Clinical study regarding the influence of the sugared and sugar-free chewing gum on the salivary pH and flow rate

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Summary

The knowledge that salivary stimulation leads to an increase in the flow rate, pH and supersaturation of saliva in hydroxylapatite has produced much interest in agents that stimulate an increase in salivary flow.
Having in view of the clinical importance of the salivary properties in maintaining the equilibrium between demineralization and remineralization of the crystalline phase of the enamel, the aim of this study is to assess the influence of the sugared and sugar-free chewing gums on the salivary flow rate and pH.
This study was made on a number of 23 children, the average age of 12 years and 9 months. To stimulate the salivary flow rate we used: paraffin wax, a sugared chewing gum and a sugar-free chewing gum.
The mean results show that the pH of the stimulated saliva decreases in the following order: sugar-free chewing gum, paraffin wax, and sugared chewing gum, with similar results between paraffin wax and sugar-free chewing gum, but with an important difference between these two and the sugared chewing gum. Regarding the stimulated salivary flow rate, the highest value was obtained for the sugared gum.
As a conclusion, we can state that even the sugar-containing gums are able to stimulate the salivary flow, the salivary induced pH is low, and so the benefits of their use cannot be guaranteed. Chewing a sugar-free gum containing xylitol is safer and very effective for the dental health.

Key words: salivary stimulated flow rate, salivary pH, chewing gum.

Introduction

Even in decline, dental decay is still one of the most frequently diseases in humans, starting soon after the eruption and whose prevalence is increasing with age [10, 11].

In the last decades, the biochemical and morphological researches of the processes that are taking place at the enamel surface and at the enamel-oral fluids interface, demonstrated that dental decay was not the result of a continuous demineralization of the enamel by the action of the acids resulting from the fermentative processes in the bacterial dental plaque, but the result of an alternation of successive de- and re-mineralizations.

The evolution of the carious process is the result of loosing the equilibrium between the de- and re-mineralization processes, all of these being dependent by the composition and the chemical status of the oral fluids - the saliva and plaque fluid [2, 7].

The knowledge that salivary stimulation leads to an increase in the flow rate, pH and supersaturation of saliva in hydroxylapatite has produced much interest in agents that stimulate an increase in the salivary flow.

In the view of the clinical importance of the salivary properties in maintaining the equilibrium between demineralization and remineralization of the crystalline phase of the enamel, the aim of this study is to assess the influence of the sugared and sugar-free chewing gums on the salivary flow rate and pH.

Material and methods

The study was made on a number of 23 children, pupils of the 6th grade of the General School number 43 of Constanta *(Figure 1)*.

The average age of the subjects was 12 years and 9 months. The study was made in the classroom, during the dental education hours.

The teamwork was made by two students in the 6th year and a teaching member of the Faculty of Dental Medicine and Pharmacy - "Ovidius" University of Constanta, being helped by the school-master of the class *(Figure 2)*.

The study conditions were explained first to the children and then to their parents and, after parental consent had been granted, to the school personnel.

After this first meeting, the parents and teachers of the children received one-hour oral presentation regarding the etiology of the dental caries, the main ways to prevent this disease, and information regarding the importance of the correct dietary habits for the oral health.

Figure 1

Figure 2

In order to obtain correct values in the experiments testing the salivary properties, the patient should not eat and drink (except water) for at least 1 h before the collection of saliva. Our study started after the first hour of the daytime class, after an average of 80 minutes from the last meal.

The teamwork distributed the necessary materials: disposable cups on which the number of the salivary collection and the name of the child was written *(Figure 3)*, napkins, paraffin wax tablets and chewing gum, with and without sugar *(Figure 4)*.

The children have been then instructed, ensuring that all steps of the study are made in the same time for all subjects *(Figures 5, 6)*.

The first step of the study consisted in the collection of the paraffin-stimulated saliva. All the subjects were provided with a piece of unflavored paraffin wax (approximately 1 g) and were instructed to hold it in the mouth until it became soft (30 seconds).

Figure 3

Figure 4

Then the subjects were instructed to chew continuously for 10 minutes, spitting all of the secreted saliva into the number 1 cups *(Figures 7, 8).*

At the end of the chewing period, the cups were collected for the flow rate and buffering capacity measurements.

The second step of the study - the collection of the saliva stimulated by chewing a sugared gum, took place after one-hour break, in this period the subjects being restricted from eating or drinking anything else than water.

One of the sugared gum used most frequently used by pupils has in its composition sugar, gum-base, glucose syrup, citric acid, and other usual ingredients of the chewing gums.

One pellet of gum weighs approximately 4 grams.

The collection of the stimulated saliva was made in the same way as with paraffin wax - the subjects took in their mouths only one piece of gum, and chewed continuously for 10 minutes, spitting all the secreted saliva into the number 2 cups *(Figure 9).*

The cups were then collected for the pH and flow rate measurements.

Before the last step of the study, the subjects had another 1-hour break, again with the restriction of food or beverage intakes, excepting water.

The sugar-free gum used (Wrigley's) contains sorbitol, gum-base, xylitol, manitol, calcium and other usual ingredients of the chewing gums. One pellet of gum weighs approximately 2.6 grams.

The stimulated saliva was collected after 10 minutes in the number 3 cups *(Figure 10).* All collected saliva was then subjected to salivary flow and pH determination.

A portable pH-meter, "Piccolo I" *(Figure 11)* was used for the pH determination of the saliva samples; to determine the amount of the salivary flow, the secreted saliva was poured into a graduated cylinder.

Figure 5

Figure 6

Figure 7

Figure 8

Results

After the collection of the saliva samples, the individual values for the salivary pH and flow rate were as follows *(Table 1)*.

The average results *(Table 2)* show that the pH of the stimulated saliva decreased in this order: sugar-free chewing gum, paraffin wax, and sugared chewing gum, with similar results between paraffin wax and sugar-free chewing gum, but with an important difference between these first two and the sugared chewing gum.

Regarding the stimulated salivary flow rate, the highest value was obtained for the sugared gum, decreasing for the sugar-free gum and than for the paraffin wax.

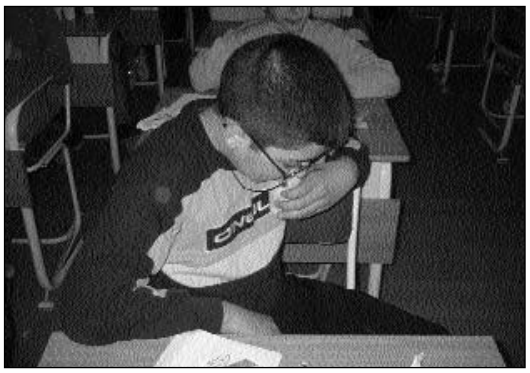

Figure 9

Figure 10

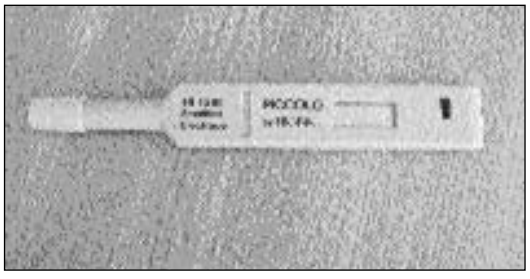

Figure 11

Discussion

Several large studies of unstimulated salivary flow rates in healthy individuals have found the average value for whole saliva to be about 0.3-0.5 ml/minute, but the normal range is very large [1, 3].

Regarding the stimulated saliva secreted in response to masticatory or gustatory stimulation, several studies have been made in healthy population, most of them showing a wide variation among individuals [10, 11].

The stimulated secretion rate in adults is influenced by many factors: mechanical, gustatory, olfactory, anatomical (gland size), dietary factors (food intake), the normal rate being about 1-2 ml/min. The maximum stimulated salivary flow rate is obtained after using citric acid, for whole saliva having an average maximum value of about 7 ml/min [4, 5].

The values in our study, regarding the stimulated salivary flow rate are of 1.48 ml/min for paraffin wax, 1.74 ml/min for sugar-free chewing gum, and 2.18 ml/min for sugared chewing gum. The comparison of these results with similar others is relative, as different studies use different products for stimulating the salivary flow.

However, regarding the paraffin wax, our results are lower (1.48 ml/min) than those published by Shannon and Frome (1973), whose average value is about 1.6 ml/minute.

For sugar-free chewing gum, our results (1.74 ml/min) are a little greater than those of Heintze et al. (1983), which found a mean value of 1.7 ml/min for the saliva stimulated by sugar-free chewing gum [5].

It is thought that these differences do not have clinical significance, the most important results being the stimulation of the salivary secretion at rates 5-6 times greater than the unstimulated one.

Regarding the sugared chewing gum, the stimulated salivary flow rate reached the value of 2.18 ml/min, meaning a salivary secretion 7-8 times greater than the unstimulated secretion.

In these conditions, we can state that the increase in salivary flow over a prolonged period is beneficial for the oral health.

Chewing gum is a unique food because of the fact that in normal use it is chewed for a prolonged period (usually 20-30 minutes) while in the same time its contribution of calories to the diet is negligible. This combination of attributes

Table 1.

no. of the saliva sample	pH of the paraffin-stimulated saliva	salivary paraffin-stimulated flow rate (ml/min.)	pH of the sugared chewing-gum stimulated saliva	salivary sugared chewing-gum stimulated flow rate (ml/min.)	pH of the sugar-free chewing-gum stimulated saliva	salivary sugar-free chewing-gum stimulated saliva (ml/min.)
1.	7.73	1.70	6.00	1.98	7.20	1.39
2.	7.72	1.53	5.18	2.10	6.95	1.42
3.	7.56	1.69	5.43	2.15	6.90	1.47
4.	7.25	1.66	5.13	2.13	6.91	1.52
5.	7.47	1.55	5.03	2.05	6.76	1.46
6.	7.80	1.48	6.11	2.11	7.42	1.38
7.	7.50	1.62	5.19	1.99	7.28	1.48
8.	7.75	1.54	5.10	2.19	7.10	1.41
9.	7.91	1.67	6.42	2.14	6.93	1.47
10.	7.74	1.72	5.00	2.12	6.58	1.36
11.	7.72	1.58	5.82	2.16	6.73	1.50
12.	7.91	1.67	5.43	1.95	7.13	1.43
13.	7.27	1.71	4.76	2.23	7.05	1.47
14.	7.50	1.56	5.60	2.15	7.20	1.48
15.	7.85	1.63	4.52	2.13	6.53	1.52
16.	8.05	1.69	5.78	2.20	7.61	1.49
17.	7.60	1.85	4.60	2.18	5.99	1.42
18.	7.64	1.72	4.87	2.05	6.70	1.39
19.	7.30	1.53	5.48	2.09	7.18	1.41
20.	7.82	1.71	6.04	2.14	7.40	1.49
21.	7.57	1.68	5.02	2.09	6.52	1.47
22.	7.91	1.76	6.62	2.10	7.65	1.40
23.	7.40	1.78	5.43	1.99	7.25	150

Table 2.

pH of the paraffin-stimulated saliva	salivary paraffin-stimulated flow rate (ml/min.)	pH of the sugared chewing-gum stimulated saliva	salivary sugared chewing-gum stimulated flow rate (ml/min.)	pH of the sugar-free chewing-gum stimulated saliva	salivary sugar-free chewing-gum stimulated saliva (ml/min.)
6.99	1.48	5.41	2.18	7.65	1.74

makes it an important item of diet in the context of salivary stimulation.

Even the level of gustatory stimulus partially falls in the same time with the consumption of the flavored components, and the intensity of the masticatory stimulus falls due to softening of the gum, the chewing gum elicits a continuous flow of saliva during prolonged mastication.

On the other hand, the composition of saliva is affected by a number of factors (glandular source, duration of stimulation, previous stimulation, biological rhythms, nature of stimulus, plasma composition), but the main factors affecting the composition of the saliva are the flow rate and the duration of stimulation.

As the flow rate increases, the pH and concentrations of some constituents rise (protein, sodium, chloride, bicarbonate), while those of others fall (magnesium and some types of phosphates) [6].

Regarding the buffering ability of saliva, the rising of the bicarbonate level with the increasing rate and the duration of stimulation is the most important factor, which has to be considered when the effect of the chewing gum is discussed. Bicarbonate concentration varies from less than 1 mmol/l in unstimulated parotid saliva to almost 60 mmol/l at very high flow rates, with whole saliva elicited by chewing-gum having a bicarbonate concentration of about 15 mmol/l [8]. This increasing of the bicarbonate concentration is followed by the increasing of the salivary pH.

The pH of parotid saliva increases from about 5.5 for unstimulated saliva to about 7.4 when the flow rate is high. The respective pH values for submandibular saliva are 6.4 and 7.1, in both cases this being due to the increase in sodium and bicarbonate concentrations [7].

In our study, the paraffin wax and the sugar-free chewing gum have produced an increasing of the salivary pH at 6.99 and 7.65 as response to the stimulation of the secretion flow rate. When we used the sugared chewing gum, even the salivary stimulated flow rate was greater than those obtained with sugar-free chewing gum and paraffin wax, but the salivary pH decreased at 5.41. Therefore, even the sugared chewing gum seams to have a favorable effect for the dental health through an important increasing of the salivary flow rate, this effect being reduced by the simultaneous presence of the fermentable carbohydrates, with unfavorable consequences on the bacterial dental plaque pH.

Recent works regarding the plaque pH suggest that if sugared gum is chewed after meals which contain fermentable carbohydrates, it is able to rise the plaque pH, but less than sugar-free gum. It is suggested that, if sugared gum are chewed immediately after meals, they provide only a small increment in the plaque acids production, and the increasing of the bicarbonate by the salivary stimulation may neutralize this increasing. After the first period of chewing, when the sugar is cleared from the mouth, the effect of the stimulated saliva is similar to that of sugar-free gum [9].

However, these possible positive effects of the sugared chewing gum are contradicted by other clinical studies whose results show a tendency to an increased number of dental caries in individuals frequently consuming sugared chewing gum.

Taking into consideration the fact that the chewing gum is used, especially by children, mostly between meals, inducing a low pH level in the saliva (5.41 in our study) for a relatively long period, it has for sure an inappropriate effect regarding the pH and the acid production in the dental plaque.

Conclusions

1. As a modern dental medicine requires the adoption and the application of all known methods for preventing dental disease, the using of chewing gum based on some objective and scientific criteria has a very important role in the prevention of dental caries.

2. The fact that the correct using of chewing gum stimulates the salivary flow rate on the entire period of mastication, with demonstrated beneficial effects on the oral health, is unquestionable.

3. The sugared gum cannot be recommended for the prevention of dental caries, the beneficial effects cannot be guaranteed, and irregular use may lead to increased caries. As with any sugared food, their use must be restricted only at mealtimes.

4. Chewing a sugar-free gum, especially one with xylitol, leads to safe saliva stimulation and an increase of the salivary pH, with proved beneficial effects for the entire oral health.

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