

The Effect of Sugar-Free Gum on the Salivary pH of Children after Consuming Sweetened Milk

Rouaa Kamel Zamzam¹, Nada Gorge Bshara^{2*}

¹ Master, Pediatric Dentistry, Faculty of Dentistry, Damascus University.

^{2*} Professor, Department of Pediatric Dentistry, Faculty of Dentistry, Damascus University. nada.bshara@damascusuniversity.edu.sy

Objectives: This study aimed to monitor the changes in saliva pH after consuming a package of sweetened and chocolate-flavored milk, then studying the saliva pH changes after consuming a sugar-free gum sweetened with xylitol and sorbitol, in children with different additionally dental caries at the age of 3-5 years after conducting a laboratory study of milk to measure its acidity and the amount of added sugars and proteins to it.

Materials and Methods: A chemical analytical laboratory studied the pH and the amount of sugar and proteins added to milk (sweetened and chocolate flavored milk from (Hawa Al Sham Company). And a clinical observational study, of 30 children aged 3-5 years to find out the change in saliva pH after drinking sweetened and chocolate milk, then the effect of chewing sugar-free gum sweetened with xylitol and sorbitol on the pH.

Results: The results showed that the value of the significance level is smaller than ($P < 05.0$), which means at the 95% confidence level, there are statistically significant binary differences in the salivary pH values between the two time periods before the test, two minutes after consuming milk and saliva pH values after two minutes of eating gum were greater than before the test and two minutes after consuming milk.

Conclusions: Drinking sweetened milk decrease a salivary pH below the resting value, but it did not fall below the critical value (5.5), which means milk remains a non-cariogenic substance even if sucrose and flavorings are added to it. The sugar-free chewing gum sweetened with sorbitol and xylitol had a role in raising the salivary pH values above the resting values, and have the positive effect in preventing dental caries.

Keywords: Saliva pH, Sweetened processed milk, Sugar-free gum, Xylitol, Sorbitol

Received: 7/5/2024

Accepted: 21/7/2024



Copyright: Damascus University- Syria, The authors retain the copyright under a **CC BY- NC-SA**

تأثير العلكة الخالية من السكر على درجة حموضة اللعاب لدى الأطفال بعد تناول الحليب المحلى

رؤى كميل زمزم¹، ندى جورج بشاره*²

¹ ماجستير ، طب أسنان الاطفال، كلية طب الاسنان، جامعة دمشق.

² * استاذ دكتور في قسم طب أسنان الاطفال، كلية طب الاسنان، جامعة دمشق.

nada.bshara@damascusuniversity.edu.sy

الملخص:

هدف البحث: هدفت هذه الدراسة لمراقبة تغيرات pH اللعاب بعد تناول عبوة من أنواع الحليب المحلى والمنكه بالشوكولا ثم دراسة تغيرات pH اللعاب

بعد استهلاك أحد أنواع العلكة الخالية من السكر والمحلاة بالإكزيتول والسوربيتول والمتوفرة بالسوق التجارية عند الأطفال مختلفي الإصابة الخيرية

بعمر 3-5 سنوات بعد إجراء دراسة مخبرية للحليب للتأكد من حموضته و كمية السكريات والبروتينات المضافة له.

المواد والطرق: دراسة مخبرية تحليلية كيميائية لدراسة pH وكمية السكريات والبروتينات الموجودة بالحليب(حليب محلى منكه بالشوكولا من شركة

هوى الشام)، ودراسة مراقبة سريرية لـ30 طفلاً بعمر 3-5 سنوات لمعرفة التغير الحاصل في pH اللعاب بعد تناول أحد أنواع الحليب الصناعي

المحلى والمنكه بالشوكولا ثم أثر تناول العلكة الخالية من السكر والمحلاة بالإكزيتول والسوربيتول على pH.

النتائج: أدى تناول الحليب المحلى والمنكه بالشوكولا إلى انخفاض قيمة pH اللعاب بشكل دال إحصائياً ثم ارتفع بشكل سريع بعد تناول العلكة.

الاستنتاج: انخفضت قيمة pH اللعاب عن القيمة الراحية بعد تناول الحليب المحلى والمنكه بالشوكولا لكن لم تنخفض دون القيمة الحرجة (5.5)،

أي يمكن اعتبار الحليب المستعمل في الدراسة مادة غير محدثة للنخر السنّي حتى إذا تم إضافة السكرز والمنكهات له. وكان للعلكة الخالية من

السكر دوراً في رفع قيم pH اللعاب فوق القيم الراحية، أي كان لها دور إيجابي في الوقاية من النخر السنّي عند أطفال ما قبل المدرسة.

الكلمات المفتاحية: درجة حموضة اللعاب (pH)، الحليب المحلى، علكة خالية من السكر، الإكزيتول، السوربيتول.

Introduction

Dental caries is the main cause of premature tooth loss and malocclusion in children and known as a biochemical process caused by demineralization of dental tissue. In addition to its physical and psychological health implications (Selwitz et al, 2007). Saliva plays an important role in protecting teeth from dental caries, as it contains physical, chemical, anti-bacterial and caries protective factors (Edgar et al, 2006). The normal pH of saliva is (6.7 - 7.4). This number decreases when eating cariogenic foods to reach the critical pH (pH = 5.5) or less at which demineralization begins (Baliga et al, 2013). Milk is considered part of the human diet, especially for children, as it provides adequate nutrition for the child during the growth stage (Aasim, 2016). It's a non-cariogenic food, containing lactose, which causes caries to a moderate degree. However, high concentrations of calcium, phosphorus, vitamins, and proteins, have an antibacterial effect in the oral cavity and raise the pH (Varanganar et al, 2019), in addition to the fact that lactose is the least dietary sugar that causes caries. (Rugg-Gunn et al, 2007). Studies have confirmed that adding sugars or flavorings to milk does not pose a cariogenic risk, as the pH value did not drop below critical value after consuming it (5.5) (Navit et al 2020) (Aasim, 2016). Therefore, it is necessary to study locally produced milk to which various saccharides and flavorings are added and are commonly consumed by children to ascertain their effect on the pH of saliva and thus its effect on oral health. Since that parents consider it a good alternative to other drinks such as soft drinks and fruit juices. Chewing gum is a popular, enjoyable, and repetitive activity for adults and children, mostly consumed by teenagers (Ly & Milgrom, 2006). Currently, most gums sold in Europe are sweetened with sugar substitutes, especially sugar alcohols (polyols). Chewing sugar-free gum after eating stimulates saliva, which contributes to the drainage and removal of deposits, microorganisms, raising the pH of saliva, promoting remineralization of enamel, and primary carious lesions. It is preferable to chew gum after eating meals and foods containing carbohydrates, especially if mechanical teeth cleaning is not possible, but it is not a substitute for it. Therefore, it is necessary to study the effect of locally produced types of sugar-free gum on oral health to encourage parents and children to choose it as an alternative to other sweeteners

that cause dental caries.

The aim of the study

A laboratory study on a type of sweetened and chocolate-flavored milk to determine its acidity and the amount of saccharides and proteins present in it. A study to monitor the changes in saliva pH after consuming a bottle of milk in children with dmft \geq 1 aged 3-5 years. Studying the effect of eating a piece of gum sweetened with Xylitol and Sorbitol on pH value of saliva.

Materials and Methods

Study design

Clinical observational, study, in which the experimental sample is the same as the control sample.

Study sample

After obtaining informed consent from the parents, 30 children aged 3-5 years were selected from Fakhri Naif Al-Ahmad kindergarten, in Damascus, they tested the effect of consuming a glass of the test milk, measuring the pH of saliva before and after consuming the milk and then after consuming sugar-free gum.

Inclusion criteria

A healthy child, free of systemic diseases, cooperating, with temporary occlusion, written consent from the guardian, dmft \geq 1

Exclusion criteria

Taking medications that affect the flow rate or composition of saliva, having an allergy to milk protein or preservatives, orthodontic treatment using space maintainers or removable devices.

Laboratory study

The chemical analytical study of milk was carried out within the Al-Moradi Laboratory for Food Chemical Analysis and the Analytical Laboratory Within the Faculty of Pharmacy, Damascus University. To analyze the pH, saccharides and protein of the tested milk, according to the following:

Measuring the pH of milk

The pH of milk was measured using a pH meter from the German company WTW. It was titrated before making measurements using standard liquids with a pH of 0.7-0.4. For the same company. The container of the tested milk was opened immediately before the measurement and 50 ml of each was poured into a glass beaker, then the electrode was dipped into the tested sample and the pH value shown on the device screen was recorded. The measurement was done at room temperature and the head was washed with distilled water and dried between each measurement.

Titration of the total concentration of saccharides

Fehling's method was adopted (Jain et al, 2020): This method depends on the ability of the returned saccharides to oxidize with heavy metal oxides, where copper oxide is returned to cupric oxide.

Calculating the protein percentage

Using Keldahl method (David M et al, 1990) which relies on estimating the nitrogen in the sample.

Adding the chemical agents to it

(0.5) g of copper sulphate CuSO_4 for each sample and (15) g of Sodium sulfate Na_2SO_4 , for raising the boiling point of the solution to 410-370 degrees Celsius.

Adding 25 ml of 98% concentrated sulfuric acid

The digestion process continues until the solution turns transparent pink. This process takes about 3 hours. After the digestion process was complete, the digestion beak was cooled and transferred to the distillation beak.

The solution was distilled into a receiving beak containing a hydraulic acid solution, and titrated with 0.1 caustic soda until it reached a pinkish-red, orange or yellow color. Finally, converting the percentage of nitrogen to the percentage of protein: Each type of food has a conversion factor. Here, the milk protein conversion factor (6.38) was used.

Method of working in the clinical study

An oral clinical examination was conducted for the children of a kindergarten in the city of Damascus, and 30 of those who met the conditions were selected. They were given written instructions for the research directed to the parents, including: A simplified explanation of the research, its benefit to the child's health, and the date of test Brushing the child's teeth after breakfast and at least two hours before the test. The written consent of the parents, which also includes information about the general diseases of the child and about the medications taken. The next day, after making sure that the parents agreed and followed the instructions, each child was given a serial

number from 1-30, their names were enrolled in the clinical study forms to record salivary pH measurements for each child.

How to measure saliva pH

The pH of saliva was measured using pH strips after cutting it into equal rectangular pieces and placing the piece on the back of the tongue by Dressing plier for several seconds until the required color change was achieved. Saliva here represents the entire oral cavity. First, the resting value of saliva pH had been taken before the child ate any foods, then the child took a cup of the tested milk. After that, saliva pH measurement is taken after 2 mins. Then the child eats a piece of sugar-free gum and the pH changes are measured. The time was set for each child with their own timer on the multi timer application. The pH value was read by the researcher and an external observer by comparing the color of the strip with the color guide attached to the package (according to the company's instructions).

Results

Results of the chemical analytical laboratory study of the tested milk is in Table 1. Results of the clinical study of the protective effect of chewing gum is in Table 2. The Wilcoxon algebraic signed rank test was performed to study the significance of binary differences in saliva pH values between the time periods studied (before the test, two minutes after consuming milk, two minutes after eating gum). Table (3) shows that the that the saliva pH values in the time period (two minutes after consuming milk) were lower than those before the test in the group of eating chocolate-flavored milk, and the saliva pH values two minutes after eating gum were greater than those before the test and after two minutes of drinking milk.

Table 1. Shows the results of the laboratory study of the studied milk

The Studied milk	pH	Protein %	Monosaccharides%	Disaccharides%
Chocolate-flavored	5.51	1.7	3.4	4.8

Table 2. shows the arithmetic mean, standard deviation, standard error, minimum and maximum levels of saliva pH

Type of the studied nutrient	Time period	Arithmetic average	Standard deviation	Standard error	Lowest Level	Highest Level
Chocolate-flavored milk , Sugar free -gum	Before test	6.13	0.36	0.07	5.3	6.8
	Two minutes after drinking the milk	5.69	0.29	0.05	5	6.2
	Two minutes after chewing the gum	6.88	0.25	0.05	5.9	7

Table 3. The results of the Wilcoxon test for the differences in saliva pH values between the 3 time periods studied.

Type of nutrient	Comparison of values between the two periods	The differences between the two averages	Calculated z value	Significance level value	Result of comparison
Chocolate-flavored milk, Sugar free -gum	Two mins after drinking milk – before test	0.44	-4.380	0.000	There are significant differences
	Two mins after chewing gum – before test	0.75	-4.799	0.000	There are significant differences
	Two mins after chewing gum- two mins after drinking milk	1.20	-4.822	0.000	There are significant differences

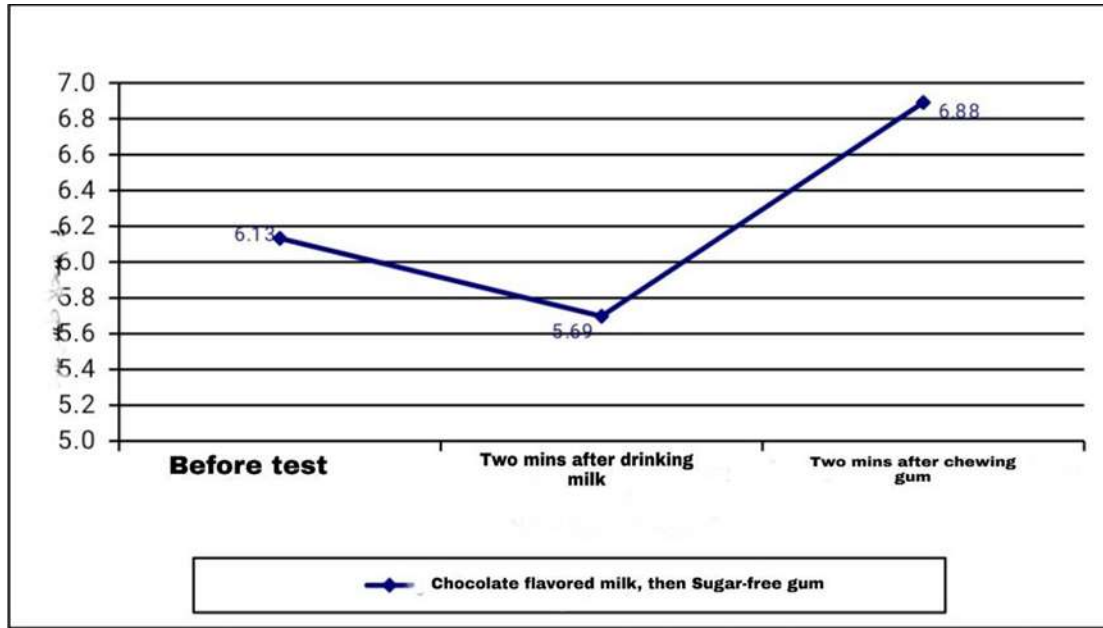


Figure 1. Mean pH values before and after drinking milk and consuming sugar free gum

Discussion

Dental caries remains the most prevalent chronic disease in both children and adults, despite all efforts exerted to control it. There are many reasons that contribute to dental caries, nutrition and sugar are one of the most important of these reasons (2010, Pipsa). The repeated consumption of sugary foods between main meals doubles the risk of dental caries, especially in children during their school period, when the child desires to drink sweetened drinks and sticky foods such as candy and gum. A type of locally produced milk was chosen. The effect of a type of sugar-free gum sweetened with sorbitol and xylitol, also made locally, was tested.

The research was divided into two studies:

A laboratory study aimed to determine the pH degree and total concentration of carbohydrates and proteins of milk produced locally from the Hawa Al-Sham Trading Company (sweetened milk flavored with chocolate) and a crossover clinical study aimed to monitor the short-term effect of saliva pH in children aged 3-5 years after consuming the studied milk and the Sugar-free gum (from Siham Trading Company). Saliva pH test was chosen since that saliva is an indicator of the pH value of dental plaque and it represents oral health (Wu et al, 2018). 30 children aged 3-5 years

were selected, as primary teeth are considered more susceptible to dental caries than permanent teeth due to their early eruption into the oral cavity (6 months), the child does not have the ability to provide proper oral care, in addition to the fact that the thickness of dental enamel and mineralization is less than permanent teeth. With the presence of gaps between teeth in children (Mohsen et al, 2020). Milk consumption in children at this age is greater than in adults (Pipsa et al, 2010). Chewing sugar-free gum with added protective substances such as (xylitol - fluoride - CPP_ACP - Sorbitol) is considered one of the most important strategies used in the world to reduce the risk of dental caries in pre-school children. The clinical study sample was chosen from children who suffer from dental caries because they constitute the largest percentage according to the study (Kouka, 2021). The prevalence of dental caries among kindergarten children in Damascus city, aged 3-5 years old, was 79%. The criteria for selecting the clinical study sample included selecting children who were free of systemic diseases that might affect their cooperation, their salivary secretory function, or their digestive functions and their intake of the foods studied, while

children who were excluded: 1. Those who have allergy to lactose or milk protein. 2. Children that have from gingivitis or periodontitis due to their effect on the acidity of saliva, 3. Children who take medications that affect the secretion of saliva, diseases of the salivary glands, and cases of dry mouth. 4. Children undergoing orthodontic treatment with space-maintainers or removable devices during the research period due to their possible impact on chewing functions and the accumulation of food waste. 5. Children whose parents did not agree to include them in the research sample. 6. Children who were not committed to daily attendance in kindergarten. In the clinical study, the pH of saliva was measured by applying litmus strips to the back of the tongue for 30 seconds, as the saliva here represents the entire oral environment (Disabato et al, 1996), and this method is relatively inexpensive with the possibility of applying it in school outside the laboratory and transporting the necessary materials and tools easily, without the need to take samples whose properties may change during their transportation and storage. This method has been used by both (Tayab, 2012) (Al-monakel & Bashara, 2016). Parents were instructed to serve breakfast for their child before coming to school as an ethical aspect related to the child's nutrition, general health, and academic achievement. Brush the teeth at least two and a half hours before the test time. In order to focus on the importance of brushing their teeth after breakfast before going to school, and protecting them from exposure to acids resulting from the fermentation of food residues during school hours. which may exceed 6 hours per day. The period of two and a half hours was determined between brushing and starting to take measurements because it is the sufficient time for the toothpaste effect to disappear from the pH of saliva, according to (Tayab, 2012) study. Teachers were instructed to monitor the children not to eat any foods. Each child was asked to take his brush and toothpaste to school to brush his teeth after eating the tested foods

.Discussing the results of the laboratory study:

The average pH value of the tested milk was (5.51), which is lower than the pH value of cow's milk, which ranges between (6.7-6.4) (Ahmad, 2008). It must be taken into account that the amount of acid

produced within the mouth due to bacterial activity that converts saccharides into acid is greater than those available within the food itself. The percentage of tested milk saccharides was 3.4% monosaccharides and 4.8% disaccharides, as stated on the product package (11g). This percentage is considered high for children, and it is preferable to choose other types of milk that contain a lower percentage of added saccharides. Children tend to choose foods that contain mostly carbohydrates during their time in school, which are considered low in nutritional value and high in calories and do not contribute effectively to the general health of the body and are considered to cause dental caries. While the percentage of proteins in the tested milk reached (1.7%), this percentage is acceptable for children aged 3-5 years, but it is not considered a primary source of the amount of protein that the child needs, which must be proportional to the age and weight of the child.

Discussing the results of the clinical study:

Saliva pH value decreased with a statistically significant difference from the rest value two minutes after consuming milk, but it did not decrease below the critical value (5.5) that causes enamel demineralization, according to (Selwitz et al, 2007). This confirms that the tested milk is a substance that does not cause dental caries, and this It agrees with the study of (Sham et al, 2016) (Navit et al, 2020) (Aasim, 2016). However, the amount of this milk that children consume during the day must be taken into account, as it is considered a fast food that is considered low in nutritional value and high in calories. The results of the study of the protective effect of sugar-free gum also showed that saliva pH values increased two minutes after eating gum more than the rest values and more than the values after consuming milk, with a statistically significant difference. Which shows the importance of eating sugar-free gum sweetened with sorbitol and xylitol or with other protective substances added after meals in adjusting the pH value of saliva. This is consistent with (Tatiya N et al, 2022) (Dong, 2003). Therefore, mothers must be educated to monitor what children eat at school and replace foods that cause dental caries with alternative foods that have a preventive effect and high nutritional value.

Conclusions

Consuming sweetened milk flavored with chocolate led to a decrease in saliva pH value below the resting value, but it did not decrease below critical value (5.5), meaning that milk remains a substance that does not cause dental caries even if sucrose and flavorings are added to it. Sugar-free gum had a role in raising saliva pH values above resting values, and had a positive effect in preventing dental caries.

Funding information: this research is funded by Damascus university – funder No. (501100020595).

References

- Ahmad, S. and Gaucher I, Effects of acidification on physico-chemical characteristics of buffalo milk: A comparison with cow's milk. *Gaucheron Food Chemistry*, (2008) 106(1)
- Al-monakel, S .and Bshara, N, Children's Snacking Habits at Schools and Mother's Nourishment Knowledge. *Current Nutrition & Food Science*, (2016) 13(1)
- Baliga, S, Muglikar, S. and Kale, R, Salivary pH: A Diagnostic Biomarker *Journal of Indian Society of Periodontology*, (2013) 17(4)
- Brostek A, Bochenek A, Walsh L, Shanghai Kou Qiang Yi Xue Shanghai, Minimally invasive dentistry: a review and update. *Journal of Stomatology*.
- Dietary Guidelines for Americans USDA 2015 – 2020 Dietary Guidelines for Americans (8th edition) (2015)
- DiSabato-Mordarski, T. and Kleinberg, I, Measurement and comparison of the residual saliva on various oral mucosal and dentition surfaces in humans. *Archives of Oral Biology*, (1996) 41(7)
- Disabato-Mordarski, T. and Kleinberg, I, Use of a paper-strip absorption method to measure the depth and volume of saliva retained in embrasures and occlusal fissure of the human dentition. *Archives of Oral Biology*, (1996) 41(8-9)
- Edgar, W, Higham, S. and Manning, R, Saliva stimulation and caries prevention. *Advances in dental research*, (2006)
- Jirattanasopha V, Pruetpongpun N, Sangunsin S, Effect of non-fluoridated milk and fluoridated milk on acidic dental plaque. *Pediatric Dental Journal* (2019) 29(2)
- Keukenmeester, Slot D, Van der Weijden G, The effect of medicated, sugar-free chewing gum on plaque and clinical parameters of gingival inflammation: A systematic review. *International Journal of Dental Hygiene*, (2013)
- Keukenmeester, The effect of maltitol sweetened chewing gum on the oral microbiology -RCT-NTR4165 <http://www.who.int/trialsearch/Trial2.aspx?TrialID=NTR4165> (2013)
- Kyttälä, P. and Virtanen, S, Food consumption and nutrient intake in Finnish 1–6-year-old children. *Public Health Nutrition*, (2010) 13(6A)
- Ozdemir, Dental Caries and Preventive Strategies. *JOURNAL OF EDUCATIONAL AND INSTRUCTIONAL STUDIES*, (2014) 4(4)
- Ozdemir, Dental Caries: The Most Common Disease Worldwide and Preventive Strategies. *International Journal of Biology*, (2013) 5(4)
- Rugg-Gunn, A, Adamson, A. and Hackett, A, Sugars consumption by 379 11–12-year-old English children in 1990 compared with results in 1980. *Journal of Human Nutrition and Dietetics*, (1993) 6(5)

16. Rugg-Gunn A, Dental caries: strategies to control this preventable disease. *Acta Medica Academica*, (1993)
17. Scannapieco, F, *Pneumonia and Oral Pathogens*, (2014)
18. Schachtele C, Jensen M, Comparison of Methods for Monitoring Changes in the pH of Human Dental Plaque. *Journal of Dental Research* (1982) 61(10)
19. Selwitz R, Ismail A, Pitts N, Dental caries. *Lancet*, (2007)
20. Shah A, Comparison of changes in salivary pH levels after consumption of plain milk and milk mixed with Sugar. *International Archives of Integrated Medicine*, (2016)
21. T, Rai K. and Tayab Thomas, Effect of chewing paneer and cheese on salivary acidogenicity: a comparative study. *International journal of clinical pediatric dentistry* (2012) 5(1)
22. Welle S, Thornton C, McHenry B, Post-prandial myofibrillar and whole-body protein synthesis in young and old human subjects. *American Journal of Physiology - Endocrinology and Metabolism*, (1994) 267(4 30-4)

