

Plaque and salivary pH changes after consumption of fresh fruit juices

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The concept of health has prevailed for centuries and the dietary habits are apparently changing with modernization. "Healthy eating" is now perceived to be important. The desirability of a healthful lifestyle has led to an increased consumption of juices. Drinking large amount of fruit juice is frequently practiced these days and the consumption of these juices is further modified with behavioral habits such as swishing and frothing the drinks around the mouth, sucking frozen fruit juices, use of feeder cups at bed time etc. Hence this study was conducted to find the acidogenic potential of the commonly consumed fresh fruit juices (Grapes, orange, and pineapple) and the juices stored at various temperatures (room temperature, refrigerator and freezer) on the plaque and saliva at various intervals. It was observed that grape juice was more acidogenic compared to orange and pineapple juice. Frozen fruit juices caused a greater drop in plaque and salivary pH followed by the refrigerated juice.
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INTRODUCTION

Since the evolution of mankind drastic changes have occurred in the dietary patterns. Much emphasis has been placed on "healthy" food and drinks. Changes in diet have included substantial increases in the consumption of carbonated beverages and acidic drinks.¹ Fruit juices are marketed aggressively and are promoted as a "Health Drink". The parents are aware of the deleterious effect of the various carbonated beverages on the teeth and they prefer more natural and healthful products such as fresh fruit juices, which are conveniently prepared at home and are considered to be healthier as it provides a good source of vitamin C.²

Fruit juices are worldwide popular with children of all ages as they are sweet and perceived to be healthful.

However claims of its safety for the teeth are unsubstantiated due to inadequate reports in the literature. The erosive effects of fruit juices has been recognized for a long time, with references dating back as early as 1892 (Darby).³ W. D. Miller (1907)⁴ reported tooth decalcification due to excessive fruit juice consumption. It is not just the total exposure to acidic substances that appears to have increased in recent years; there have also been changes in habits and general lifestyles. A modern undocumented trend among consumers, especially children, is to freeze and suck the frozen fruit juice products. This kind of abusive habit has deleterious effects on teeth. It is the excessive consumption of these fruit drinks in various forms, which poses hazard to young children especially in their primary dentition, due to the reduced amount of tooth structure⁵. The dangers, from the increased frequency of consumption of these fruit juices in various forms, need to be highlighted. Thus the aim of this study was to observe the plaque and salivary pH values, after the consumption of different fruit juices kept at varying temperatures.

MATERIALS AND METHODS

This study was performed on 30 children of both the sexes, between the age group of 10-12 years, after the approval to conduct the study from the local ethics committee. All the children included in the study were selected with a DMFT and deft < 3, Simplified oral hygiene index < 1.2. There was no relevant past medical

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history, and no history of any medication or antibiotic therapy 2 months prior to the study. The subjects were verbally explained about the procedure to be done and informed consent was obtained. The study was conducted in the morning around 9 A.M. for 4 consecutive days. On the 1st day, thorough oral prophylaxis was done, and volunteers were requested to refrain from brushing their teeth or using any oral hygiene aid for the next 24 hours, and from eating food or drink for at least 8 hours prior to the procedure.⁶ On days 2, 3 and 4, volunteers were divided into 3 groups of 10 subjects each and for the next 3 consecutive days salivary and plaque pH was measured at various intervals after

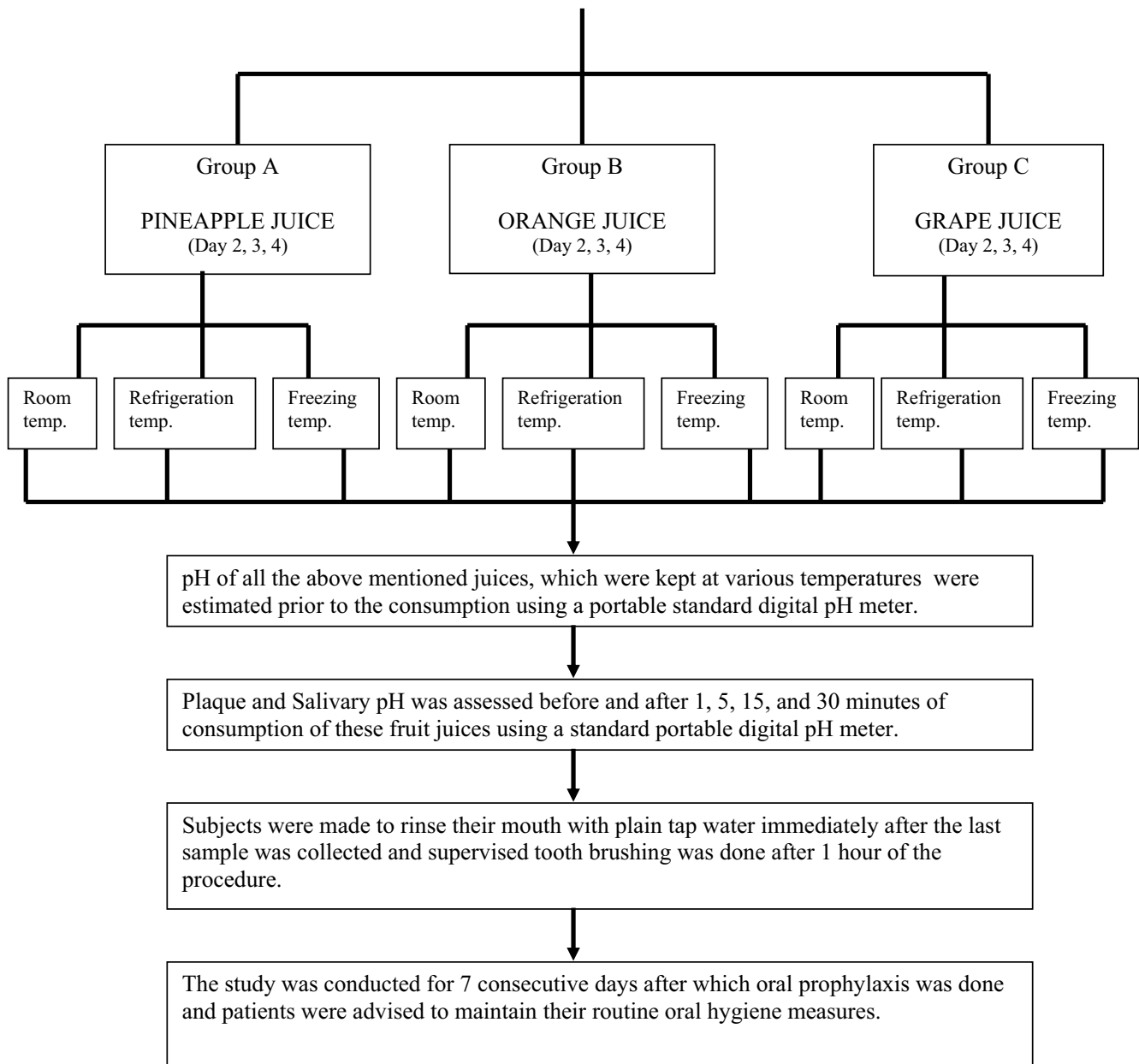
exposing them to the freshly prepared pineapple, orange and grape juices kept at room temperature, refrigeration temperature and freezing temperature respectively. pH was measured with a micro pH electrode (Me-5114 Broadley James Custom Electrodes CA, USA)

The collected data was then analyzed using students unpaired “t” test followed by multivariate analysis (MANOVA).

RESULTS

The data of this study was analyzed and the pH values were estimated in relation to 100% of the baseline pH.

Study design:



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Table 1: Recorded pH values of the Fresh fruit Juices

Juice	Temperature	pH of fresh fruit juice
Grapes	Room Temp.	2.97
	Refrigerator	2.95
	Freezer	2.81
Orange	Room Temp.	3.98
	Refrigerator	3.44
	Freezer	3.05
Pineapple	Room Temp.	4.11
	Refrigerator	3.42
	Freezer	3.21

Among the three fruit juices, grape juice showed the lowest pH followed by orange and lastly the pineapple juice. The frozen fruit juice demonstrated the lowest pH, followed by the refrigerated juice and lastly the juices which were kept at room temperature. (Table 1) Maximum percentage reduction in plaque and salivary pH was observed within 5 minutes of consumption of these fruit juices. Maximum percentage reduction in plaque and salivary pH was recorded after the consumption of grape juice followed by orange and pineapple juice respectively. Maximum percentage reduction in plaque pH was recorded after the consumption of ice candy prepared from these juices followed by the refrigerated juice and the juices which were kept at room temperature. (Graph-2, Table-2) The multivariate analysis of various fresh fruit juices (grapes, orange and pineapple), for comparing the plaque and salivary pH variation, at different time intervals showed significant ($p < .05$) plaque and salivary pH variation at 1 and 5 minutes of consumption of these freshly prepared juices which were kept at various temperatures. There was no significant variation observed at 15 and 30 minutes after the consumption of the above mentioned fruit juices ($p > .05$). (Tables 2, 3)

Table 2: MULTIVARIATE ANALYSIS COMPARING PLAQUE pH VARIATION IN DIFFERENT FRESH FRUIT JUICES AT DIFFERENT TEMPERATURES

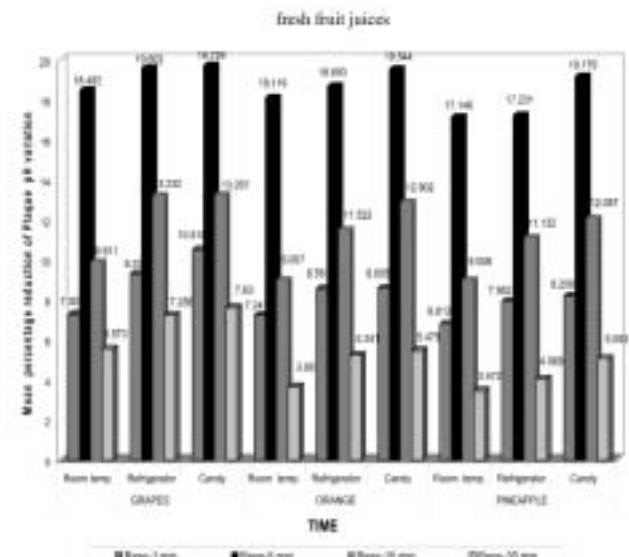
SOURCE	DEPENDENT VARIABLE (Percentage reduction from Base to ...)	F	p
Fruits	1 min	4.656	.036 **
	5 min	4.739	.028 **
	15 min	2.943	.087 *
	30 min	2.83	.096 *
Temperature	1 min	4.582	.044 **
	5 min	5.872	.024 **
	15 min	.743	.479 *
	30 min	.784	.46 *

p - Probability.
 $p < .05$ - Significant **.
 $p < .01$ - Highly significant ***.
 $p > .05$ - Not significant *.

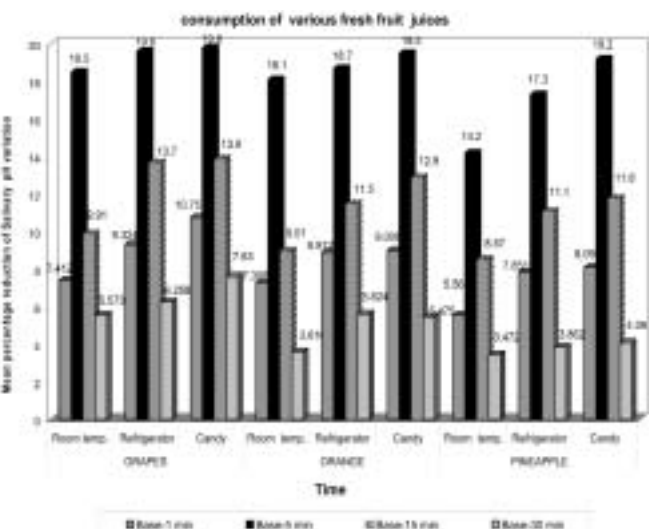
TABLE 3: MULTIVARIATE ANALYSIS COMPARING SALIVARY pH VARIATION IN DIFFERENT FRESH FRUIT JUICES AT DIFFERENT TEMPERATURES

SOURCE	DEPENDENT VARIABLE (Percentage reduction from Base to ...)	F	p
Fruits	1 min	4.608	.036 **
	5 min	5.378	.028 **
	15 min	2.727	0.102 *
	30 min	2.757	.119 *
Temperature	1 min	5.264	.029 **
	5 min	5.438	.024 **
	15 min	2.835	.095 *
	30 min	1.435	0.244 *

p - Probability.
 $p < .05$ - Significant **.
 $p < .01$ - Highly significant ****.
 $p > .05$ - Not significant *.



Graph 1: Graph showing the mean percentage reduction of plaque pH value after the consumption of various fresh fruit juices



Graph 2: Graph showing the mean percentage reduction of salivary pH values after the consumption of various fresh fruit juices

DISCUSSION

There are many complex factors that contribute to the total acidogenic potential on the enamel. The increased awareness of the population about health has led to an increased consumption of natural food products especially fruits and fruit juices. But healthy diet has also been proven to contain substantial acids,⁷ which has the potential to cause loss of tooth structure. Acidified sugar – containing drinks have shown to be cariogenic and erosive in rats.⁸ Foods and beverages, especially fruits and fruit juices, can contain a variety of acids that have the potential to damage the teeth.⁹ The initiation and progression of this dental morbidity which is caused by the consumption of the acidic drinks may involve a multi factorial process, such as the pH of the drink, intra oral pH changes, and the organic acid content of the drink. The development of plaque pH models has provided an insight into the knowledge and understanding of acidogenic potential of various food and drinks.¹⁰ Thus, this study was conducted to find the erosive potential of various commonly consumed freshly prepared fruit juices (orange, pineapple and grapes) which were kept at varying temperatures, and also to assess the fall in plaque and salivary pH after the consumption of these fruit juices.

A significant decrease in plaque and salivary pH was recorded in this study after the consumption of these low pH fruit juices. Maximum fall was recorded in most of the subjects, below the critical pH level (5.5 ± 0.3) within 5 minutes of consumption of these juices, followed by a gradual recovery to the near normal values within 30 minutes of the study. This can be attributed to the neutralizing effects of saliva by the virtue of its buffering system (mainly bicarbonates), which gets activated with the increased salivary secretion and occurs due to an acidogenic challenge.¹¹ The resting plaque pH usually ranges between 6 - 7. When a low pH drink is consumed it causes a fall in this resting plaque pH. The length of time for which this low pH remains at its minimum is important, since if it reaches the so called “critical pH” value, it initiates dissolution of enamel. The lower the pH, faster is the demineralization.¹² Thus recording the plaque and salivary pH gives us an important clinical insight on the deleterious effect of the fruit juices. Some authors,¹³ suggested that the pH of the oral cavity affected the solubility of dental tissues. The consumption of these low pH fruit juices caused a drop in the oral pH below the critical pH (5-5.5), and if it persisted even for few minutes, caused potential damage to teeth. It was reported that the solubility of dental tissues increases by a factor of 7-8 with each decrease of pH by 1 unit, thereby significantly increasing the potential risk for demineralization.

On analyzing our data it was found that, maximum fall in plaque and salivary pH occurred after the consumption of frozen fruit juice followed by the refrigerated and room temperature juices. This also correlates

with the findings of various other authors who stated that the consumption of frozen fruit juices can be more deleterious than the unfrozen form.^{14,15} The greater pH fall can be attributed to prolonged period of consumption of these fruit candies (approximately 5 minutes), which could expose the teeth to dangerously low levels of pH as the acid is held for a prolonged period in contact with the teeth. This correlates with the study conducted by James and Parfitt (1953)¹⁶ where erosion occurred in children due to history of prolonged sucking of dummies dipped into numerous fruit syrups. The increased acidity in frozen fruit candies occurs because freezing changes the physical state (i.e. from liquid to solid phase) of the residual juice and as the solute concentrates (as the molecules being tightly packed) there is a decrease in the buffering capacity (which results in a prolonged pH fall).¹⁷ The sucking of these frozen juices thus causes a greater pH fall and requires more than usual volume of alkaline salivary buffering action to rinse and normalize the oral environmental pH.¹⁴ The above finding can also be more closely related to the rate of acid accumulation than to the amount of acid which was present in the fruit juice candy.¹⁸ Despite the fact that high levels of acids may be present, the rate at which these acids are added, if it exceeds the rate at which they are neutralized or buffered may lead to a prolonged pH fall.

Among the 3 fruit juices compared, grape juice demonstrated greater fall in the plaque and salivary pH followed by the orange and pineapple juice respectively. Similar results were obtained in rat studies, where it was found that canned apple and grape juice were more destructive than pineapple or orange juice.¹⁹ In another animal study conducted it was found that grape fruit juice caused more demineralization than plums, mangoes and pineapple juice. It was also reported that fruit juices were 10 times more destructive than the whole fruit.²⁰

The above study highlights the detrimental effects caused by the excessive and abusive consumption of the fruit juices and their frozen products. The neutralization of an acidogenic challenge in the oral cavity is a complex phenomenon. The constant bathing of tooth by saliva in the oral cavity helps in the neutralization of plaque pH, but the same effect could not be replicated in our study as the plaque and saliva samples were obtained individually. Thus a clinical *in vivo* study would be recommended, to assess the post plaque and salivary pH variation after an acidogenic diet challenge. This would further help in demonstrating the sudden variation in the intra oral pH, after the intake of an acidogenic diet, which can have deleterious effects on the teeth. Though the amounts of acid beverages normally drunk by children may be insignificant, the presence of immature enamel, inadequate neuromuscular coordination and inability to clear the retentive substrate, along with the deleterious methods of con-

sumption, makes them susceptible to dental erosion.²¹ Hence, it becomes mandatory for us as preventive dentists, to strongly discourage children and parents against the consumption of these fruit juices in an abusive form, with adequate parent education and diet counseling for healthier teeth.

CONCLUSION

It was found that the commonly consumed fresh fruit juices like grape, orange and pineapple had a low pH ranging between 2.97 – 4.11, thus demonstrating an acidic nature. Among the grape, orange and pineapple juices it was found that grape juice caused a greater fall in plaque and salivary pH with maximum fall in pH within 5 minutes of consumption of these fruit juices. There is a dynamic, two-way relationship between diet/nutrition and oral health. Hence it is incumbent for us as Pediatric Dentists to provide appropriate diet counseling tailored for particular individual to maximize compliance and to eliminate the abusive habits associated with the consumption of these fruit juices.

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