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# Effect of Arenga Pinnata on Enamel Surface Microhardness: An Ex-Vivo Study.

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Abstract

Introduction: Palm sugar, a traditional sweetener derived from palm tree sap, is gaining attention for potential health benefits, particularly in oral health. This study investigates its impact on tooth demineralization compared to sucrose.

Methodology: Thirty-four natural teeth samples were divided into groups treated with palm sugar and sucrose. Streptococcus mutans inoculation was carried out, and Vickers microhardness tests (Shimadzu HMV-G, Kyoto, Japan) were conducted after 7 days of immersion in sugar-enriched broths.

Results: Significant enamel hardness reduction was observed with sucrose, while palm sugar demonstrated no such effect. One-way ANOVA highlighted a significant difference between sucrose and palm sugar, emphasizing the potential of palm sugar as a superior alternative.

Conclusion: The study suggests that palm sugar may be a promising alternative to sucrose in preventing enamel demineralization. Further research is essential to validate these findings in real-life scenarios.

Key words: Arenga Pinnata, Enamel Surface Microhardness, Streptococcus Mutans

## Introduction

Palm sugar, also known as coconut sugar or Arenga pinnata, has been used as a traditional sweetener in many parts of the world for centuries. It is made from the sap of various palm trees, including the coconut palm, and is minimally processed, making it a popular choice among health-conscious consumers. In recent years, palm sugar has gained attention for its potential health benefits, particularly in the field of oral biology.

Palm sugar's nutritional content, low glycemic index, antibacterial properties, and potential effects on tooth surface hardness and demineralization make it a promising alternative to refined sugar. However, it should be taken in moderation as part of a balanced diet to support general health and well-being just like any other food.

Studies have shown that palm sugar contains several nutrients, like potassium, magnesium, and calcium, which are significant for maintaining the health of teeth and gums. Additionally, palm sugar is low on the glycemic index, indicating it doesn't cause a rapid spike in the levels of blood sugar, making it a better alternative to refined sugar.

Research has also suggested that palm sugar may have antibacterial properties due to the presence of antioxidants that can help with host immunity, thus preventing the development of harmful bacteria in the mouth, which can lead to dental caries and gum disease [1].

In addition to its potential benefits for overall health, palm sugar may also have specific benefits for dental health. One of the most significant ways that palm sugar can promote oral health is by reducing the risk of dental caries. Dental caries is caused by oral bacteria that produce organic acids, which demineralize the enamel on the teeth.

A correlation between surface hardness and the demineralization of the enamel surface by weight percentage of Fluoride ions was established with higher hardness values correlating to greater mineralization and vice versa [2].

In this article, we will examine the potential health advantages of palm sugar in the context of tooth demineralization. We will evaluate the effect of palm sugar on tooth surface hardness and demineralization.

Materials & Methods

This study was done after getting approval from the Institution's Ethics Committee of Saveetha Dental College (SRB/SDC/ENDO-2107/22/019)

The size of the sample for this investigation was determined with G*Power software 3.1.9.7, with reference to a prior study. A total of 34 teeth (17 teeth in each group) made up the sample size 3.

Preparation of tooth samples

This study contained thirty-four newly removed natural teeth, free of cavities, that were taken from the tooth bank. The dental crowns were extracted from their roots using a diamond disk, and then they were preserved in distilled water until they were ready for additional examination . The buccal surface of the crown was used to produce the samples, which were made to measure around 5 x 5 mm. Every sample was examined before analysis to identify any defects like cracks or white spots that may exclude it from the research. Teflon tape was applied to one-half of each sample's tooth surface, acting as a control.

Inoculation of Streptococcus mutans

The Streptococcus mutans culture used in this investigation was kept in Saveetha Dental College's microbiology lab. The 34 prepared samples were evenly split into two groups of 17 samples each, called Group A (samples treated with sucrose) and Group B (samples subjected to palm sugar). A microcentrifuge tube comprising 1 mL of BHI medium (BHI broth) supplemented with 1 percent newly produced sucrose and 1 percent Arenga pinnata solutions was used for each tooth sample from Group A and Group B. Each sample received fifty microliters of the Streptococcus mutans culture that had grown overnight, and the samples were all cultured for 120 hours at 37°C. The tooth samples were removed from their corresponding solutions after the incubation time and carefully washed with deionized water.

An in vitro study was done on 10 non-carious anterior teeth, split into two groups of 5 (Group A and Group B). Group A was submerged in Eppendorf tubes of 1% palm sugar (Arenga pinnata) enriched BHI broth with streptococcus mutans while Group B was submerged in Eppendorf tubes of 1%

sucrose-enriched BHI broth with streptococcus mutans. Both groups were kept submerged for a duration of 7 days after which they were subjected to Vickers micro hardness tests with sealed portions of the same tooth used as control. The microhardness test is done using a Vickers hardness tester(Shimadzu HMV-G, Kyoto, Japan) (Figures 1-2).

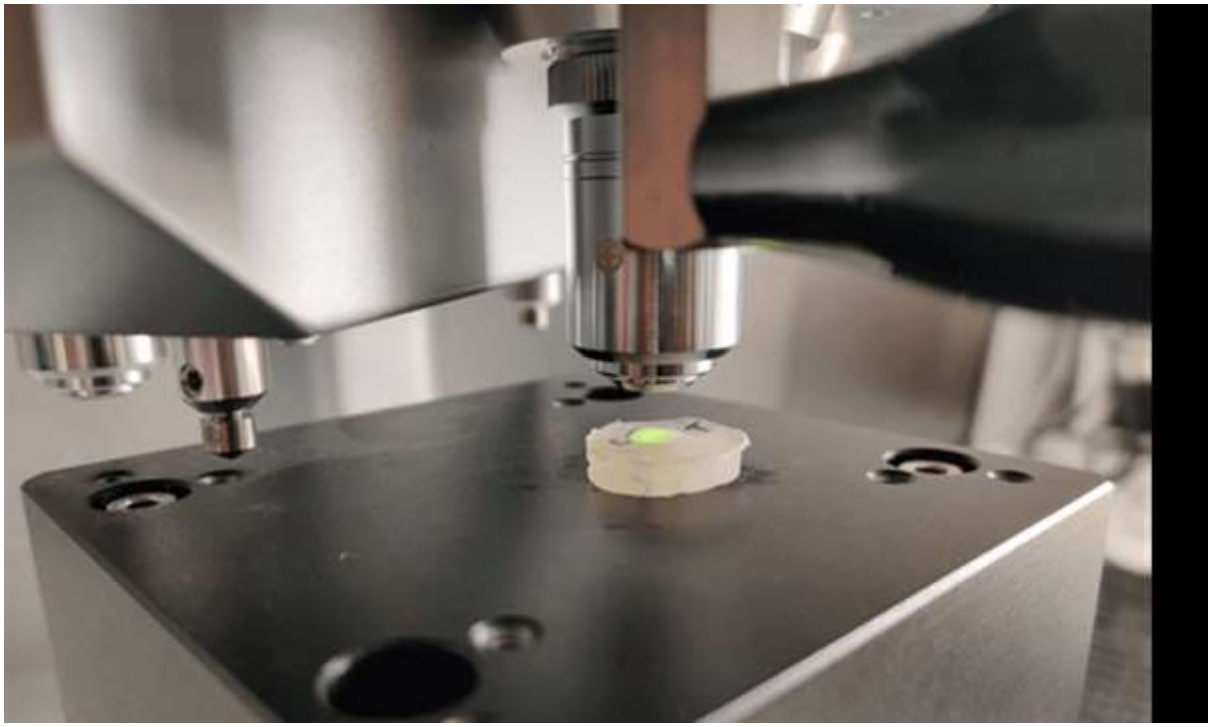

Figure 1: Tester stylus being placed on tooth surface

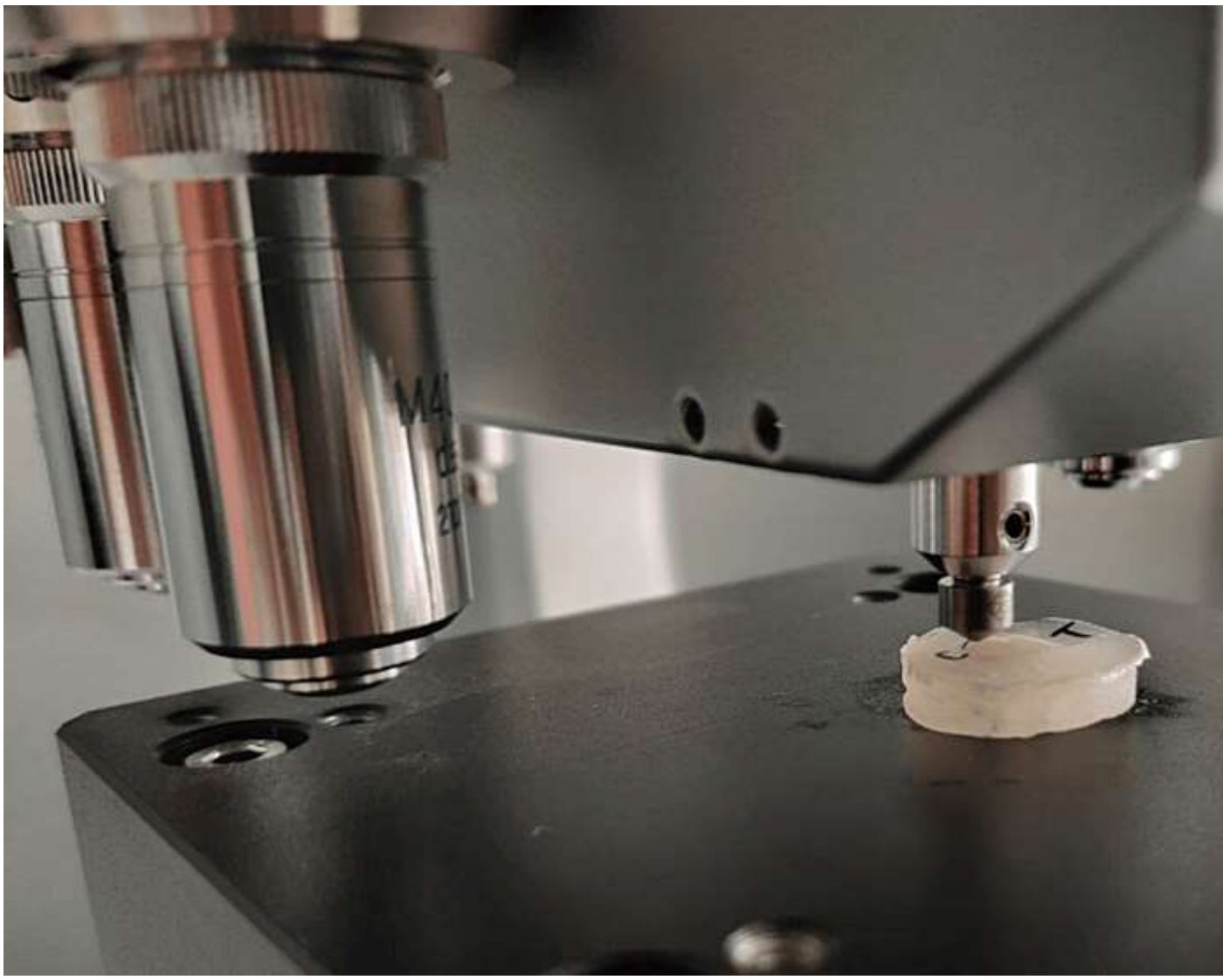

Figure 2: Indentation being visualized using x100 CCD Microscope

Results

On conducting a One way ANOVA (Table 1), it was seen that the sum of squares between groups (SSB) was substantially larger than the sum of squares within groups (SSW), indicating that there were significant differences between the group means. The mean square between groups was much larger than the mean square within groups, further supporting the presence of significant differences between the groups. The odds ratio between groups was 2, suggesting that the odds of variability between groups are 2 times greater than the odds of variability within groups. Thus, it was seen that there are significant differences between the group means. The F-statistic (Variation between sample means / Variation within the samples) further supports this conclusion, indicating that the observed differences between group means are likely to be statistically significant, especially given the very low significance level of $\alpha$=0.

| ANOVA | | | | | |
|---|---|---|---|---|---|
| Vickers Hardness | | | | | |

| | Sum of Squares | or | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 70198.067 | 2 | 35099.033 | 35.643 | 0.000 |
| Within Groups | 26588.100 | 27 | 984.744 | | |
| Total | 96786.167 | 29 | | | |

Table 1: One-way ANOVA between the three groups

or - Odds Ratio

F - Variation between sample means / Variation within the samples

Sig. - Significance

This chart (Figure 3) shows the mean and standard deviations of all 3 groups, which are palm sugar, sucrose, and control. Groups with similar letters (A) show no significant difference between each other while groups with dissimilar lettering show significant differences.

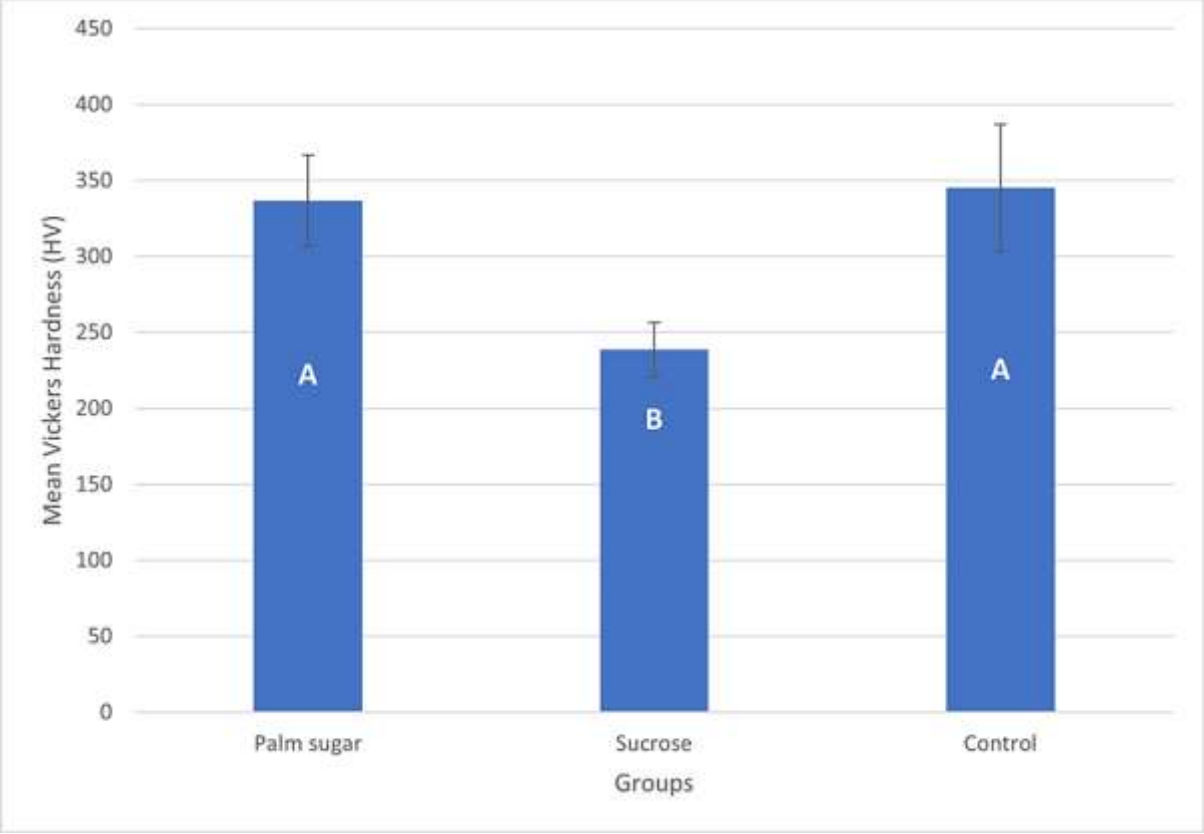


Figure 3: Chart showing the mean and standard deviations of all three groups

Error bars: +/- Standard Deviation

HV: Vickers Pyramid Number

The average Vickers hardness values for palm sugar, sucrose, and the control group were 336.7, 238.6, and 345.2, respectively. Statistical analysis revealed a significant difference in hardness among the groups ($p < 0.05$). Specifically, the hardness of samples treated with palm sugar and sucrose and

the samples treated with sucrose and control. The control and Palm sugar samples showed no statistical differences although control exhibited higher Vickers Hardness levels.

Discussion

White sugar, also known as granulated sugar, is a highly refined form of sugar made from sugarcane or sugar beet. It is processed to remove all impurities and molasses, leaving behind pure sucrose crystals. White sugar is commonly used in baking, cooking, and as a sweetener for coffee, tea, and other beverages. It has a neutral flavor and dissolves quickly, making it a popular choice in many recipes.

Palm sugar, on the other hand, is a natural sweetener made from the sap of various palm trees. It is commonly used in Southeast Asian cuisine, particularly in Thailand, Indonesia, and Malaysia. Palm sugar is usually sold in block or paste form and has a dark brown color and a distinct flavor that is often described as caramel-like or smoky. Unlike white sugar, palm sugar is unrefined and retains some of its natural minerals and nutrients, making it a healthier alternative to white sugar.

In addition to their different flavors and textures, white sugar and palm sugar also have different nutritional profiles. White sugar is pure sucrose, while palm sugar contains trace amounts of vitamins and minerals such as potassium, iron, and zinc. However, it is important to note that palm sugar is still high in calories and should be consumed in moderation. The high fiber content of palm sugar leads to its being broken down at a lower rate compared to regular sugar. This process reduces the rate of demineralization.

The mechanism of action of demineralization of enamel involves a complex interplay between the acids, bacteria, and minerals in the enamel. Sugar is metabolized by the bacteria in the oral cavity, producing organic acids as a byproduct. These acids lower the pH in the mouth, making it more acidic and thus making it vulnerable to demineralization [4-6].

The variables investigated in this study, with the profilometric study as the reference, include the effect of Arenga pinnata solution on enamel surface microhardness and the depth of demineralization. This involves assessing changes in enamel hardness after exposure to the solution, with the reference study providing a benchmark for comparison in sample size and methodology due to the ability to have homogenous data that can be compared and evaluated [3].

Enamel is made up of hydroxyapatite crystals, which are made up of phosphate, calcium, and hydroxyl ions. When the pH in the mouth drops below a pH of 4.5 to 5.5, the hydroxyapatite crystals in the enamel begin to dissolve, releasing calcium and phosphate ions into the mouth. This process is known as demineralization [7-10].

The study investigated the impact of palm sugar and sucrose on tooth enamel surface hardness and discovered intriguing results that may have implications for dental health. The presence of sucrose in a Streptococcus mutans broth was found to significantly decrease the surface hardness of enamel, whereas the presence of palm sugar did not exhibit a significant effect on enamel hardness. This finding holds significance as it implies that palm sugar might offer a superior alternative to sucrose in terms of reducing the risk of enamel demineralization and dental caries [11-16].

Sucrose, a commonly encountered sugar in processed foods and beverages, is a major contributor to dental caries. Upon consumption, oral bacteria break down sucrose into organic acids, which subsequently demineralize the enamel [1,11,12].

In contrast, palm sugar is a minimally processed sweetener that possesses a lower glycemic index and contains essential nutrients like potassium and calcium, crucial for maintaining oral health. Moreover, the study's findings indicate that palm sugar does not significantly diminish enamel hardness, unlike sucrose [17-23].

These outcomes suggest that palm sugar may present a promising alternative to sucrose in promoting dental well-being. By mitigating the risk of enamel demineralization, palm sugar may contribute to the prevention of dental caries [24-26].

Additionally, its lower glycemic index renders it potentially advantageous for individuals managing conditions such as diabetes that necessitate careful blood sugar control.

Finally, there was a study done on the demineralization of giomers, which are synthetic materials designed to mimic natural tooth structure but typically contain a combination of glass fillers, resin matrix, and other components. Despite these differences, certain properties of dental restorative materials like giomers can provide insights into potential effects on enamel under similar conditions. Findings from the study on giomers suggested that there's no direct correlation between microhardness and surface roughness in these materials. Further research would be needed to confirm whether similar conclusions apply to enamel [27-29].

Limitations:

The present study acknowledges a number of limitations that should be taken into account. First of all, the frequency and pH variations of the material and treatment substrate were not taken into consideration. Furthermore, the exposure period to solutions containing palm sugar and sucrose was restricted to just seven days, indicating a comparatively short duration. Therefore, in order to properly understand the possible effects on dental health, future research should incorporate extended exposure durations. Additionally, as the focus of this study was planktonic bacteria, more investigation into circumstances involving polymicrobial biofilms might improve our comprehension of the oral environment. It's also critical to remember that this study was carried out in a controlled laboratory environment, which may have limited the findings' relevance in actual clinical settings. To properly understand the implications for tooth health and disease prevention, more research conducted under more realistic conditions is required. Caution is therefore urged when extending these results to clinical scenarios.

Conclusions

The study found that the surface hardness of enamel is significantly reduced in the presence of sucrose in a Streptococcus mutans broth while the hardness of enamel was not significantly reduced in the palm sugar solution, suggesting that palm sugar may be a better alternative to sucrose in regard to enamel demineralization. Although further study is required to completely comprehend the dental benefits of palm sugar, these results are promising and may have important implications for dental health.

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Author Contributions:

Sashwat Sathish – Manuscript writing, involved in sample preparation and assessment, Study idea

Surendar Sugumaran – Guide, Manuscript writing, involved in sample preparation and assessment, study idea

Annie Sylvia Valan - involved in sample preparation and assessment, study idea.

Conflict of interest:

There is no conflict of interest.

Ethical approval:

This study was done after getting approval from the Institution's Ethics Committee of Saveetha Dental College (SRB/SDC/ENDO-2107/22/019)

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