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Article *in* International Medical Journal (1994) · August 2018

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Effect of Different Fruit Juices on the Level of Salivary pH at Different Time Periods in the Caries Free Dental Students

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ABSTRACT

Background: **Nature of saliva plays a critical role as a causative factor for caries of teeth as well as teeth erosion. Nowadays, there is a clear increase in the consumption of readily available carbonated drinks and fruit juices. Decreasing in the pH of saliva following drinking of any acidic juices has a detrimental effect on the oral health, therefore, this study was designed to test the effect of three types of fruit juices on the level of pH of saliva at different time periods.**

Materials and Methods: **A baseline score was measured by collecting salivary samples of the subjects in sterile test tubes after chewing of paraffin wax (one gram) before drinking of fruit juices. Subjects drank the selected fruit juices used in this study(commercially available peach juice, fresh banana juice and fresh apple juice), after that saliva of each subject was collected in an identified test tubes after 1 minute, 5 minutes, 10 minutes, 30 minutes and 60 minutes of fruit juices intake.**

Results: **This study showed that all three juices caused significant fall in the salivary pH. The commercially available peach juice showed the highest drop in the pH of saliva comparing to the other fresh juices at different time interval, showed lowest pH value at 1 minute after drinking.**

Conclusions: **Fruit juices have a low pH and can adversely affect the pH of saliva, so the excessive intake of these juices must be avoided.**

KEY WORDS

fruit juice, pH of saliva, tooth decay, dental erosion

INTRODUCTION

The concept of health has succeeded for centuries and the dietary behaviors are apparently changing as well. Alteration of the lifestyle and financial development has led to rapid changes in diet[1)]. Also there has been a substantial increase in consumption of soft drinks (carbonated beverage & fruit juices)[2)].

A wide range of all ages of population has excessively drink fruit juices as they think to be more suitable for health and are sometimes preferred over other soft drinks which are highly acidic. Literature provides insufficient assay about if this drinks safe or not for teeth health[3)]. Teeth erosion caused by fruit juices have been recognized for a long time as evident in the study of Mythri[4)] who stated that frequent fruit juice drinking can cause tooth destruction.

Dental caries (tooth decay) is a chronic disease caused by special species of bacteria that infected the calcified tissue of the teeth, dental decay occurs when bacteria metabolizes sugar in the mouth to make acid which then dissolves the tooth (demineralization).When the balance between demineralization and reminaralization is lost tooth decay may occur[5)]. Despite the great advancement in dentistry but the problem of tooth decay still persists, with DMFT (Decayed Missing Filling Tooth Index) scores increasing every year.

Dental erosion is a loss of tooth structure not related to any bacteria but related to chemicals[6)]. Dental erosion is a prevalent problem everywhere. Erosion can be caused by drinks that have low endogenous pH (acidic)[7)].The erosive potential depends on low pH and buffering capacity of the drinks. The different acid contents of the drinks (carbonated drinks contain carbonic acid, packaged fruit juices contain organic acids derived from the fruits) and the preservatives are responsible for their erosive potential[8)]. These inherent acids and sugars have both acidogenic and cariogenic potential[9)].

Buffering action of saliva plays a significant role in the maintenance of dental health by neutralization of acids after eating and drinking, thus helps prevent decay[10)]. The consumption of sugary foods or beverages will cause a drop in the pH of saliva. The highest decrease in the pH of saliva is closely related to intake of sugary beverages[11)]. When the pH of saliva reaches this value, this mean a critical level of the pH is 5.5. If the value of pH additionally drops, tooth decay occurs in relation to imbalance in the calcium and phosphate regulation[12)].

Many researchers have studied the effects of carbohydrated foods in relation to tooth decay and dental erosion but less studies have been done on acidic fruit juices that contain several types of acids and carbohydrate. Therefore, this study was aimed to determine the level of pH of saliva at various periods after using three commonly consumed fruit juices.

MATERIALS AND METHODS

Sample selection: Thirty subjects aged 19-20 year, who were volunteers from college of dentistry, University of Anbar were considered as study subjects. The subjects invited to participate in this study had

Received on April 15, 2017 and accepted on July 11, 2017

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Table 1. Means of salivary pH values to all groups.

	Time interval	Group I (n = 10)		Group II (n = 10)		Group III (n = 10)	
		Mean	SD	Mean	SD	Mean	SD
1	Baseline pH	7.22	0.04	7.18	0.04	7.24	0.09
2	PH at 1 min	5.48	0.23	6.35	0.01	6.29	0.02
3	PH at 5 min	6.32	0.03	6.87	0.01	6.80	0.02
4	PH at 10 min	6.54	0.11	7.05	0.05	7.01	0.04
5	PH at 30 min	6.97	0.09	7.10	0.04	7.13	0.01
6	PH at 60 min	7.17	0.04	7.15	0.02	7.21	0.02

Table 2. Paired t.test for all groups

Groups	Comparison	t-test	DF	p-value
Group I	Baseline and pH at 1 min	14.242	4	.000
	Baseline and pH at 5 min	35.567	4	.000
	Baseline and pH at 10 min	13.613	4	.000
	Baseline and pH at 30 min	5.136	4	.001
	Baseline and pH at 60 min	7.906	4	.007
Group II	Baseline and pH at 1 min	39.485	4	.000
	Baseline and pH at 5 min	14.299	4	.000
	Baseline and pH at 10 min	10.729	4	.000
	Baseline and pH at 30 min	3.091	4	.037
	Baseline and pH at 60 min	1.347	4	.249
Group III	Baseline and pH at 1 min	142.916	4	.000
	Baseline and pH at 5 min	25.838	4	.000
	Baseline and pH at 10 min	9.960	4	.001
	Baseline and pH at 30 min	13.500	4	.023
	Baseline and pH at 60 min	3.586	4	.073

Table 3. Comparison of mean pH to all groups at different time periods

Comparison	t-test	DF	p-value
Baseline pH			
GI - GII	2.384	4	.076
GI - GIII	1.108-	4	.330
GII - GIII	3.207-	4	.083
pH at 1 min			
GI - GII	8.416-	4	.001
GI - GIII	7.855-	4	.001
GII - GIII	5.439	4	.006
pH at 5 min			
GI - GII	36.193-	4	.000
GI - GIII	22.514-	4	.000
GII - GIII	4.111	4	.015
pH at 10min			
GI - GII	11.062-	4	.000
GI - GIII	10.330-	4	.000
GII - GIII	1.271	4	.273
pH at 30 min			
GI - GII	-3.293-	4	.030
GI - GIII	-4.332-	4	.012
GII - GIII	-2.008-	4	.115
pH at 60 min			
GI - GII	.964	4	.389
GI - GIII	-1.853-	4	.138
GII - GIII	-4.053-	4	.115

Decayed Missing Filling Tooth Index (DMFT) = 0[10] & healthy gingiva[11]. Subjects having any history of systemic diseases were excluded.

30 students were divided into three groups (N = 10) for each group:

Group I: commercially available peach juice .
Group II: fresh banana juice.
Group III: fresh apple juice.

Before drinking of juices, endogenous pH of the tested juices were determined. These were as follows: commercially available peach juice pH (3.35), fresh banana juice pH (4.86) and fresh apple juice pH (4.16).

Each subject was informed previously not eating or drinking for at least 2 hours prior to procedure of saliva collection. In order to collect saliva of the subjects before intake of tested drinks, they were instructed to chew paraffin wax, this saliva was considered as baseline readings. After 1 minute, 5 minutes, 10 minutes, 30 minute and 60 minute of drinking the juices, saliva of each subject was collected in separate sterile test tubes that were identified with special letter to each subject. All these samples of saliva were then centrifuged. The pH of the purified samples of saliva were measured in the laboratory using calibrated digital pH meter by the same investigator. Before starting determination of the pH and to gain accurate readings the pH meter was standardized. Before and after each reading, the electrode was cleaned using distilled water and placed in a standard solution of pH (7). This ensured stable readings.

RESULTS

The salivary pH values (means ± SD) for all tested groups in various time intervals are summarized in table 1. Data were analyzed using one-way ANOVA and paired t-test. In these tests, $P > 0.05$ (Non significant), $P \leq 0.05$ (Significant), $P < 0.001$ (Highly significant). Paired t-test as shown in table 2 demonstrated that group I (commercially available peach juice) showed a minimum pH value at 1 min (5.48 ± 0.23) that was statistically lower significantly comparing to baseline pH in this group (7.22 ± 0.04).Value of pH recover after 5min (6.32 ± 0.03) and the recovery continuous throughout 10 min (6.54 ± 0.11), 30 min (6.97 ± 0.09) and 60 min (7.17 ± 0.04) but still statistically lower significantly in relation to baseline pH value. These values slowly started to return back to baseline value.

Group II (fresh banana juice) showed a minimum pH value at 1 min (6.35 ± 0.01) that was statistically lower significantly comparing to baseline pH in this group (7.18 ± 0.04). Recovery of pH began at 5 min (6.87 ± 0.01) and also continuous throughout 10 min (7.05 ± 0.05) and 30 min (7.10 ± 0.04) but these values statistically lower significantly in relation to baseline pH. At 60 min the pH (7.15 ± 0.02) statistically did not differ significantly when compared to baseline pH. Group III (fresh apple juice) showed a minimum pH value at 1 min (6.29 ± 0.02) that was statistically lower significantly comparing to baseline pH in this group (7.24 ± 0.09). Recovery of pH began at 5 min (6.80 ± 0.02) and continuous throughout 10 min (7.01 ± 0.04) and 30 min (7.13 ± 0.01) but these values were statistically lower significantly in relation to baseline pH. At 60 min the pH (7.21 ± 0.02) statistically did not differ significantly when compared to baseline pH.

Comparison between the tested groups at different time periods in table 3 showed that the difference was significant between (group I and group II) (group I and group III), and (group II and group III) at 1 min. Also the difference was significant between (group I and group II), (group I and group III) and between (group II and group III) at 5 min. At

10 min and 30 min the difference was significant between (group I and group II) and (group I and group III). Except these significant differences the other differences were non-significant.

DISCUSSION

Fruits and fruit juices contain several types of acids that can kick off demineralization of the teeth[10]. Harmful effect of frequent use of these drinks on the tooth occur either by "their high acidity that can damage surfaces of the teeth not covered by dental plaque" or by "their contents of fermentable carbohydrates that may be considered as a substrate diffusing into the dental plaque", from which microorganisms inhabitation the plaque can generate the acid that initiates the destructive process of dental caries in the subsurface of the enamel beneath the dental plaque. Differ time scales of the two processes, however, process may affect firstly on "tooth surfaces with direct contact with drinks"[7]. A fall of salivary pH lower than the critical pH due to consumption of low pH fruit juices causes prospective destruction of teeth if it is persisted even for few minutes[12]. A variety of factors can play a role in determining the cariogenicity of sugar containing drinks[13].The drop of salivary pH produced is dependent on the sugar content, endogenous pH and also the buffering capacity and the drinks consumption method[13].

This study showed that drinking commercially available peach juice (GI) produced a lowest pH value at 1 minute (5.48 ± 0.23), this value considered as a critical pH value. pH level will try to regain the baseline value gradually within 60 minute throughout the study. Studies of Saha *et al*[13] and Banan *et al*[1] showed the same results of our study. This greater fall of pH level could be related to the relatively lower endogenous pH of commercially available peach juice. Ability of packed fruit juice to combat salivary buffers due to their high intrinsic acidity is the direct reason for immediate decreasing of pH of saliva[13]. Another reason for such drop is the high amount of added sugar (sucrose) content of packed fruit juices which is highly cariogenic[14]. The extent of time for which this low pH remains at its minimum is important, excessive dissolution of enamel accompany the longer duration of the critical pH value. It has been reported that solubility of dental tissue is increased by a factor of 7-8 with each drop of pH by 1 unit thereby significantly increasing the potential risk for demineralization[13].

In the present study, consuming fresh fruit juices (banana (GII) and apple (GIII)) showed a significant drop in pH of saliva from baseline pH value and gradually started to come back to baseline value. This can be attributed to the juices content of various sugars in addition to non-volatile organic acids. Fresh juices contain fructose and glucose were considered to be less cariogenic than sucrose, but they cause a decrease in the microhardness of the enamel due to formation of dental plaque in the presence of a mixture of these two sugars[14]. Group III (apple juice) showed significantly lower pH at 1 minute and 5 minutes this may be due to lower endogenous pH of this juice.

From the theoretical point of view, the important factors that determined the ability of a soft drink (carbonated beverage or fruit juice) to cause teeth erosion include the immediate effect of the drink, duration of its clearance on the tooth, method of consumption, the protective effect of saliva, the amount of residual drink after swallowing, the real amount of drink consumed and the number of drink intake. In general, exposure of teeth to a critical pH during consumption of acidic drinks at first time is of minor importance but if repeated, the ability of the saliva to deal with the acid decreases. Hence, the danger is the frequent use of these fruit juices over time. People who consume acidic, sugar drinks frequently are at high risk of acid demineralization and ultimately leading to dental erosion and caries. If the challenge is frequent enough and there are few or no protective factors as in caries susceptible people this can be quite aggressive[9].

CONCLUSION

Consumption of fruit juices (packed or fresh) can cause a harmful effect on teeth, with these concepts kept in mind, frequent drink of fruit juices should be avoided.

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