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Original Article

Dentistry Section

Evaluation of Plaque pH Changes Following Consumption of Health Drinks by Children: A Pilot Study

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ABSTRACT

Introduction: With increased trend among people to choose a healthy diet, there is an increased consumption of health drinks by children. Thus, it is important to know their cariogenicity.

Aim: To evaluate the effect of consumption of health drinks viz., Horlicks, Boost and Complan on plaque pH in children.

Materials and Methods: The study consisted of four groups: Group I (control)- 10% sucrose solution, Group II- Horlicks, Group III- Boost, Group IV- Complan. Samples of plaque from representative teeth were collected and pH was measured using an electrode outside the mouth. After baseline pH was recorded, children were given their respective drinks and were asked to consume slowly over a period of three to five minutes following swish with 20 ml of the test drink for one minute. The pH was then recorded after 10, 20, 30, 40 and 60 minutes of the post consumption period. Obtained values were subjected to one-way ANOVA test for multiple group comparison followed by Post-Hoc Tukey's test for group wise comparison.

Results: Twenty minutes after consumption of Complan and Boost, pH was decreased, but not to the critical pH value as in case of sucrose. The pH was found to be slightly increased, 20 minutes post Horlicks consumption. Post 60 minutes consumption of all the drinks including sucrose solution, the pH was increased in comparison to post 20 minutes. However, 60 minutes post consumption of Boost and Horlicks, pH increased above the baseline.

Conclusion: Consumption of health drinks viz., Complan and Boost did not lower the plaque pH to the level of critical pH. Consumption of Horlicks increased the plaque pH.

Keywords: Beverages, Cariogenic, Sucrose

INTRODUCTION

The concept of health has prevailed for centuries and "Healthy diet" is now perceived to be important. Though with modernization there is a substantial increase in the consumption of beverages and fruit drinks, people have become aware of the deleterious effects caused by carbonated beverages and thus prefer more natural and healthy products [1,2] like Horlicks, Boost, Complan. These are universally used by all, irrespective of their age group and are being popularly marketed as "health drinks" by various companies [1,2].

Consumption of these drinks has two main dental concerns: 1) Acidic nature of these drinks can damage the tooth surfaces; and 2) Fermentable carbohydrate content present can serve as a substrate, from which microorganisms inhabiting the plaque can produce the acid that causes dental caries [3,4].

A positive correlation has been established through studies between the acidogenicity of a food and changes in the plaque pH post consumption of that particular food [5,6]. Thus, for the estimation of the cariogenic potential of the food items and drinks following their consumption, plaque pH evaluation has been adapted routinely as the method of choice [7].

Disaccharide lactose (4%-5%) is the primary carbohydrate present in the milk. Following fermentation of lactose by biofilm bacteria the plaque pH lowers to around 6.0 as against sucrose, following fermentation of which the plaque pH lowers to 5. Thus, under normal conditions, the lactose content confers a low cariogenic potential to the milk [8]. Health drinks like Horlicks, Boost, Complan contain milk with respective powders and added sugar. The effect of interplay between all these components together on plaque pH is not known. Thus, the aim of our study was to evaluate the effect of consumption of health drinks viz., Horlicks, Boost and Complan on plaque pH of children. The null hypothesis was set as there will be no difference in the plaque pH following consumption of Horlicks/Boost/Complan when compared to 10% sucrose solution.

MATERIALS AND METHODS

This was an experimental in vivo comparative study and it was initiated after approval from Institutional Ethics Committee of Manipal College of Dental Sciences, Mangalore, Karnataka, India. Procedures followed in the study were in accordance with the Helsinki Declaration of 1975 that was revised in 2000. Lack of previous studies done on effect of health drinks on plaque pH, prompted us to do a pilot study in the beginning taking five subjects in each group. Based on the results of the pilot study the sample size of five per group (20 subjects) achieved 100% power to detect differences among the means at a significance level of 0.05. Thus, sample size of five per group was considered as adequate for the study.

The study consisted of four groups: Group I (control)- 10% sucrose solution, Group II- Horlicks, Group III- Boost, Group IV- Complan. Out of the variety of health drinks available in market, Horlicks, Boost and Complan were chosen based on the patient pole where outpatients visiting the department were made to vote for their favourite health drink. Allotment of the selected subjects to a particular group was made by lottery system.

Study setting: Children in the age group six to 10 years, who visited the outpatient clinics of Paedodontics and Preventive Dentistry Department of Manipal College of Dental Sciences, Mangalore were selected for the study.

Inclusion and exclusion criteria: Children who showed optimum cooperation for the smooth functioning of the investigation and those who had all first permanent molars with an overall dft and/DMFT not more than three were included in the study. Children

Health drink	Powder	Milk	Sugar
Horlicks	30 g	125 ml	10 g
Boost	20 g	125 ml	10 g
Complan	33 g	125 ml	10 g

[Table/Fig-1]: Preparation of the health drinks according to manufacturers' instructions.

with restorations on the labial/buccal and lingual surfaces of teeth, crowding, history of allergy to dairy products or to any of the health drinks used in the study, history of lactose intolerance and presence of systemic diseases were excluded from the study. Also, children who were on antibiotic coverage within three months of the study and who had not followed the instructions given prior collection of plaque sample were excluded from the study [1,3].

Parents of the eligible participants were given an information summary to read, along with the verbal explanations of the procedure and made to sign the informed consent form.

Preparation of health drinks: The health drinks were freshly prepared by adding respective powder to milk containing sugar according to manufacturer's instructions [9] [Table/Fig-1].

Plaque pH assessment: Subjects were asked to refrain from oral hygiene procedures for 24 hours [3]. All appointments were fixed to take place in the morning. Children were asked not to drink or eat anything (except water) until the completion of sample collection procedure. The compliance of the subject with the instructions given was confirmed before the commencement of the study [7]. Standardization of the pH meter was done with a standard buffer of pH 4 and 7 before recording the plaque pH on it [1].

Plaque collection and pH measurement: Plaque pH was measured by the "harvesting method" that involved collection of small samples of plaque using sterile toothpicks from representative teeth and its pH measurement using an electrode outside the mouth [7]. Plaque samples were collected from all (buccal/mesial/distal/lingual/occlusal) surfaces of all first permanent molars using a sterile toothpick [10] and were dissolved in the test beakers having 5 ml of double distilled de-ionized water [3]. The pH was then recorded immediately (within 90 second) with the help of electrodes of the pH meter so that resting plaque pH could be noted [1]. Plaque sampling was done before the consumption of test drinks (baseline pH) and at various intervals after the consumption of the test drinks. After baseline pH was recorded, 10% sucrose was given to children in control group and the children belonging to Group II, III and IV were given their respective health drinks. Each child was then asked to swish with 20 ml of the test drink for one minute and to consume slowly over a period of three to five minutes [7]. Plaque sampling and pH measurements were repeated post 5, 10, 20, 30, 40 and 60 minutes of consumption of health drinks [1].

STATISTICAL ANALYSIS

Changes in plaque pH between various study groups was compared using One-way ANOVA and the group wise intergroup comparisons were made using the Post-hoc Tukey's test. A p-value of <0.05 was considered as significant.

RESULTS

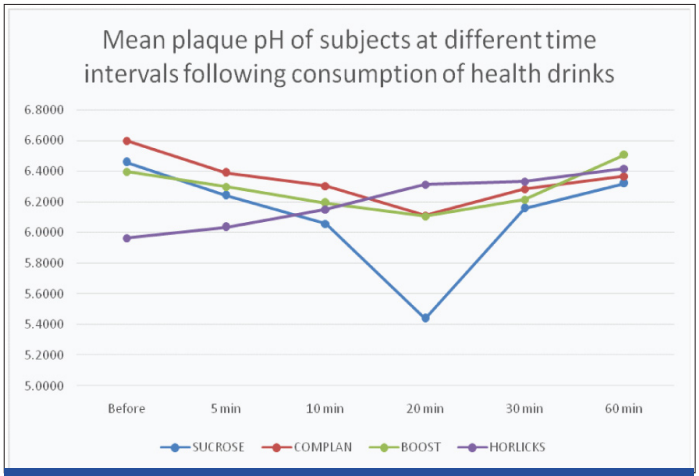
When comparison of difference between 20 minute to baseline and 60 minute to baseline was done, the difference between the groups was found to be statistically significant (p<0.001) for both the categories. However, the trend in the pH decrease was different between 20 minute to baseline category and 60 minute to baseline category. The mean decrease in the pH post 20 minutes of consumption of health drinks was found to be highest in sucrose group followed by Complan group, Boost group, least being in Horlicks group, whereas the mean change in the pH value post 60 minutes of consumption of Complan was highest followed by sucrose, Boost, least being in Horlicks [Table/Fig-2]. Post-hoc Tukey

	Groups	N	Mean pH log (mol/L)	Std. Deviation	Statistics/ mean squares	df2 (welch) / F (Anova)	p-value
Difference between 20 minutes to baseline	Sucrose	5	1.02	0.36042	88.432	7.88	<0.001
	Complan	5	0.486	0.1272			
	Boost	5	0.29	0.11916			
	Horlicks	5	-0.348	0.0545			
Difference between 60 minutes to baseline	Sucrose	5	0.138	0.069065	0.467	65.962	<0.001
	Complan	5	0.232	0.111445			
	Boost	5	-0.112	0.093915			
	Horlicks	5	-0.452	0.048166			

[Table/Fig-2]: Intergroup comparison of change in plaque pH using One-way ANOVA.
(p<0.001- significant)

Dependent Variable	Comparison Group	Compared With	Mean Difference	Std. Error	p-value
Difference Between 20 Minutes To Baseline	Sucrose	Complan	0.53400*	0.12777	0.004
		Boost	0.73000*	0.12777	<0.001
		Horlicks	1.36800*	0.12777	<0.001
	Complan	Boost	0.196	0.12777	0.442
		Horlicks	0.83400*	0.12777	<0.001
	Boost	Horlicks	0.63800*	0.12777	0.001
Difference Between 60 Minutes To Base	Sucrose	Complan	-0.094	0.053226	0.324
		Boost	0.2500000*	0.053226	0.001
		Horlicks	0.5900000*	0.053226	<0.001
	Complan	Boost	0.3440000*	0.053226	<0.001
		Horlicks	0.6840000*	0.053226	<0.001
	Boost	Horlicks	0.3400000*	0.053226	<0.001

[Table/Fig-3]: Groupwise comparison of plaque pH levels using Post-hoc Tukey's test.
(p<0.001- significant)



[Table/Fig-4]: Mean plaque pH of subjects at different time intervals following consumption of health drinks.

test also showed statistically significant differences between all the groups when intergroup comparison was done except between Complan and Boost in case of 20 minute to baseline category and Sucrose and Complan in case of 60 minute to baseline category [Table/Fig-3]. Thus, 20 minutes after consumption of Complan and Boost, pH was found to be decreased, but not to the critical pH value as in case of sucrose. The pH was found to be slightly increased, 20 minutes after Horlicks consumption. Though post 60 minutes consumption of all the drinks including sucrose solution, the pH was increased in comparison to post 20 minutes, in Boost and Horlicks groups, the pH was increased above the baseline [Table/Fig-4].

DISCUSSION

Modern diet is more refined with increased preference to more natural and healthier products that can be conveniently prepared at home [3]. While dairy products are perceived to be important for one's overall and dental health [11], health drinks are the one form through which parents make their children consume milk. Though there are various health drinks in the market, through patient pole we found out that Horlicks, Complan and Boost are most commonly used ones. Thus, we selected them as the part of our study. They contain milk along with various vitamins, marketed as essential for physical and intellectual growth of children. Thus, in paediatric population, there is increased consumption of these health drinks.

Various methods have been cited in the literature to measure the relative cariogenicity of foods and drinks viz., enamel surface topography, microhardness of the enamel and plaque pH [7,12,13]. Stephan in early 1940s, through his classic studies proposed classic Stephan's RM curve produced when dental plaque is exposed to sucrose, causing a rapid drop in pH followed by a gradual recovery towards the baseline pH [14]. Since then, the association between the production of strong acids by plaque bacteria when exposed to cariogenic diet particularly sucrose and caries activity has become well established [1]. Thus, we have used plaque pH measurement over other methods to assess the cariogenicity of the health drinks.

The age of plaque is an important factor for plaque pH measurement [5]. When Igarashi K et al., challenged plaque with sucrose solution older plaque produced a greater level of acid than immature plaque [15]. Thus, to ensure the presence of representative oral bacterial flora on the accessible tooth surfaces, professional oral prophylaxis was not performed before starting the present study. Considering the practicality, subjects were instructed not to brush their teeth for 24 hours prior to taking the pH measurements.

The usual resting plaque pH value is between 6 and 7. Upon consumption of low pH drinks, this pH value falls and remains at a lower value. If the pH drops down to the level, so called critical pH value, there will be initiation of dissolution of the enamel. Not just the pH drop, but also the length of the time for which the pH remains low at its minimum, is important [3].

Results of our study showed that there was decrease in the plaque pH following 20 minutes after consumption of Boost and Complan. However, this pH drop was not below the critical pH for both enamel and dentine. Between 20 minutes to 60 minutes after consumption of Complan though the pH increased, it remained below baseline level. Post Horlicks consumption plaque pH increased till first 20 minutes and then remained relatively stable with only a slight increase till 60 minutes. The variation in the responses among different groups can be attributed to the difference in their composition. The composition of these health drinks is complex. However, the common ingredients among all the three being milk solids, multivitamins and minerals. Apart from these Horlicks contains wheat flour and malted barley, Boost contains corn in the form of syrup and oil and; Complan contains peanut oil and beetroot juice powder [9]. To which of the compositional variation, change in the pattern of pH can be attributed requires further exploration.

The difference in pH response can also be attributed to the type of plaque bacteria present in ones' oral cavity. Few of the plaque bacteria can produce only fall in the plaque pH, whereas others (arginolytics) can either increase or decrease the pH. Thus, the shape of the Stephan's curve is always dictated by the balance between metabolic products produced by the bacteria present in the plaque [1]. In the present study, the classic Stephan's curve was reproduced only in sucrose group.

All the test drinks used in the present study contained milk (intrinsic milk in the form of powder and added milk during the preparation of the health drink). Literature suggests that milk may provide some protection from dental caries [16]. Under normal conditions milk is considered to have a low cariogenic potential in spite, it contains 4%-5% disaccharide lactose which can be fermented by plaque bacteria [8]. The anticariogenic property of milk can also be attributed directly to the chemical effects of its constituent's viz., casein, phosphopeptides, calcium, and phosphate [5]. The major source of protein in milk is casein. Reynolds EC et al., reported that addition of 2% casein to drinking water reduces the incidence of both fissure and smooth surface caries [17].

As per the obtained results of our study, all the tested health drinks were noncariogenic and can be considered dentally safe. However, so far no supportive study exists in the literature on the post consumption effect of Complan, Horlicks or Boost on plaque pH or salivary pH. Also, though the present study suggests that the tested health drinks are noncariogenic, amount of sugar added during preparation and frequency of consumption will definitely have an impact on its acidogenicity. Thus, while extrapolating the results of the present study as far as dietary counseling is concerned, addition of sugar while preparing health drinks at home and frequency of consumption should be considered with caution.

It should also be noted that along with the plaque pH, oral clearance of consumed drink, its effect on salivary flow rate and salivary pH all play a significant role in determining the cariogenicity. In the present study, these parameters were not measured. Also, if the study design was cross over, the possible difference in the pH response due to type of plaque bacteria present could be eliminated. Thus, future cross over studies are required to confirm the non-cariogenicity of these health drinks.

CONCLUSION

Under the conditions of the present study, the obtained data showed that consumption of health drinks viz., Complan and Boost did not lower the plaque pH to the level of critical pH, whereas, consumption of Horlicks increased the plaque pH.

Conflicts of interest: Nil, the authors are not affiliated with the brands being studied or have not received any grants from these brands. On behalf of other authors, the corresponding author will take the responsibility of guarantee of data.

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