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Erosive Potential Of Various Commercially Available Lollipops

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ABSTRACT

OBJECTIVES : • To measure pH and neutralisable acidity of lollipops.
• To determine salivary pH and salivary secretion.

METHODS: Chocolate, strawberry and mango flavoured lollipops were selected based on differences in pH and neutralisable capacity and tested on 10 healthy volunteers. Each experimental session included collection of unstimulated saliva, stimulated saliva and post-stimulated saliva. Saliva secretion rates were determined gravimetrically and the salivary pH was measured by electronic pH meter.

RESULTS: The pH of chocolate, strawberry and mango flavoured lollipops were 5.2, 3.8 and 2.6 respectively. The nuetralisable acidity of chocolate, strawberry and mango flavoured lollipop were 500 μl, 2600 μl and 3300 μl respectively. All lollipops stimulated salivary flow. Strawberry and mango flavoured lollipops induced a significant decrease of the salivary pH at stimulated 5 minutes (p value < 0.05).

CONCLUSION: Strawberry and mango flavoured lollipops have mild erosive potential. Chocolate flavoured lollipops seem to have no erosive potential.

Key Words: Lollipop, Erosive potential, Neutralisable acidity

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INTRODUCTION

Surface demineralization and remineralization processes have an important role for mineralized tissues, such as bones and teeth (1). Dental erosion is defined as loss of dental hard tissue by a chemical process that does not involve bacteria (2). As early as 1908, G. V. Black estimated that the prevalence of dental erosion was less than 0.1%. He hypothesised that the origin might be hereditary, but also listed other possible aetiologies from developmental, systemic or extrinsic origin (3).

Dental erosion was included in the examination for the first time in the 1993 National Survey of Child Dental Health conducted in the United Kingdom. In this study, 17,061 children were examined. Over half of the 5 and 6 year olds had erosion, 25% with dentinal involvement of the primary dentition. In the 11+ year age group, almost 25% had erosion, 2% with dentinal involvement in the mixed dentition (4).

In a cross-sectional survey conducted in 11- to 14-year-old school children attending public and private schools located in urban and rural areas of Udupi, Karnataka, the prevalence of dental erosion was found to be 8.9% (5).
Dental erosion can have extrinsic or intrinsic causes (6). Solid acidic candies have been most commonly consumed by children and these candies contain organic acids like citric acid and malic

acid to develop the characteristic sour flavour (7). There are several physiological factors that may modify the erosive process both ways, i.e. they may either protect against erosion or increase the degree of erosion. These include saliva, tooth composition and structure, dental anatomy and occlusion, anatomy of soft tissues in relation to teeth, and physiological movements like swallowing. One of the main biological parameters is saliva. It provides protection against acid erosion by different ways.

- First, there is the influence of the acquired pellicle. The acquired pellicle may protect against erosion by acting as a diffusion barrier or a semi-permeable membrane, preventing direct contact between the acids and tooth surface, thus reducing the dissolution rate of dental hard tissue.
- Second, saliva presents a diluent action over the acids.
- Third, salivary clearance gradually eliminates the acids through swallowing.
- Fourth, saliva presents buffering capacity causing neutralization and buffering of dietary acids.
- Fifth, saliva is supersaturated with respect to tooth mineral content, providing calcium, phosphate and fluoride necessary for remineralization.
- Sixth, many proteins present in saliva and acquired pellicle play an important role on dental erosion (8).

Enamel is susceptible to acid dissolution when the pH of its fluid environment is less than the critical pH below which the fluid is unsaturated with respect to tooth mineral (9). For saliva, the critical pH with respect to tooth mineral is between 5.5 and 6.5, and it is inversely related to the concentrations of calcium and phosphate in the saliva (10).

If this condition is not controlled and stabilized, the child may suffer from severe tooth surface loss, tooth sensitivity, over closure, poor aesthetics, or even dental abscesses in the affected teeth (11).

Since not much information has been available on the erosive potential of lollipops, a study was done to determine the erosive potential of a number of commercially available lollipops.

MATERIAL AND METHODS

A cross over experimental study was conducted to determine the erosive potential of several commercially available lollipops and the protective effect of saliva.

Source Of Data

The source of data was primary in nature for which an invitro and invivo experiment were carried out.

Study Population

The study was carried out among healthy volunteers.

Inclusion Criteria

- Those who are volunteers
- 20 ± 5 years of age

Exclusion Criteria

- Those with carious lesions, enamel hypoplasia, suffering from xerostomia, taste or masticatory dysfunctions
- Those who had the adverse habit of smoking

Ethical Clearance

The nature and purpose of the study was explained to the Institutional Review Board and ethical clearance was obtained. Informed consent was obtained from the study subjects.

Pilot Study

A pilot study was done among 5 healthy volunteers.

Sample Size

Using SPSS Software Version 17© keeping the power of the study 90% and alpha error at 5%, using G-power analysis, the sample size was decided, based on the comparison of mean pH values at stimulated 10 mins between three flavours of lollipops namely, chocolate, strawberry and mango and the required sample size was 9 per group.

In Vitro Experiment

Seven different flavoured lollipops of same weight were chosen. Each lollipop was homogenized with a mortar and pestle, and 5 g of the resultant powder was dissolved in 10 mL of deionised water. Subsequently, the erosive potential of each solution was assessed by measuring the pH and neutralisable acidity. The pH was determined with an electronic pH meter. Neutralisable acidity of the lollipop solutions was determined by stepwise addition of 100 μL 0.1 M NaOH till we obtain a pH > 7.0.

In Vivo Experiment

The effect of lollipops on saliva secretion rate and pH was investigated in ten healthy volunteers. The volunteers were instructed to abstain from eating, drinking and tooth brushing at least 1 h before the experiments (12).

Three different lollipops, selected on basis of differences in pH and neutralisable capacity, were tested by each volunteer on different days.

Each experimental session included collection of unstimulated, stimulated saliva and post stimulated saliva (13). The procedure included an initial collection of unstimulated whole saliva for 5 minutes.

Subsequently, a lollipop was placed in the buccal pouch and whole saliva was collected in 5 minute intervals for a total period of 15 minutes, after which the stimulus was removed and saliva was collected at 5 minute intervals for an additional 10 minutes (post-stimulated).

Saliva secretion rates was determined

Table 1: ph and neutralisable acidity of lollipop solutions

Lollipop solutions	pH	Neutralisable acidity µl 0.1 M NaOH
Chocolate	5.2	500
Red apple	2.9	3100
Peach	2.6	3300
Green apple	2.6	3700
Straw berry	3.8	2600
Water melon	2.3	14100
Mango	2.6	3300

gravimetrically (assuming 1 gram = 1 mL) and the salivary pH was measured by electronic pH meter.

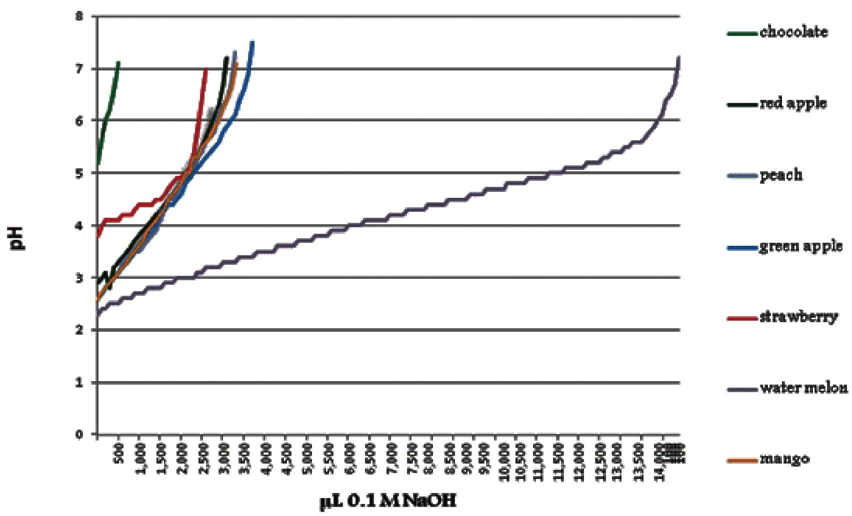


Figure 1: Neutralisable acidity and ph of lollipop solutions

RESULTS

A cross over experimental study was conducted among 10 volunteers to determine the erosive potential of several commercially available lollipops and the protective effect of saliva.

Invitro Experiment

Ph Of The Lollipop Solutions

The pH of the solutions containing chocolate, strawberry, green apple, red apple, water melon, mango and peach flavoured lollipops were found to be 5.2, 3.8, 2.6, 2.9, 2.3, 2.6 and 2.6 respectively. The highest pH was observed for the chocolate flavoured lollipop (5.2). The lowest pH was observed for the watermelon flavoured lollipop (2.3).

Neutralisable Acidity Of The Lollipop Solutions

The chocolate lollipop has a very low neutralisable acidity of about 500 µL 0.1 M NaOH, in contrast to the watermelon flavoured lollipop which had very high neutralisable acidity of 14100 µL. Other lollipops have intermediate values (2500 – 3700 µL). The neutralisable acidity was about 3200 µL for red apple. The peach lollipop has a neutralisable acidity of about 3300 µL. The green apple lollipop has a neutralisable acidity of about 3700 µL. The strawberry lollipop has a neutralisable acidity of about 2600 µL. The neutralisable acidity results are presented in Table 1 and Figure 1.

Invivo Experiment

pH and flow of unstimulated salivary samples

Unstimulated salivary flow rate at 5 minutes for chocolate, mango and strawberry lollipop was 2.2 ml, 2 ml and 1.9 ml respectively.

pH of unstimulated saliva at 5 minutes for chocolate, mango and strawberry lollipop was 7.4, 7.4 and 7.5 respectively. (Table 2,3; Figure 2,3)

Ph And Flow Of Stimulated Salivary Samples

All lollipops stimulate the salivary flow immediately after they have been introduced into the mouth.

The stimulated salivary flow rate of chocolate, mango and strawberry lollipop at 5 minutes was 3.6 ml, 4.8 ml and 4.5ml respectively. This difference in the salivary flow rate was not statistically significant.

The pH of stimulated saliva of chocolate, mango and strawberry lollipop at 5 minutes was 7, 5.7 and 6.2 respectively (Figure 3).

The stimulated salivary flow rate of chocolate, mango and strawberry lollipop at 10 minutes was 4.9 ml, 5.7 ml and 5.9 ml respectively. This difference in the salivary flow rate was not statistically significant.

Table 2: Mean salivary flow of unstimulated, stimulated and post stimulated salivary samples

Time (minutes)	Mean Salivary flow (ml)		
	Chocolate	Strawberry	Mango
US	2.2	2	1.9
S 5	3.6	4.8	4.5
S 10	4.9	5.7	5.9
S 15	4.8	5.3	5.6
PS 5	4.1	4.3	4.6
PS 10	3.6	3.4	3.9

US: Unstimulatedsaliva; S- Stimulated Saliva; PS- Post Stimulated Saliva

TABLE 3: MEAN SALIVARY pH OF UNSTIMULATED, STIMULATED AND POST STIMULATED SALIVARY SAMPLES

Time (minutes)	Mean Salivary flow (ml)		
	Chocolate	Strawberry	Mango
US	7.4	7.5	7.4
S 5	7	6.2	5.7
S 10	7.1	6.4	6.4
S 15	7.1	6.7	6.7
PS 5	7.3	7.4	7.3
PS 10	7.2	7.4	7.4

US – Unstimulatedsaliva; S- Stimulated Saliva; PS- Post Stimulated Saliva

The pH of stimulated saliva of chocolate, mango and strawberry lollipop at 10 minutes was 7.1, 6.4 and 6.4 respectively. This difference in the pH of stimulated saliva was not statistically significant.

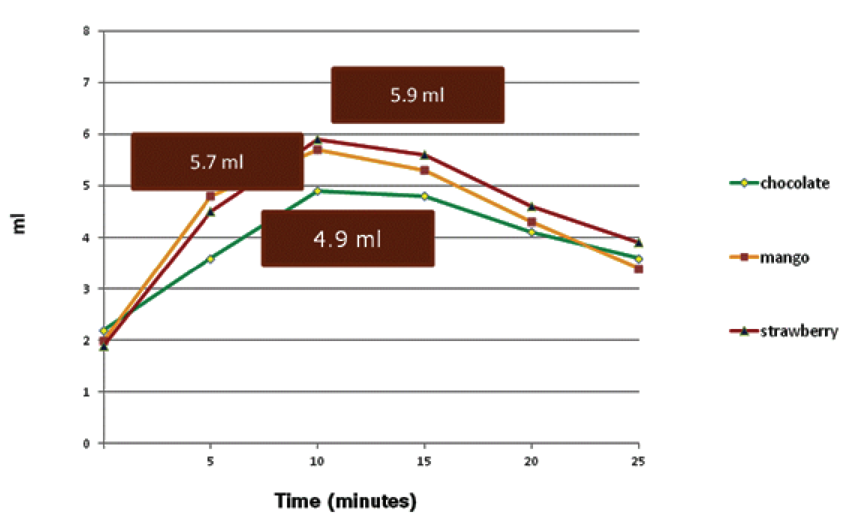
The stimulated salivary flow rate of chocolate, mango and strawberry lollipop at 15 minutes was 4.8ml, 5.3 ml and 5.6 ml respectively. This difference in the salivary flow rate was not statistically significant.

The pH of stimulated saliva of chocolate, mango and strawberry lollipop at 15 minutes was 7.1, 6.7 and 6.7 respectively. This difference in the pH of stimulated saliva was not statistically significant. (Table 2,3; Figure 2,3)

pH and flow of post stimulated salivary samples

The salivary flow rate of chocolate, mango and strawberry lollipop at 5 minutes after the removal of lollipops was 4.1 ml, 4.3 ml and 4.6 ml respectively. This difference in the salivary flow rate was not statistically significant.

The pH of post stimulated saliva of chocolate, mango and strawberry lollipop at 5 minutes was 7.3, 7.3 and 7.4 respectively. This difference in the pH of stimulated saliva was not statistically significant.



Mean salivary flow rate before, during and after use of three different lollipops. During the period 0 to 15 minutes, the lollipops were kept in the buccal pouch.

Figure 2: Mean Salivary Flow

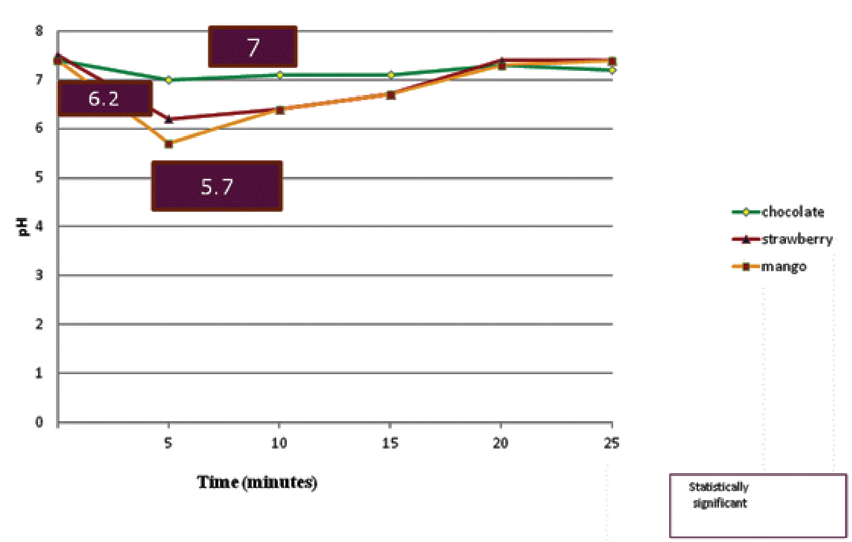
The salivary flow rate of chocolate, mango and strawberry lollipop at 10 minutes after the removal of lollipops was 3.6 ml, 3.7 ml and 3.9 ml respectively. This difference in the salivary flow rate was not statistically significant.

The pH of post stimulated saliva of chocolate, mango and strawberry lollipop at 10 minutes was 7.2, 7.4 and 7.4 respectively. This difference in the pH of stimulated saliva was not statistically significant (table 2,3; graph 2,3).

DISCUSSION

The availability of candy has been increased dramatically and many new types and tastes of candies were developed. The caries risk of sugar-containing-candy became well-known (3). However, many candies also contain organic acid, like citric acid, malic acid and/or fumaric acid, for a fresh taste. These organic acids are potentially erosive for the dental enamel as they can induce a drop in salivary pH. This risk seems especially present in solid hard candies such as lollipops. These types of candy slowly melt in the mouth and consumption often takes more than 15 minutes. Consequently, the intra-oral pH may decrease for a long time to values below critical pH value and thus possess a considerable risk for the development of dental erosion (3). Enamel softened by erosion is likely to be more susceptible to abrasion and attrition.

Fruit flavoured lollipops tested in this study were highly acidic, suggesting that they contain high levels of citric acid and/or malic acid. Their initial pH values ranged from 2.6 – 3.8, far below the pH-value of 5.5 that has generally been adopted as the critical value below which hydroxyapatite may dissolve. However, the neutralisable acidity also strongly influence the erosive potential of a lollipop. The greater the neutralisable acidity of the lollipop, the longer it will take for saliva to neutralize it.



Mean salivary pH before, during and after use of three different lollipops. During the period 0 to 15 minutes, the lollipops were kept in the buccal pouch.

Figure 3: Mean Salivary Ph

The fruit-flavoured lollipops not only have a low pH but also have the highest neutralisable acidity than chocolate flavoured lollipop suggesting that they might have a much higher erosive potential than the chocolate flavoured lollipops.

All lollipops stimulated the salivary flow immediately after they have been introduced into the mouth. This was similar to the study conducted by H.S. Brand et al in Netherlands (14).

In the present study, fruit flavoured lollipops, namely strawberry and mango flavoured lollipops have significant drop in mean salivary pH (pH 6.2 and 5.7 respectively) at stimulated 5 minutes than chocolate flavoured lollipops (pH 7), suggesting that they contain high levels of citric acid and/or malic acid. Solid acidic candies contain organic acids like citric acid and malic acid to develop the characteristic sour flavour. Whereas, in a study conducted by H.S. Brand et al, 2009 (14) among healthy adults in Netherlands, fruit flavoured lollipops induced a salivary drop below 5.5. This difference in drop in salivary pH could be due to the variations in the flavours, composition of the lollipops used.

Limitations

There are certain limitations in the present study. In the present study, only the salivary pH and flow was considered. Whereas, calcium and phosphate component in saliva, which have an influence over the salivary critical pH were not taken into consideration. The critical pH is the pH at which a solution is just saturated with respect to a particular mineral, such as tooth enamel (10). If the pH of the solution is above the critical pH, then the solution is supersaturated with respect to the mineral, and more mineral will tend to precipitate out. Conversely, if the pH of the solution is less than the critical pH, the solution is unsaturated, and the mineral will tend to dissolve until the solution becomes saturated. Infact, the critical pH varies over a wide range, its value depending on the concentrations of calcium and phosphate in the solution (10). Hence further studies are needed to analyse the effect of them on erosion.

Another limitation of the study was that it was done among adults due to various practical constraints. The accurate determination of the salivary flow rate would be difficult in young children, because it would be hard for them to follow the instructions, that is, instead of expectorating, a part of the saliva may have been swallowed. Researches indicate that primary enamel with higher organic content dissolved considerably faster than permanent enamel. Differences seem to exist in susceptibility of deciduous and permanent dentition to erosion by low pH drinks and solid acidic candy. In general, erosion of enamel was greater in the deciduous tissue, especially with increased frequency of consumption (7). Hence, it is obvious that erosion can be induced in deciduous tissue by those products that cause erosion in permanent tissues.

CONCLUSION

As the critical pH varies from individual to individual based on the calcium and phosphate component in saliva, it can be concluded from the study that,

- Strawberry and mango flavoured lollipops probably can have mild erosive potential depending on the salivary calcium and phosphate composition.
- Chocolate flavoured lollipops seem to have no erosive potential.

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