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SIP SMART: HOW YOUR MILK CHOICES IMPACT ORAL HEALTH. A RANDOMIZED CLINICAL TRIAL COMPARING SALIVARY AND PLAQUE PH CHANGES

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ABSTRACT

Background/Objectives: The study aimed to evaluate the changes in the salivary and plaque pH after the consumption of three types of milk — high protein milk, full-fat milk, and sweetened condensed milk. ***Method:*** The study population comprised 75 children aged 6-10 years and were divided into groups of 25 each. Children participating in the studyrefrained from brushing their teeth, eating, or drinking for at least 2 hours before the experiment. Salivary and plaque pH were recorded at baseline (t0). Each child then consumed 20 mL of one of the three types of milk. Following milk consumption, salivary and plaque pH were measured using pH saliva indicator strips at 15(t1), 30(t2), and 60(t3) minutes. Changes in salivary and plaque pH were analyzed to determine each milk type's impact. ***Results:*** Statistical analysis was performed using Descriptive Statistics, Repeated measures ANOVA, and Kruskal Wallis Test. The results indicated statistically significant differences in both salivary and plaque pH levels among the three milk types at various time intervals. High-protein milk consistently maintained higher pH levels, while sweetened condensed milk resulted in lower pH levels, suggesting a more acidic oral environment. ***Conclusion:*** Milk choice influences oral pH. High-protein and full-fat milk helps maintain a neutral pH, reducing caries risk, while sweetened condensed milk lowers pH, increasing cariogenic potential. Selecting appropriate milk types can support better oral health in children.

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INTRODUCTION

Dental caries remains one of the most prevalent chronic diseases in children worldwide, largely influenced by dietary habits, oral hygiene, and the biochemical environment of the oral cavity.[1] Salivary and plaque pH play a crucial role in maintaining oral homeostasis, influencing enamel demineralization and remineralization.[2] A decrease in pH below the critical threshold of 5.5 can lead to enamel demineralization, promoting the onset of caries.

Milk and dairy products are widely consumed and recognized for their nutritional benefits. They contain essential nutrients such as calcium, phosphorus, and proteins that contribute to oral health.[3] The proteins, specifically casein phosphopeptides (CPPs), enhance calcium and phosphate availability, promoting remineralization and neutralizing acids.[4] However, different types of milk exhibit varying compositions, influencing their effects on salivary and plaque pH differently.[5] High-protein milk, full-fat milk, and sweetened condensed milk differ significantly in sugar, protein, and fat content, potentially impacting the oral environment.[6] Studies have demonstrated that high-protein dairy products, particularly those

enriched with casein, can maintain a relatively neutral pH in the oral cavity, reducing acidogenic challenges.[7] Full-fat milk has been suggested to form a protective lipid layer on teeth, which may reduce bacterial adhesion and limit acid exposure.[8] On the other hand, sweetened condensed milk is likely to enhance microbial fermentation due to its high sugar content, leading to a more pronounced drop in pH and increasing the risk of dental caries.[9] A study by Vanderhout et al. (2020) emphasized the role of full-fat dairy consumption in children, showing its association with lower adiposity and better overall health.However, concerns remain regarding the cariogenic potential of sweetened dairy products due to their high fermentable carbohydrate content. In contrast, health drinks fortified with milk proteins have demonstrated a buffering effect against pH drops following consumption. Understanding how different milk types influence salivary and plaque pH is critical for making dietary recommendations in pediatric dentistry. This study aims to evaluate and compare the effects of high-protein milk, full-fat milk, and sweetened condensed milk on oral pH at different time intervals, assessing their potential cariogenic or protective effects. Given the widespread consumption of dairy products among children, this study will provide valuable insights for parents, clinicians, and public health policymakers, aiding in the formulation of evidence-based dietary guidelines for oral health maintenance

SUBJECTS AND METHODS

A total of 75 children aged 6-10 years participated in the study. The inclusion criteria included 6-10 year old healthy children without any systemic diseases showing positive and definitely positive behaviour categorized by Frankl's behaviour scale while the exclusion criteria included children under any medications and intolerance to milk protein. They were randomly assigned into three groups of 25 children each, ensuring an equal distribution of participants across the three milk types.

- **Group 1: High-Protein Milk** – Participants in this group consumed 20 mL of commercially available high-protein milk, which contains a higher concentration of casein and whey proteins.
- **Group 2: Full-Fat Milk** – This group consumed 20 mL of full-fat milk, which has a balanced fat and protein composition but lower protein content than high-protein milk.
- **Group 3: Sweetened Condensed Milk** – Children in this group consumed 20 mL of sweetened condensed milk, characterized by its high sugar content and lower protein levels.

Participants were instructed to refrain from eating, or drinking for at least two hours before the study to minimize the influence of external factors on pH measurements.

Sample Collection: Saliva and plaque samples were collected at four-time points: baseline (t0), 15 minutes post-consumption (t1), 30 minutes post-consumption (t2), and 60 minutes post-consumption (t3).

- **Saliva Collection:** Each child was instructed to rinse their mouth with drinking water before the study. At each time interval, unstimulated saliva samples were collected by asking the child to spit into a sterile vial. The samples were immediately analyzed for pH using pH indicator strips
- **Plaque Collection:** Plaque samples were collected from the cervical third of the buccal surfaces of the first permanent molars using a sterile wooden toothpick. The plaque was then transferred to a vial containing deionized distilled water and stirred to create a homogeneous solution.

pH Measurement Procedure: The salivary and plaque pH levels were measured using pH indicator strips (with a range of 4.5 to 9.0) The pH strips were immersed in the collected saliva and plaque solutions for 30 seconds, and the resulting color change was compared to a standard pH chart.

Control Measures

To ensure standardization and minimize variability:

- All measurements were conducted under the same environmental conditions.
- The same examiner conducted all pH readings to maintain consistency.
- The pH meter was calibrated at regular intervals using standard buffer solutions.
- Each participant followed identical instructions regarding pre-study oral hygiene and dietary restrictions.

Statistical Analysis

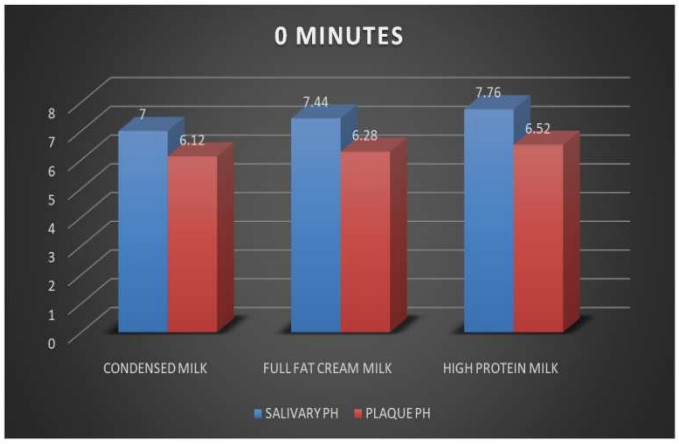
Data were analyzed using the Kruskal-Wallis test to determine statistically significant differences in salivary and plaque pH levels among the three groups at each time interval. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The results indicated statistically significant differences in both salivary and plaque pH levels among the three milk types at various time intervals.

Baseline (t0):

- A significant difference was observed in salivary pH ($p = 0.008$) and plaque pH ($p = 0.045$).
- High-protein milk had the highest salivary (Mean = 7.76) and plaque pH (Mean = 6.52), whereas condensed milk had the lowest values (salivary pH = 7.00, plaque pH = 6.12).



15 Minutes (t1):

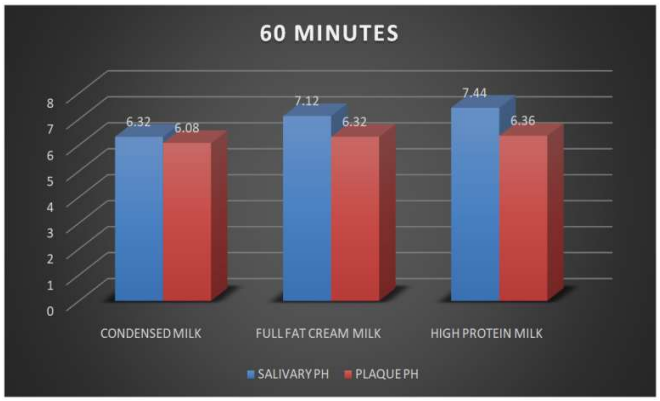
- A highly significant difference ($p < 0.001$) in both salivary and plaque pH was observed.
- Full-fat milk had the highest salivary (Mean = 7.60) and plaque pH (Mean = 6.48), while condensed milk had the lowest values (salivary pH = 6.68, plaque pH = 5.80).

30 Minutes (t2):

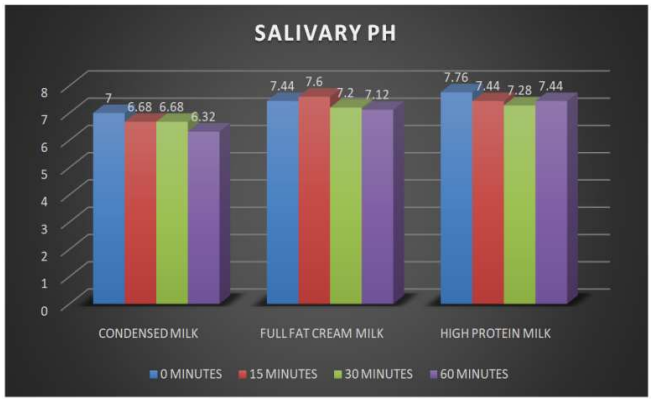
- A significant difference in salivary pH ($p = 0.008$) and a highly significant difference in plaque pH ($p < 0.001$) were noted.
- High-protein milk showed the highest values (salivary pH = 7.28, plaque pH = 6.44), whereas condensed milk had the lowest values (salivary pH = 6.68, plaque pH = 5.44).

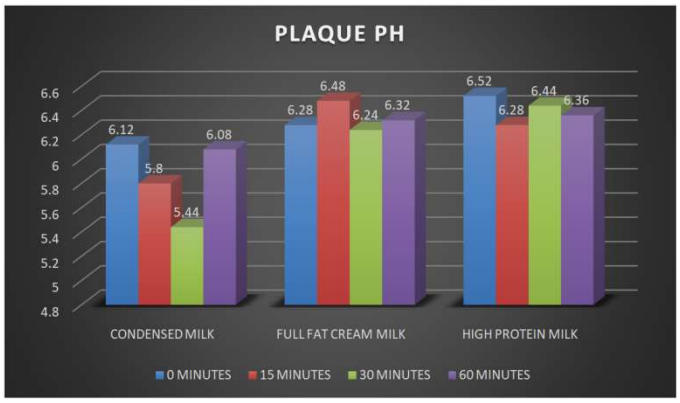
60 Minutes (t3):

- A highly significant difference in salivary pH ($p < 0.001$) was observed, with high-protein milk having the highest value (7.44) and condensed milk the lowest (6.32).
- No significant difference was found in plaque pH ($p = 0.281$), though high-protein milk had the highest pH (6.36) and condensed milk the lowest (6.08).



Combined Graphs





DISCUSSION

The present study aimed to evaluate the impact of different types of milk on salivary pH and plaque pH among children, with a focus on their potential cariogenicity. The findings provide critical insights into the role of milk and its derivatives in maintaining oral health, particularly in pediatric populations. Saliva plays an essential role in maintaining oral homeostasis, aiding in digestion, lubrication, antimicrobial defense, and buffering capacity. The pH levels of saliva and plaque are crucial determinants in the development of dental caries, with a critical pH threshold of approximately 5.5, below which enamel demineralization occurs. The study demonstrated that high-protein milk had the most stable effect on salivary pH, with minimal reductions observed post-consumption.[10]This finding aligns with previous research indicating that proteins contribute to saliva's buffering capacity. Conversely, condensed milk exhibited a more pronounced decrease in pH, likely due to its higher sugar content, which facilitates microbial fermentation and acid production.[11] These results are consistent with prior literature on the cariogenic potential of lactose and other fermentable sugars in dairy products. The comparison with other studies further supports these findings.

A systematic review analyzing cow milk fat consumption suggested that whole milk intake is associated with better dental and overall health outcomes compared to reduced-fat milk. Additionally, a randomized controlled crossover trial evaluating various types of milk on salivary pH confirmed that protein-rich milk had a neutral or slightly alkalizing effect, while sweetened milk led to more significant pH reductions. The present study's findings are in line with previous investigations into the effect of food and beverages on plaque pH. Studies have reported that health drinks such as Horlicks and Complan cause moderate pH drops post-consumption, although not reaching the critical threshold that induces demineralization. In contrast, carbonated beverages and fruit juices have been shown to cause a more rapid and sustained drop in plaque pH, indicating a higher cariogenic potential. A study assessing the effect of biscuits on salivary pH revealed similar trends, where glucose- and chocolate-based biscuits caused significant pH reductions compared to oat and salt biscuits. This suggests that food composition, including the presence of fermentable carbohydrates and buffering agents, significantly influences oral pH dynamics. The findings have several implications for pediatric dental health. First, the consumption of high-protein milk should be encouraged as part of dietary recommendations for children due to its protective effect against acid-induced enamel demineralization. Second, sweetened milk and condensed milk should be consumed in moderation, with appropriate oral hygiene measures to mitigate their potential impact on dental health. Additionally, the study underscores the need for dietary counseling that considers not just the nutritional value but also the cariogenic potential of commonly consumed food items. The inclusion of calcium- and phosphate-rich foods, along with adequate hydration and saliva-stimulating habits, can help maintain optimal oral health. Despite the study's strengths, including its controlled methodology and clinically relevant findings, certain limitations must be acknowledged. The study did not account for individual variations in salivary flow rate, microbiota composition, and oral hygiene habits,

which could influence pH dynamics. Furthermore, long-term studies are necessary to assess the cumulative impact of dietary habits on dental caries progression. Future research should explore the role of additional salivary biomarkers in assessing cariogenic risk, including microbial composition and enzymatic activity. Moreover, cross-sectional studies across diverse populations could provide a broader perspective on dietary influences on oral health.

CONCLUSION

This study highlights the significant impact of different milk types on oral pH, directly influencing caries risk. High-protein milk demonstrated the most protective effect, maintaining the highest salivary and plaque pH levels, thus reducing enamel demineralization. Full-fat milk also contributed to a protective buffering capacity, though to a lesser extent. In contrast, sweetened condensed milk led to a significant drop in pH, creating a more acidic oral environment that fosters cariogenic bacterial growth and increases the likelihood of dental caries. These findings emphasize the necessity of making informed dietary choices, particularly in pediatric populations, to prevent early childhood caries. Clinicians and parents should consider these results when recommending dietary habits for children to optimize oral health outcomes. Further research is encouraged to assess the long-term implications of milk consumption on oral health and explore additional dietary strategies for caries prevention.

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