Selcuk Dental Journal 11/1 (Nisan 2024): 43-48

**Research Article** / Araştırma Makalesi

# Effect of Chewing Gums with Different Contents on Salivary Flow Rate, pH, and Ion Exchange

## Farklı İçerikli Cikletlerin Tükürük Akış Hızı, pH ve İyon Değişimine Etkisi

**Handan YILDIRIM IŞIK**[a](ORCID-0000-0001-8850-3523)

[a]Istanbul Beykent University Faculty of Dentistry Department of Restorative Dentistry, İstanbul, Türkiye
[a]İstanbul Beykent Üniversitesi Diş Hekimliği Fakültesi Restoratif Diş Tedavisi AD, İstanbul, Türkiye

**ABSTRACT**

**Objective:** Aim of this study is to examine the effects of chewing gums with different contents on the salivary flow rate, pH, and ion exchange in healthy subjects.

**Material and Method:** Twenty healthy individuals with DMFT scores of ≤ 4, who did not use any medication or diagnosed with any systemic disease that could change the flow and characteristics of saliva were selected as the study sample. The unstimulated saliva of all individuals on day one was collected in sterile test tubes. After 24 hours, saliva stimulated by chewing paraffin was collected from each individual as a control group. Then, five different chewing gums were used for 6 minutes for seven days at 24-hour intervals (Vivident Xylit, Oneo White, Trident Recaldent, Fluogum, CB12 Boost). Saliva samples were collected graduated sterile test tubes at 0-1, 1-3, and 3-6 minute intervals. The pH of saliva collected at the end of each test period was measured with litmus paper to minimize any time-dependent pH changes. The flow rate was calculated in ml/min. Ion exchanges were evaluated according to the spectrophotometric method. Statistical analysis was performed using IBM SPSS Statistics, Version 23.0 statistical program. Statistically significance level was set as $p<0.05$.

**Results:** The calcium concentration of the collected saliva was higher in the gum group containing tricalcium phosphate than in the other groups. Calcium carbonate containing gum group showed increased salivary flow rate and higher pH when compared to other groups.

**Conclusion:** Chewing gum containing calcium carbonate and tricalcium phosphate may have beneficial effects on the structure of saliva and beneficial effects in terms of oral and dental health. Chewing gums containing calcium carbonate and tricalcium phosphate may be preferred as a priority, especially in individuals with high caries risk and xerostomia patients.

**Keywords:** Calcium concentration, Chewing gum, Ion Exchange, pH, Salivary flow rate

**ÖZ**

**Amaç:** Bu çalışmanın amacı, farklı içeriklere sahip cikletlerin sağlıklı bireylerde tükürük akış hızı, pH ve tükürük iyonları üzerine etkilerini incelemektir.

**Gereç ve Yöntemler:** DMFT skoru ≤ 4 olan, herhangi bir ilaç kullanmayan veya tükürük akışını ve özelliklerini değiştirebilecek herhangi bir sistemik hastalığı olmayan 20 sağlıklı birey çalışma örneklemi olarak seçildi. Birinci gün tüm bireylerin uyarılmamış tükürükleri steril test tüplerinde toplandı. 24 saat sonra kontrol grubu olarak parafin çiğnetilerek her bireyden uyarılmış tükürükleri toplandı. Daha sonra yedi gün boyunca 24 saat arayla beş farklı ciklet (Vivident Xylit, Oneo White, Trident Recaldent, Fluogum, CB12 Boost) 6 dakika süreyle çiğnettirildi. Dereceli steril test tüplerine 0-1, 1-3 ve 3-6 dakika aralıklarla tükürük örnekleri alındı. Her test periyodunun sonunda toplanan tükürüğün pH'ı, zamana bağlı pH değişikliklerini en aza indirmek için turnusol kâğıdı ile ölçüldü. Akış hızı ml/dk olarak hesaplandı. İyon değişimleri spektrofotometrik yönteme göre değerlendirildi. İstatistiksel analiz, IBM SPSS Statistics, Version 23.0 istatistik programı kullanılarak yapıldı. İstatistiksel olarak anlamlılık düzeyi $p<0,05$ olarak belirlendi.

**Bulgular:** Toplanan tükürüğün kalsiyum konsantrasyonu trikalsiyum fosfat içeren sakız grubunda diğer gruplara göre daha yüksek bulunmuştur. Kalsiyum karbonat içeren sakız grubu, diğer gruplara göre daha yüksek tükürük akış hızı ve daha düşük pH göstermiştir.

**Sonuç:** Kalsiyum karbonat ve trikalsiyum fosfat içeren cikletlerin tükürüğün iyon yapısı üzerinde faydalı etkileri olabileceği gibi ağız ve diş sağlığı açısından da faydalı etkileri olabilir. Özellikle yüksek çürük riskli bireklerde ve kserostomili hastalarda kalsiyum karbonat ve trikalsiyum fosfat içerikli cikletler öncelikli olarak tercih edilebilir.

**Anahtar Kelimeler:** İyon Değişimi, Kalsiyum konsantrasyonu, pH, Tükürük akış hızı

## Introduction

Saliva is considered to be one of the important factors in maintaining oral health[1,2] by preventing the demineralization of enamel with its flow rate, buffering agents, and mineral contents such as phosphate, fluorine, and calcium.[3-5]

One of the important factors affecting saliva's composition is saliva's flow rate.[6] Increasing salivary flow rate increases protein, sodium, bicarbonate, and chloride levels while decreasing magnesium and phosphate levels.[7] In addition, with the increase in salivary flow rate, the acid potential of harmful substances such as plaque and sugar is neutralized. In the literature, it is recommended to chew sugar-free gum for 5-30 minutes after meals. This will stimulate the salivary flow rate, which buffers and neutralizes the pH drop after meals. Thus, the pH of the microbial dental plaque increases.[8,9]

Different types of caries preventive agents in chewing gums have been described. The most widely used of these is Xylitol, a natural 5-carbon sugar.[10,11] While many studies have investigated the effect of chewing gum containing Xylitol on salivary flow rate and pH, there is no comparative, up-to-date study investigating the effects of chewing gum containing different caries-preventing agents such as Tricalcium Phosphate (TP), Calcium Carbonate (CC), Zinc (Z), and Fluorine (F) on saliva pH and flow rate. Therefore, this study aimed to examine the effects of chewing gums with different contents on the salivary flow rate, pH, and ion exchange in healthy subjects. The null hypothesis was that there is no relation between salivary Ca+2 ion exchange, flow rate, and pH levels with different chewing gums.

## Material and Method

The study sample consisted of saliva collected from 20 healthy, non-smoker dental students with DMFT scores of ≤ 4, who did not use any medication or diagnosed with any systemic disease that could change the flow and characteristics of saliva. All participants were clinically examined and interviewed by the same researcher. The number of samples was determined by the statistical power analysis (Power: 0.80 and α: 0.05) as n=20. All participants were asked to sign an informed consent form before starting the study.

The study consists of two stages: 1) Comparison of salivary flow rate and pH by chewing gums on volunteers; 2) Comparison of the effect of chewing gums on salivary Calcium ($Ca^{+2}$) ion. Different chewing gums and their active contents used in this study are listed in **Table 1**.

**Gönderilme Tarihi/Received:** 9 Mayıs, 2023
**Kabul Tarihi/Accepted:** 6 Kasım, 2023
**Yayınlanma Tarihi/Published:** 26 Nisan, 2024
**Atıf Bilgisi/Cite this article as:** Yıldırım Işık H. Effect of Chewing Gums with Different Contents on Salivary Flow Rate, pH, and Ion Exchange. Selcuk Dent J 2024;11(1): 43-48 Doi: 10.15311/ selcukdentj.1292843

**Sorumlu yazar/Corresponding Author:** Handan YILDIRIM IŞIK
**E-mail:** yildirimhandan91@hotmail.com
**Doi:** 10.15311/ selcukdentj.1292843

**Table 1. The names and contents of the chewing gums used in the study.**

| Chewing Gum Name | Active component |
|---|---|
| Vivident Xylit | Xylitol |
| Oneo White | Calcium Carbonate |
| Trident Recaldent | Tricalcium Phosphate |
| Fluogum | Xylitol + Fluor |
| CB12 Boost | Zinc + Fluor |

Saliva sample collection was performed based on the guidelines from the University of Southern California School of Dentistry.12 Participants were asked not to eat, drink, or chew gum until at least one hour before the saliva collection period. To avoid the effects of circadian rhythms on salivary flow rate, the study was planned to be conducted between 9:00 and 11:00 a.m. On day one, unstimulated saliva was collected from all participants for 6 minutes at 0-1, 1-3, and 3-6 minute intervals before chewing gum. After 24 hours, as a control group, saliva samples were collected in sterile tubes by chewing paraffin for 6 minutes at the same time intervals for each individual. In the following days, each individual was given the chewing gum we included in the study and chewed for 6 minutes at the same time intervals. At the earliest, 24 hours was waited to allow salivary flow rates and pH to return to basal levels before chewing other gum with different contents.

Saliva collection was performed using disposable graduated sterile tubes. The salivary flow rate was calculated by dividing the volume of collected saliva in milliliter (mL) by the time required for collection in minute (min) flow rate (mL/min) = volume (mL)/time (min).[13] The pH of the sampled saliva was measured immediately after collection using litmus paper to minimize any time-dependent pH changes. For the determination of $Ca^{+2}$ ion, 14 randomly selected samples determined by power analysis were sent to Yıldız Technical University Central Laboratory. Ion determination was made with Perkin Elmer Optima 2100 DV Atomic Emission Spectrometer (Perkin Elmer Inc., Wellesley, USA). This study was carried out with the approval of Istanbul Yeni Yüzyil University Faculty of Dentistry Ethics Committee dated 04 October 2021 (Decision No: 2021/ 10-718). All study parameters were conducted in accordance with the Declaration of Helsinki.

### Statistical Analysis

Statistical analysis was done with IBM SPSS Statistics for Windows, Version 23.0 statistical program. The conformity of the measurable data to the normal distribution was checked with Shapiro-Wilk tests. Kruskal Wallis analysis of variance was used for comparisons between groups that did not show normal distribution, Mann Whitney U test was used for pairwise comparisons, and analysis of variance was used for groups with normal distribution. Median (Min-Max) values and arithmetic mean ± standard deviation were given as descriptive statistics. The limit of significance for all statistics was taken as $p<0.05$.

### Results

Saliva pH measurement results according to various groups and times are given in **Table 2**. According to these results, when the comparisons within each group were examined, it was seen that there was no significant relationship between time and pH in all groups. When the relationships between different groups at the same time intervals were examined (**Table 3**), it was observed that there were significant differences. After applying Calcium Carbonate (Oneo) and Xylitol (Vivident) gums between 0-1 min, statistically significantly higher pH values were obtained from the stimulated saliva (chewing Paraffin) and the unstimulated groups. In the 1-3 minutes range, the pH values obtained in the Calcium Carbonate group were significantly higher than the unstimulated, stimulated (chewing Paraffin) and Zinc + Fluor (CB12) groups. Between 3-6 minutes, the pH of the Calcium Carbonate group was found to be significantly higher than all other groups except the Xylitol group.

**Table 2. Saliva flow rate according to various groups and times. Aroused, CB12, Oneo, Vivident. Different capital letters indicate significant differences between groups (A, B, C).**

| Groups | Time (min) | Salivary flow rate (mL/min) | |
|---|---|---|---|
| | | Mean±SD | Median (Min-Max) |
| **Unstimulated** | 0-1 | 2.1±0.84A | 2(0.5-3) |
| | 1-3 | 1.4±0.4.1AB | 1.3(0.33-2.33) |
| | 3-6 | 1.2±0.4.1B | 1.21(0.5-2.08) |
| **Stimualted** | 0-1 | 3.55±0.07A | 3.5(1-5) |
| | 1-3 | 2.83±0.92B | 2.5(1.33-4.33) |
| | 3-6 | 2.6±0.87B | 2.5(1.17-4) |
| **CB12** | 0-1 | 5.75±2.32A | 5(4-12.5) |
| | 1-3 | 3.9±1.2B | 4.16(2.5-6) |
| | 3-6 | 3.01±0.01B | 2.91(1.91-5) |
| **Trident** | 0-1 | 5.25±1.26A | 5(3-7.5) |
| | 1-3 | 3.62±1.18B | 3.66(1.67-5.83) |
| | 3-6 | 2.84±1.03B | 2.5(1.17-5) |
| **Fluogum** | 0-1 | 5.79±1.68A | 5(3-10) |
| | 1-3 | 3.42±0.95B | 3.33(1.5-5.33) |
| | 3-6 | 2.58±0.72B | 2.5(0.8-3.8) |
| **Oneo** | 0-1 | 6.22±1.6A | 5.75(4-10) |
| | 1-3 | 4.27±1.27B | 4.16(2-6.67) |
| | 3-6 | 3.22±1.28B | 3.25(1.67-5.5) |
| **Vivident** | 0-1 | 5.45±0.9A | 5(4-7) |
| | 1-3 | 3.42±0.85B | 3.33(2-6) |
| | 3-6 | 2.68±0.75C | 2.5(1.7-4.3) |

**P<0,05.*

**Tablo 3. Intergroup salivary flow rate values at the same time intervals. 3-6 min: ANOVA, 0-1 and 1-3 min: Kruskal Wallis, Mann Whitney U. Different capital letters indicate significant differences between groups.**

| Time (min) | Group | Salivary flow rate (mL/min) | | p |
|---|---|---|---|---|
| | | Mean±SD | Median (Min-Max) | |
| 0-1 | Unstimulated | 2.1±0.84A | 2(0.5-3) | 0.000* |
| | Stimulated | 3.55±0.97A | 3.5(1-5) | |
| | CB12 | 5.75±2.32B | 5(4-12.5) | |
| | Trident | 5.25±1.26B | 5(3-7.5) | |
| | Fluogum | 5.79±1.68B | 5(3-10) | |
| | Oneo | 6.22±1.6B | 5.75(4-10) | |
| | Vivident | 5.45±0.9B | 5(4-7) | |
| 1-3 | Unstimulated | 1.4±0.41A | 1.3(0.33-2.33) | 0.000* |
| | Stimulated | 2.83±0.92BC | 2.5(1.33-4.33) | |
| | CB12 | 3.9±1.2B | 4.16(2.5-6) | |
| | Trident | 3.62±1.18B | 3.66(1.67-5.83) | |
| | Fluogum | 3.42±0.95B | 3.33(1.5-5.33) | |
| | Oneo | 4.27±1.27BD | 4.16(2-6.67) | |
| | Vivident | 3.42±0.85B | 3.33(2-6) | |
| 3-6 | Unstimulated | 1.2±0.41A | 1.21(0.5-2.08) | 0.000* |
| | Stimulated | 2.6±0.86B | 2.5(1.17-4) | |
| | CB12 | 3.01±0.91B | 2.91(1.91-5) | |
| | Trident | 2.84±1.03B | 2.5(1.17-5) | |
| | Fluogum | 2.58±0.72B | 2.5(0.8-3.8) | |
| | Oneo | 3.32±1.28B | 3.25(1.67-5.5) | |
| | Vivident | 2.68±0.75B | 2.5(1.7-4.3) | |

**P<0.005*

A significant difference was observed between the amounts of saliva over time in each group. The amount of saliva between 0-1 minutes in each group was statistically significantly higher than the amount of saliva between 3-6 minutes (**Table 4**).

**Table 4. Saliva pH values according to various groups and times.**

| Groups | Time (min) | pH | | p |
|---|---|---|---|---|
| | | Mean±SD | Median (Min-Max) | |
| **Unstimulated** | 0-1 | 6.9±0.31 | 7(7-6) | |
| | | 6.9±0.31 | 7(7-6) | >0.999 |
| | | 6.9±0.31 | 7(7-6) | |
| **Stimualted** | 0-1 | 6.9±0.31 | 7(7-6) | |
| | | 6.95±0.22 | 7(7-6) | 0.768 |
| | | 6.95±0.22 | 7(7-6) | |
| **CB12** | 0-1 | 7±0 | 7(7-7) | |
| | | 7.05±0.22 | 7(7-8) | 0.601 |
| | | 7.05±0.22 | 7(7-8) | |
| **Trident** | 0-1 | 7.1±0.31 | 7(7-8) | |
| | | 7.15±0.49 | 7(6-8) | 0.884 |
| | | 7.15±0.49 | 7(6-8) | |
| **Fluogum** | 0-1 | 7±0 | 7(7-7) | |
| | | 7.15±0.37 | 7(7-8) | 0.194 |
| | | 7.15±0.37 | 7(7-8) | |
| **Oneo** | 0-1 | 7.3±0.47 | 7(7-8) | |
| | | 7.5±0.61 | 7(7-9) | 0.150 |
| | | 7.65±0.59 | 7(7-9) | |
| **Vivident** | 0-1 | 7.3±0.46 | 7(7-8) | |
| | | 7.3±0.47 | 7(7-8) | >0.999 |
| | | 7.3±0.47 | 7(7-8) | |

**P<0.05.*

Comparison of saliva amount at the same time intervals between all groups revealed that the least amount of saliva was in the unstimulated saliva for each chewing gum group (**Table 5**). The amount of saliva obtained in the unstimulated saliva at each time interval was statistically significantly lower than all other groups. The highest amount of saliva in all groups was determined in the Calcium Carbonate group. While there was no significant difference in the amount of collected saliva between the stimulated and unstimulated groups 0-1 min, there was a significant difference between these two groups and all other groups. At the 1-3 min time interval the amount of collected saliva in the unstimulated group was significantly lower than all groups. The highest amount of collected saliva was observed in the Calcium Carbonate group, and there was only a significant difference between unstimulated and stimulated saliva groups. At the 3-6 min time interval, only the unstimulated group was statistically significantly lower than the other groups.

**Table 5. Intergroup pH values at the same time intervals. Different capital letters indicate significant differences between groups.**

| Time (min) | Group | pH | | p |
|---|---|---|---|---|
| | | Mean±SD | Median (Min-Max) | |
| 0-1 | Unstimulated | 6.9±0.31A | 7(7-6) | 0.000* |
| | Stimulated | 6.9±0.31A | 7(7-6) | |
| | CB12 | 7±0AB | 7(7-7) | |
| | Trident | 7.1±0.31AB | 7(7-8) | |
| | Fluogum | 7±0AB | 7(7-7) | |
| | Oneo | 7.3±0.47B | 7(7-8) | |
| | Vivident | 7.3±0.47B | 7(7-8) | |
| 1-3 | Unstimulated | 6.9±0.31A | 7(7-6) | 0.000* |
| | Stimulated | 6.95±0.22A | 7(7-6) | |
| | CB12 | 7.05±0.22A | 7(7-8) | |
| | Trident | 7.15±0.49AB | 7(6-8) | |
| | Fluogum | 7.15±0.37AB | 7(7-8) | |
| | Oneo | 7.5±0.61B | 7(7-9) | |
| | Vivident | 7.3±0.47AB | 7(7-8) | |
| 3-6 | Unstimulated | 6.9±0.31A | 7(7-6) | 0.000* |
| | Stimulated | 6.95±0.22A | 7(7-6) | |
| | CB12 | 7.05±0.22A | 7(7-8) | |
| | Trident | 7.15±0.49A | 7(6-8) | |
| | Fluogum | 7.15±0.37A | 7(7-8) | |
| | Oneo | 7.65±0.59B | 7(7-9) | |
| | Vivident | 7.3±0.47AB | 7(7-8) | |

**P<0.05.*

Statistically significantly higher pH values were obtained from the chewing gum group containing Calcium Carbonate at 0-1, 1-3, and 3-6 minutes time intervals compared to the other groups.

Evaluation of the salivary flow rate showed that the amount of saliva in the 0-1 minutes time interval in each group was statistically significantly higher than the amount of 3-6 minutes time interval, and the highest flow rate in all groups was found in the Calcium Carbonate group.

In addition, $Ca^{+2}$ mineral analysis was performed on three samples from each group, and the average values are given in **Table 6**. The highest $Ca^{+2}$ values were observed in the Tricalcium Phosphate group, and the lowest in the unstimulated group, followed by the stimulated saliva group. The difference between $Ca^{+2}$ values of Zinc + Fluor, Calcium Carbonate, and Xylitol + Fluor was not statistically significant.

As a result, according to the findings obtained in this study, it was observed that Calcium Carbonate containing chewing gums gave more significant results in an increase in pH value and an increase in the amount of saliva while chewing gums containing Tricalcium Phosphate gave more significant results in an increase in $Ca^{+2}$ ion value.

**Table 6. $Ca^{+2}$ ion values between groups.**

| Group | Ca values |
|---|---|
| | Mean (mgkg-1) |
| Unstimulated | 15.56 |
| Paraffin | 19.44 |
| CB12 | 47.1 |
| Trident | 85.67 |
| Fluogum | 51.23 |
| Oneo | 45.96 |

**Discussion**

Saliva has an enormous capacity to prevent the initiation and progression of dental caries, and research with saliva is at the forefront of these studies.[2,9] Saliva flow rate, saturation with tooth minerals, buffering capacity, the amount of fluorine, calcium, and phosphate that the saliva contains are the most critical subjects of saliva studies.

As the salivary flow rate changes throughout the day (circadian rhythm), it is important to standardize the hours at which saliva is collected in salivary flow rate studies. According to previous literature, it has been reported that the flow rate of saliva collected in the morning will be lower than that of saliva collected in the afternoon.[14,15] In addition, it has been reported that the flow rate is also affected by position, light, odor, and taste stimulation.[16] Besides, in many studies, chewing paraffin has been used to stimulate saliva flow because it is tasteless and odorless.[10,17-21] Therefore, in this study, saliva samples were collected according to these limitations mentioned before and paraffin used as a control group for the detection of stimulated salivary flow rate. At neutral pH, saliva secreted from stimulated and unstimulated parotid and submandibular glands is saturated with $Ca^{+2}$, but salivary-induced remineralization occurs very slowly due to the low ion concentration gradient in saliva.[22,23] For this reason, more effective and rapid calcifying agents and agents that increase salivary $Ca^{+2}$ are needed to ensure remineralization, and research on this subject continues.[24] In studies on this subject, it has been reported that chewing gums containing different components such as $Ca^{+2}$, phosphate, fluoride, and sorbitol are different types of caries preventive agents. Studies have shown that remineralization is provided on the tooth surface in contact with oral fluids, with the increase in $Ca^{+2}$ and phosphate concentrations in the mouth during chewing gum containing Calcium-Phosphate.[25-30] According to some researchers, it has been recommended to chew sugar-free gum for 5 to 30 minutes after meals, because chewing gum stimulates saliva flow rate, which buffers and neutralizes the pH drop that occurs after meals.[1,31] Sjogren observed that salivary flow rate and pH value increased rapidly after chewing gums. The findings of this study have confirmed the same results that the saliva pH values of chewing gums with different contents increased rapidly.

There are different types of caries preventive agents in the contents of chewing gums. The most widely used of these is xylitol. Xylitol, which cannot be metabolized by bacteria in the oral flora, has been observed to decrease salivary Streptococcus Mutans levels in many studies.[10] It is also known that xylitol increases the salivary flow rate and buffering capacity, thus increasing the intraoral pH value. The $OH^-$ ions in xylitol bind with calcium and phosphate ions in the saliva, keeping the $Ca^{+2}$ level in the saliva and mouth at a certain level.[11,31] The fluor ion in chewing gum has advantages such as accelerating the precipitation of calcium and phosphate ions from the saliva on the tooth surface and being bactericidal. Therefore, the presence of fluoride in saliva and plaque is very important.[32] In addition to $Ca^{+2}$ ion, fluor ion also has an important place in preventing caries formation. Many studies have investigated salivary fluor levels after consumption of fluor-containing toothpastes, mouthwashes, chewing gums, tablets, and water. However, it has been reported that saliva fluor concentrations increase after a single use of these applications, but return to their former concentrations within a few hours.[33-36] However, the amount of floride in the drinking water of the region should be taken into consideration before recommending flouride-containing gums to patients.[37] For this reason, only $Ca^{+2}$ ion concentration has been investigated in this study. Calcium carbonate, another anti-caries agent found in chewing gums, has an alkaline pH, and its solubility is very low at neutral pH. Therefore, its effect on plaque acidogenicity is limited, but small particles are deposited in dental plaque even hours after brushing with calcium carbonate toothpaste. Since calcium carbonate neutralizes plaque acidogenicity, it potentiates the effect of fluor.[32,38] Tricalcium phosphate, on the other hand, is a biomaterial with a chemical formula of $Ca_3PO_4$ in alpha and beta form.[39] Some researchers have reported that the use of chewing gum containing 2.5% alpha Tricalcium phosphate caused a small increase in plaque and calcium phosphate levels in saliva.[29] Alpagot et al.[16] have shown in their study that the reduction of calcium and phosphate ions in saliva would increase the rate of enamel dissolution. According to results of another study that evaluated the effect of alpha amylase, calcium, magnesium, phosphate on buffering capacity and pH in saliva, no statistically significant relationship was observed between these parameters.[5] On the other hand, Ben-Arhey et al.[40] reported a statistically significant relationship between caries and zinc, magnesium and calcium concentrations in human saliva. Besides, in many previous researches it has been determined that calcium-phosphate containing chewing gums increase the calcium and phosphate ions in the saliva during chewing and thereby increasing the mineral saturation of the tooth surfaces and providing remineralization in contact with oral fluids.[25] Vogel et al.[29] reported that the use of chewing gum containing 2.5% alpha tricalcium phosphate caused a small increase in calcium phosphate levels in saliva and dental plaque. Similar to these findings, in the present study it was observed that chewing gums containing calcium phosphate increased the salivary flow rate by 2-3 times. Shen et al.[41] determined that the calcium phosphate-containing chewing gums increased the salivary flow rate by 4-7 times. In addition, in their study, they advocated that salivary calcium concentrations increased, while salivary phosphate concentrations decreased.

According to this study data, statistically significantly higher pH values were obtained from the chewing gum group containing calcium carbonate at 0-1, 1-3, and 3-6 minutes time intervals than the other groups. This result may be due to the effect of calcium carbonate on the buffering capacity of saliva.

**Limitation of the Study**

In the present study, litmus paper tips were used to measure pH instead of a pH meter because it gives faster results. Flour ion concentrations could not be detected in saliva samples because of time limitations.

**Conclusion**

Within the limitations of this study, according to the findings, it may be concluded that using chewing gums containing calcium carbonate and tricalcium phosphate is an effective method in increasing saliva pH and flow rate when necessary. Patients with higher risk of caries or dry mouth could be advised to use this chewing gum. However, since there are not enough studies in the literature on the remineralization capacity of tricalcium phosphate and calcium carbonate, more studies are required before it can be used as a caries preventive material.

**Değerlendirme / Peer-Review**

İki Dış Hakem / Çift Taraflı Körleme

**Etik Beyan / Ethical statement**

Bu makale, sempozyum ya da kongrede sunulan bir tebliğin içeriği geliştirilerek ve kısmen değiştirilerek üretilmemiştir.

Bu çalışma, yüksek lisans ya da doktora tezi esas alınarak hazırlanmamıştır.

Bu çalışmanın hazırlanma sürecinde bilimsel ve etik ilkelere uyulduğu ve yararlanılan tüm çalışmaların kaynakçada belirtildiği beyan olunur.

This article is not the version of a presentation.

This article has not been prepared on the basis of a master's/ doctoral thesis.

It is declared that during the preparation process of this study, scientific and ethical principles were followed and all the studies benefited are stated in the bibliography.

**Benzerlik Taraması / Similarity scan**

Yapıldı – ithenticate

**Etik Bildirim / Ethical statement**

ethic.selcukdentaljournal@hotmail.com

**Finansman / Grant Support**

Yazarlar bu çalışma için finansal destek almadığını beyan etmiştir. | The authors declared that this study has received no financial support.

**Çıkar Çatışması / Conflict of Interest**

Yazarlar çıkar çatışması bildirmemiştir. | The authors have no conflict of interest to declare.

**Yazar Katkıları / Author Contributions**

Çalışmanın Tasarlanması | Design of Study: HYI (%100)
Veri Toplanması | Data Acquisition: HYI (%100)
Veri Analizi | Data Analysis: HYI (%100)
Makalenin Yazımı | Writing up: HYI (%100)
Makale Gönderimi ve Revizyonu | Submission and Revision: HYI (%100)

**REFERERENCES**


1. Takenouchi et al., "Effects of chewing gum base on oral hygiene and mental healty: A pilot study," Bull Tokyo Dent Coll, 62(1):7-14, 2021.
2. U. K. Vantipalli, "Effect of three commercially available chewing gums on salivary flow rate and pH in caries-active and cariesfree children: An in vivo study," Journal of Indian Society of Pedodontics and Preventive Dentistry, vol. 35, no. 3, pp. 254-259.
3. Akyüz S, Yarat A, Tanboğa İ ve Emekli N. Comparison of salivary calcium, phosphorus and total protein concertration with dmft index levels in children 4-6 years of age, Journal of Marmara university dental Faculty. 1991; (2): 67-73.
4. Edgar WM. Saliva and dental health. Clinical implication of salivaİ: report of concensus meeting. Br. Dent. J. 1990; 169(3-4); 96-98.
5. Kırzıoğlu Z. Ve Bakan N. 22-28 yaşları arasındaki çürüklü ve çürüksüz bireylerde tükürük Ca, P, Mg, amilaz, Ph seğerleri ve tamponlanma kapasitelerinin karşılaştıtılması. Atatürk Uni Diş Hek Fak Dergisi. 1993; 3(2): 1-6. (Türkçe)
6. Wellington PB. Risk factors in dental caries. Int Dent 3 1998: 38:211-217.
7. FDI Working Group 10, CORE: saliva, its role in health and disease, Int Dent J 1992; 42: 291-304.
8. M. E. Jensen, "Effects of chewing sorbitol gum and paraffin on human interproximal plaque pH," Caries Research, vol. 20, no. 6, pp. 503–509, 1986.
9. Du et al., The economic benefts of increased sugar-free chewing gum in China: a budget impact analysis'' BMC Oral Health 21:436, 2021.
10. Tuncer D, Onen A, Yazici AR. Effect of chewing gums with xylitol, sorbitol and xylitol-sorbitol on the remineralization and hardness of initial enamel lesions in situ. Dent Res J (Isfahan). 2014;11(5):537-43.
11. Cardoso CAB, Cassiano LPS, Costa EN, Souza-E-Silva CM, Magalhães AC, Grizzo LT, et al. Effect of xylitol varnishes on remineralization of artificial enamel caries lesions in situ. J Dent. 2016;50:74-8.
12. Navazesh M, Kumar SK; University of Southern California School of Dentistry. Measuring salivary flow: Challenges and opportunities. J Am Dent Assoc 2008;139:35S-40S.
13. Al-Moosawi RIK, Qasim AA. (2020) The Impact of Dental Environment Stress on Dentition Status, Salivary Nitric Oxide and Flow Rate. Journal of International Society of Preventive and Community Dentistry, 10(2), 163-170.
14. Balakrishnan M, Simmonds RS, Tagg JR. Dental caries is a preventable infectious disease. Aust Dent J. 2000;45(4):235-45.
15. Blomfield J., Rush AR. And Ailars UM. Interrelationships between flow rate, amylase, calcium, potassium and inorganic phosphate in stimulated human saliva. Archs Oral Biol 1976; 21: 645-650.
16. Alpagot T, Doğangün R ve Çağlayan G. 30-45 yaş arasındaki periodontal hastalıklı bireylerde diş çürüğü oranı ve parotis salyası, akış hızı, pH ve Ca değerlerinin çürükle ilişkisinin incelenmesi. İÜ Diş Hekimliği Fakültesi Dergisi. 1991; 25(3): 137-140.
17. Ölmez S, Yüksel B, Uzanıtş M ve Ozalp M. Tükürük akış hızı, asit tamponlarna kapasitesi, mutans streptokok ve laktobasillerin süt, karma ve daimi diş dentisyonda incelenmesi. Hacettepe Diş Hekimliği Fakültesi Dergisi. 1995;19(1-2): 101-104.
18. Narhi TÜ. Prevalence of subjective feelings of dry mouth in the elderly. J Dent Res. 1994;73(1): 20-23.
19. Bal F. ve Dural E. Tükürük akışındaki farmakolojik azalmaların tat alma duyarlılığına etkisinin PTC (Fenildiyokarbamit) ile incelenmesi. İstanbul Üniversitesi Diş Hekimliği Fakültesi Dergisi. 2012;25(3): 137-140.
20. Baum R.l. Evaluation nf Stifnulated parciid saliva flow rale in different age groups. J Dem Res. 1981; 60(7): 1292-1296.
21. Çınarcık S ve Toygar N. Diaheili hastalarda parotis salgısı akını hızı ve kalsiyum iyonu yoğunluk değişimlerinin incelenmesi. Ege Dişhekimliği Fakültesi Dergisi. 1993; 14:160-164.
22. Larsen, M.J., Pearce, E.I. (2003). Saturation of human saliva with respect to calcium salts. Archives of Oral Biology, 48,17-322.
23. Legeros, R.Z. (1999). Calcium phosphates in demimeralization/remineralization processes. The Journal of Clinical Dentistry, 10,65-73.
24. Aras, S., Sütlaş, E. (2011). Baslangıç mine lezyonlarının tedavisinde florid ilave edilmis kazein fosfopeptit amorfoz kalsiyum fosfat (CPP-ACPF) ile floridli sütün etkinliğinin Araştırılması. Bilimsel Arastırma Projeleri, Ankara Üniversitesi, Ankara.
25. S. Tazegül, E. Bodrumlu, H. Erten, D. Erten and R. Kasap, "Kalsiyum Fosfat İçerikli Cikletlerin Tükürük Kalsiyum ve Fosfat Konsantrasyonları ile Tükürük pH ve Akış Hızına Etkileri", GÜ Diş Hek. Fak. Derg., vol. 21, no. 1, pp. 1-5, 2004.
26. Serra, M.C., Cury, J.A. (1992). The in vitro effect of glass-ionomer cement restoration on enamel subjected to a demineralization and remineralization model, Quintessence International, 23, 143-147.
27. Vieira, A.R., de Souza I.P., Modesto, A. (1999). Fluoride uptake and release by composites and glass ionomers in a high caries challenge situation. American Journal of Dentistry, 12, 14-18.
28. Sjogren, K., Birkhed, D., Ruben, J., Arends, J. (1995). Effect of post-brushing water rinsing on caries-like lesions at approximal and buccal sites. Caries Research, 29(5), 337-342.
29. Vogel GL, Zhang Z, Carey CM, Ly A, Chow LC, Proskin HM. Composition of plaque and saliva following a sucrose challenge and use of an alpha-tricalciumphosphate-containing chewing gum. J Dent Res. 1998;77: 518-524.
30. Sungurtekin Ekçi E, Özdemir Özenen D. Süt dişlerinde görülen beyaz nokta lezyonlarının remineralizasyon tedavilerinde güncel yaklaşımlar. Türkiye Klinikleri. 2017;3(1): 19-24.
31. Sjogren K, Lingstrom P, Lundberg AB, Birkhed D. Salivary Fluoride concentration and plaque pH after using a fluoride containing chewing gum. Caries Rest 1997; 31: 366-372.
32. Savaş S, Küçükyılmaz E. Diş hekimliğinde kullanılan remineralizasyon ajanları ve çürük önleyici ajanlar. Atatürk Üniv. Diş Hek. Fak. Derg. 2014;9: 113- 125.
33. Bruun C. Giyeskov H. Fluoride concentretions in saliva in relation to chewing of various supplementary fluoride preparations. Journal of Dental Research. 1978; 87: 1-6.
34. Bruun C. Thylstrup A. Fluoride in whole saliva and dental caries experience in areas with high or low concentrations of flouride in the drinking water. Caries Res. 1984; 18: 450-456.
35. Bruun C. Lambrau D. Larsen MJ. Fejerskov O. Thylstrup A. Fluoride in mixed human saliva after different topical fluoride treatments and possible relation to caries inhibition. Community Dent Oral Epidemiol. 1982; 10: 124-129.
36. Ekstrand J. Fluoride concentrations in saliva after single oral doses and their relation to plasma flouride. Scand J Dent. 1979; 85: 16-17.
37. Tokatlı, Cem, et al. "A pioneering study on health risk assessment of fluoride in drinking water in Thrace Region of northwest Türkiye." Groundwater for Sustainable Development 19 (2022).
38. Lynch RJM, ten Cate JM. The anti-caries efficacy of calcium carbonate-based fluoride toothpastes. Int Dent J. 2005;55: 175-178.
39. Tavassoli-Hojjati S, Atai M, Haghgoo R, Rahimian-Imam S, Kameli S, AhmaianBabaki F, Hamzeh F, Ahmadyar M. Comparison of various concentrations of tricalcium phosphate nanoparticles on mechanical properties and remineralization of fissure sealants. J Dent,.
40. Ben-Arhey N, Miron D, Szargel R and Gutman D. Whole- saliva seeretion rates in eld and young healthy subjects. J Dent Res. 1984; 63(9):1147-1148.
41. Shen R, Cai A, Nowicki A, Vincent J, Reynolds EC. Remineralization of enamel subsurface lesions by sugar-free chewing gum containing casein phosphopeptide-amorphous calcium phosphate. J Dent Res. 2001; 80(12): 2066-2070.