pH changes in dental plaque after using sugar-free pediatric medicine

Ali Mentes*

The aim of this study was to compare the pH changes in the dental plaque after rinsing with sugared-(sucrose) or sugar-free (saccharine, cyclamate and sorbitol) versions of the same pediatric acetaminophen solution (ekosetol®) up to one hour. Twenty-nine undergraduate dental students (17 girls and 12 boys) collected plaque for 48 hours by abstaining from oral hygiene, during which period they maintained normal dietary habits. Plaque sampling was done in two subsequent days before and 2, 5, 10, 15, 20, 25, 30, 40, 50 and 60 minutes after rinsing with both solutions. Measurements of pH were done within one hour using a micro pH electrode and a pH meter. All experiments were finished in 6 days by dividing the group to three. Results showed a significant difference between groups in respect to pH values and pH drops after rinsing. Mean pH values were below 5.70 for one hour in sugared solution, whereas no mean pH value was detected below 5.80 for one hour with the sugar-free solution. Minimum pH values (sugar-free: 5.62±0.36; sugared: 5.00±0.33, $p<0.001$) and maximum pH drops (sugar-free: -0.57±0.26; sugared: -1.16 ± 0.44, $p<0.001$) were also significantly different. No difference was found between genders. We concluded that changing of sucrose to non-acidogenic sweeteners was essential to prevent the cariogenic potential of the pediatric medicines.
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INTRODUCTION

The etiology of dental caries is well known and the role of sugar as the main dietary factor has been well established. In addition it would appear that the frequency of sugar intake is more important than the total amount consumed. Thus an important method of preventing dental caries is to limit the frequency of sugar containing foods and drinks to meal times. Many parents are aware that sugar causes tooth decay but commonly compare this solely with the consumption of sweets and biscuits. They are often unaware of the hidden, added sugar in many foods and drinks, including pediatric liquid medicines.

Roberts and Roberts[17] first demonstrated the harmful effect of sugar-containing pediatric medicines on dental health. Other workers have confirmed that these preparations are acidogenic and cariogenic.[4,6,8,10,16] In order to overcome this danger sugar-free preparations have been introduced in many western countries and much emphasis has been placed on trying to persuade pharmaceutical industry to formulate sugar-free medicines and the medical profession to prescribe sugar-free preparations in preference to sugar-containing medicines.[2,3,7,13]

In Turkey a survey done in our clinics has shown that more than 80% of the pediatric medicines contained 30 to 60 percent of sucrose solution and among 31 pediatric liquid analgesic solutions none were sugar-free.[15] Recently a new sugar-free analgesic product was introduced in Turkey with the claim of "harmless to teeth". So the aim of this study was to compare the pH changes in the dental plaque after rinsing with sugared-(sucrose) or sugar-free (saccharine, cyclamate and sorbitol) versions of the new pediatric acetaminophen solution (Ekosetol®) up to one hour.

MATERIALS AND METHODS

Test Products

The sugar-free pediatric acetaminophen solution (Ekosetol®) contains no saccharin, no cyclamate and sorbitol as sweeteners. In order to compare the solution with a sugared version we asked the company Ekofarma Pharma Co., (Istanbul, Turkey) To prepare the same medicine with the difference of its sweetener content. A new product was then made without sweeteners and the same amount of sweet compound was added to the solution as sucrose.

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Table 1. Mean minimum pH values and maximum pH drops observed for sugared and sugar-free groups (standard deviations) with p values. Groups 1,2 and 3 are also shown separately to compare subgroup differences

	Min pH values			Max pH drop		
	sugar-free	sugared	p	sugar-free	sugared	p
Total	**5.62(0.36)**	**5.00(0.33)**	**0.0000**	**0.57(0.26)**	**1.16(0.44)**	**0.0000**
Group 1	5.61(0.38)	5.04(0.25)	0.0001	0.56(0.30)	1.11(0.44)	0.0009
Group 2	5.59(0.32)	5.01(0.37)	0.0023	0.59(0.25)	1.19(0.47)	0.0034
Group 3	5.67(0.40)	4.95(0.42)	0.0009	0.57(0.24)	1.22(0.45)	0.0008
p(1,2,3)	0.1225	0.1072	-	0.0656	0.1855	-

Subject Selection

This study was performed with 29 undergraduate dental students (17 females and 12 males), who had moderate dmft values (mean: 4.3 ± 2.6) without any active caries. All subjects collected plaque for 48 hours by abstaining from oral hygiene, during the period which they maintained normal dietary habits.

Plaque pH Measurements

Since the time for pH reading was limited, all experiments were finished in 6 consecutive days by dividing the group to three subgroups:

1st day: 12 subjects (7 girls, 5 boys) 6 rinsed with sugared vs. 6 with sugar-free medicine,

2nd day: same subjects rinsed with opposite solution.

3rd day: 8 subjects (3 girls, 5 boys) 4 rinsed with sugared vs. 4 with sugar-free medicine,

4th day: same subjects rinsed with opposite solution

5th day: 9 subjects (7 girls, 2 boys) 4 rinsed with sugared vs. 5 with sugar-free medicine,

6th day: same subjects rinsed with opposite solution.

Plaque pH was measured using the method of Frostell[5], modified by Rugg-Gunn *et al*.[18] and Manning and Edgar.[12] On each test day a sample of plaque was taken from the buccal surfaces of four sites of the subject's teeth using a sterile stainless steel probes. The experiment began at 9 a.m. and every subject rinsed 10 ml. of the solution for 1 minute and plaque sampling was done before (as a baseline) and 2, 5, 10, 15, 20, 25, 30, 40, 50 and 60 minutes after rinsing. Subjects were asked to swallow immediately before plaque collection to minimize salivary contamination and during plaque collection care was taken to avoid contamination with blood or saliva. The collection time for each sample was standardized as 30 seconds and the samples were transferred to 0.5 ml of distilled and deionized water. All pH measurements were done over a period of up to one-hour using a micro pH electrode (lot t406 Ingold Electrodes Inc. USA) in conjunction with a pH meter (metrohm).

RESULTS

Mean pH data and pH drop at each sampling time from the pH value obtained before rinsing as well as minimum pH values and maximum pH drops during experiment and number of subjects where a pH drop below 5.7 was recorded were calculated. The results were evaluated by analysis of variance followed by t-tests.

Significant difference was found between sugared and sugar-free groups in respect to pH values and pH drops after rinsing (Figures 1 and 2). Mean pH values were below 5.70 for one hour in sugared solution, whereas, no mean pH value was detected below 5.80 for one hour with the sugar-free solution and the difference was significantly different. The pH drops of the sugared group were almost 3 times greater than the sugar-free group at 10 minutes.

Minimum pH values and maximum pH drops, which were also significantly different (Table 1), no differences were observed between genders for both solutions at each sampling time.

Figure 3 compares three groups of subjects for mean pH values and Figure 4 compares three groups of subjects for pH drop. There were difference between subjects in response to the sampling time and the two solutions, but no such differences were seen when the mean min pH and max pH drop values were examined in Table 1. The data were also examined to compare the rinsing period and sequences in Table 2. There was no difference in pH responses whether the subject first rinses sugared or sugar-free solutions. Table 3 showed that there was a high number of subjects who rinsed sugared medicine below the critical pH value even after one hour than the subjects who rinsed with the sugar-free medicine.

DISCUSSION

Measurements of plaque acidity, principally as changes in pH, form a very important group of test for assessing food or drink cariogenecity. Plaque pH techniques have been used for many years and the measurement of pH in dental plaque may give valuable information about the cariogenic potential of any product including pediatric medicines. Rekola[16] investigated 10 medicines in syrup form with different sweetener content. He used in situ palladium touch pH electrode and found that all sugared products decreased dental plaque pH after rinsing. In the present study, the harvesting technique

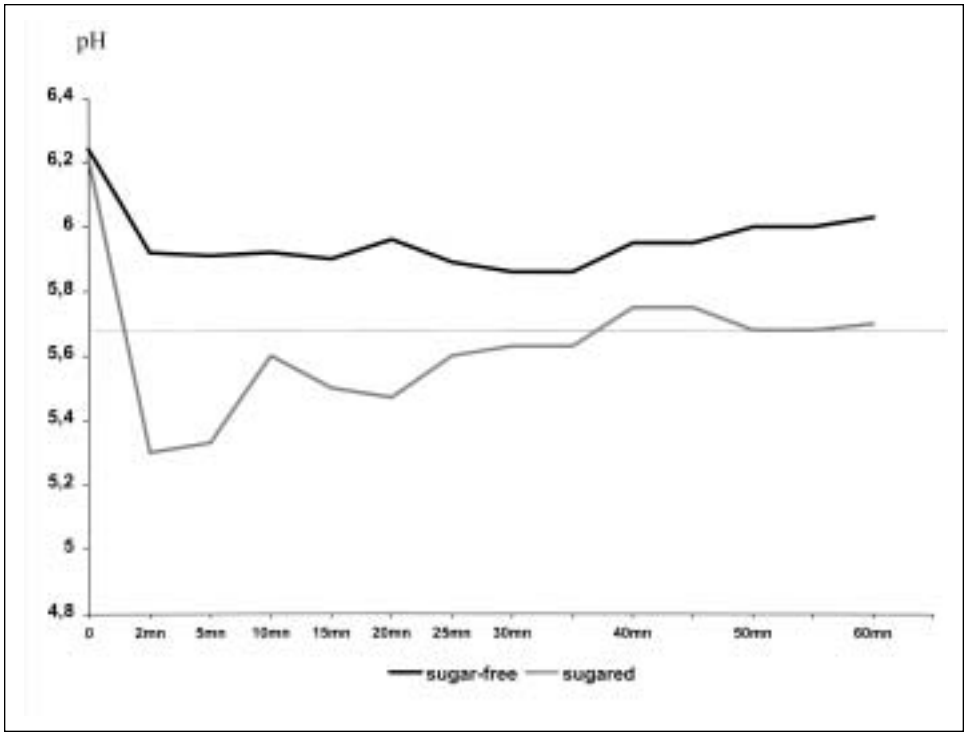

Figure 1. Mean pH changes of sugared and sugar-free groups (Stephan curves). Dotted line is for pH = 5,7

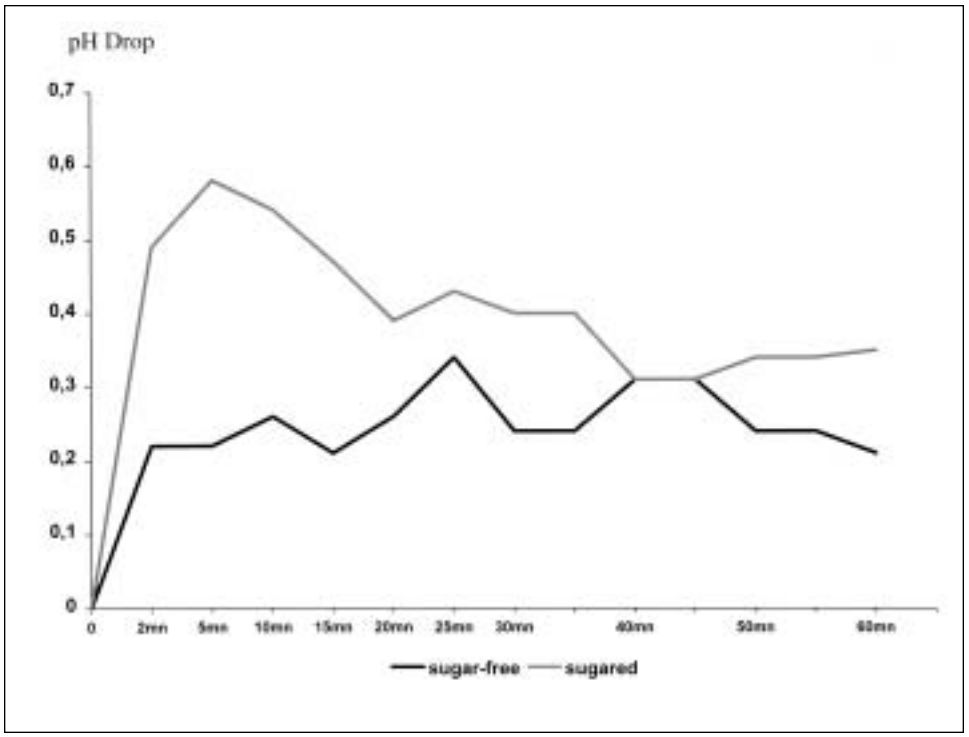

Figure 2. Mean pH drops after rinsing with sugared or sugar-free solution for each time interval.

was used and pH drops in plaque following the sugared solution were equally remarkable and lasted at least 20 minutes, whereas, pH drops following sugar-free medicine were minimal. The variations between subjects were also notable but the difference was not significant. Marathaki *et al.*[13] investigated six medicines with a similar pH measurement technique and the test also indicated that all sucrose-containing preparations pro-

Table 1. Mean minimum pH values and maximum pH drops observed for sugared and sugar-free groups (standard deviations) with p values. Groups 1, 2 and 3 are also shown separately to compare subgroup differences

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Group 1	5.61(0.38)	5.04(0.25)	0.0001	0.56(0.30)	1.11(0.44)	0.0009
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p(1,2,3)	0.1225	0.1072	-	0.0656	0.1855	-

Table 2. Mean minimum pH and maximum pH drop values (and SD) of the subjects who first rinsed sugared solution with the subjects who first rinsed sugar-free solution with p values and gender comparison of the same data.

	Min pH values			Max pH drop		
	sugar-free	sugared	p	sugar-free	sugared	p
1st day	5.54(0.30)	4.96(0.33)	0.0000	0.56(0.35)	1.23(0.49)	0.0001
2nd day	5.70(0.40)	5.05(0.35)	0.0000	0.58(0.15)	1.09(0.38)	0.0001
p	0.1095	0.2584	-	0.4129	0.1855	-
male (n=12)	5.64(0.35)	4.91(0.19)	0.0000	0.53(0.21)	1.22(0.49)	0.0008
female (n=17)	5.60(0.37)	5.07(0.30)	0.0003	0.63(0.39)	1.13(0.41)	0.0000
p	0.3864	0.08251	-	0.14465	0.3051	-

Table 3. Number (and percentage) of subjects where a pH drop below 5.7 was recorded for each period of time and p values.

test	before	2mn	5mn	10mn	15mn	20mn	25mn	30mn	40mn	50mn	60mn
Sugar-free <5.7 (%)	2(7)	5(17)	6(21)	6(21)	6(21)	7(24)	6(21)	7(24)	8(28)	6(21)	3(10)
Sugared b<5.7 (%)	3(10)	20(69)	23(79)	16(55)	17(59)	19(66)	16(55)	15(52)	11(28)	14(48)	15(52)
p	0.371	0.000	0.000	0.002	0.000	0.000	0.002	0.007	0.025	0.001	0.001

duced a significantly greater drop in plaque pH than their sucrose-free counterparts. They claimed that their study provided evidence in support of prescribing sugar-free preparations for children on long-term medication.

The long-term use of prescribed medicines by chronically sick children is known to be a cause of dental caries.[4,17] It is generally assumed that other healthy children take medicine infrequently and for short periods. Therefore, even if the medicine contains sugar they present no risk to dental health. But in Turkey many pediatric medicines (analgesics, vitamins, antibiotics and cough medicines) are available in pharmacy without prescription even though they are not categorized as over-the-counter medicines. Many parents prefer obtaining such medicaments at will and use them at any circumstances. Children take medicine on average of on day in ten or one week in every eight hours. These medicines are often given to children last thing at night. Reduced salivary flow during sleep limits natural cleaning and buffering, so caries risk of the child increases significantly. This study clearly showed that the sugared medicine lowered the plaque pH for one hour. It is easy to assume that this acid production would be even greater and last longer during sleep.

Many non-cariogenic sweeteners are currently available, but it was reported that formulating sugar-free medicines is expensive, a combination of bulk and intense sweeteners as well as other flavoring agents usually have to use in order to get the same taste as acceptable as sugars.[9,10] Sugar also can act as a preservative in medicine, which make some artificial flavoring necessary for sugar-free substitutes and finally the viscosity of the sugar syrup have to be compensate with some thickening agents for these products. Thus, when formulating sugar-free medicines a greater number of ingredients are required than for the sugar containing equivalents. However, since the manufacturers respond to the consumer's demands easily, altering the views of health professionals and parents would seem to be an appropriate strategy and this has already been progressing in some European countries.[1,11] McVeigh and Kinirons[14] reported that the major factors influencing the provision of sugar-free medicines were parental request, health promotion literature, reports and media advertising. We hope that this study will encourage the

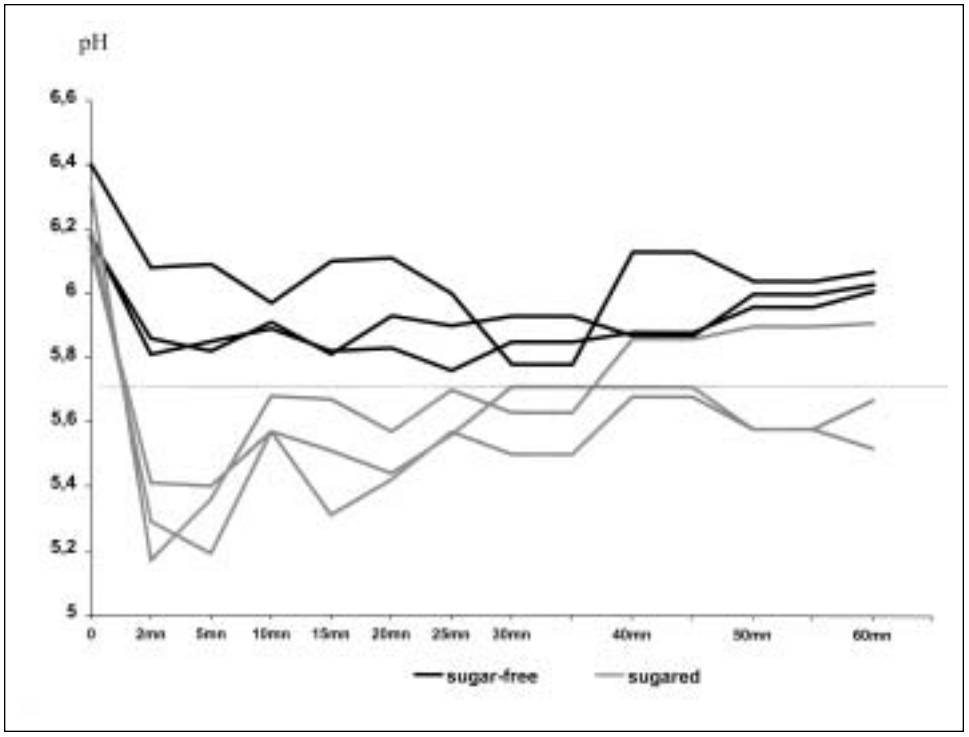

Figure 3. Mean pH changes of sugared and sugar-free groups (Stephan curves) in three subgroups. Dotted line is for pH = 5,7

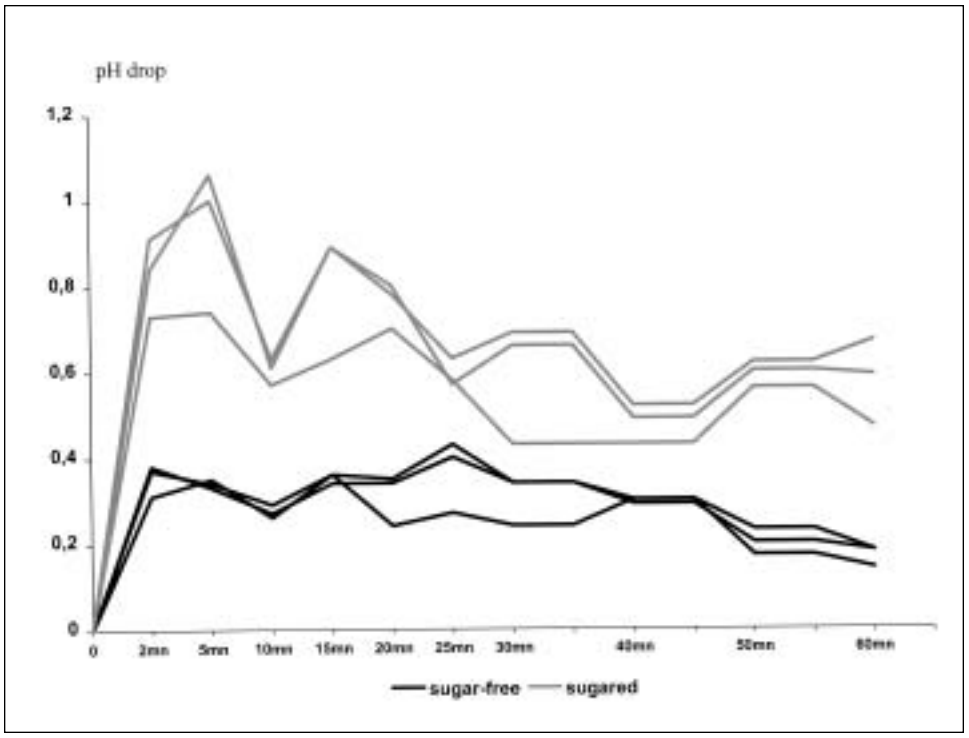

Figure 4. Mean pH drops after rinsing with sugared or sugar-free solution for each time interval in three subgroups.

companies of our county to produce such healthier products in the future.

It can be concluded that great achievement is obtained by the sugar-free version of the pediatric medicine in terms of plaque acidogenicity and changing of sucrose to non-acidogenic sweeteners is essential to prevent the cariogenic potential of the pediatric medicines.

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