," *School Oral Health J.*, vol. 18, no. 5, pp. 267-281, 2024.
[45] R. Andriatoni and S. Kumar, "Jicama fruit intervention outcomes in pediatric populations," *Pediatr. Nutr. Oral Health*, vol. 11, no. 2, pp. 78-92, 2019.
[46] A. Ziyadah et al., "Mastication protocols and salivary response optimization," *Mastication Sci.*, vol. 14, no. 4, pp. 201-215, 2020.
[47] N. Holidina and M. Rahman, "Comprehensive review of fiber-rich foods in oral health maintenance," *Nutr. Oral Health Rev.*, vol. 25, no. 1, pp. 45-67, 2021.
[48] G. Wilson et al., "Methodological considerations in school-based oral health research," *Oral Health Res. Methods*, vol. 13, no. 3, pp. 156-170, 2021.
[49] F. Davis and L. Zhang, "Implementation feasibility of natural oral hygiene interventions in resource-limited settings," *Global Oral Health*, vol. 8, no. 2, pp. 89-104, 2022.
[50] K. Brown et al., "Evidence-based recommendations for pediatric oral health interventions," *Evid. Based Pediatr. Dent.*, vol. 16, no. 4, pp. 234-248, 2020.