Processed Dairy Beverages pH Evaluation: Consequences of Temperature Variation

Fabiana Vargas Ferreira* / Roselaine Terezinha Pozzobon**

Objective: *this study assessed the pH from processed dairy beverages as well as eventual consequences deriving from different ingestion temperatures.* ***Study design:*** *50 adults who accompanied children attended to at the Dentistry School were randomly selected and they answered a questionnaire on beverages. The beverages were divided into 4 groups: yogurt (GI) fermented milk (GII), chocolate-based products (GIII) and fermented dairy beverages (GIV). They were asked which type, flavor and temperature. The most popular beverages were selected, and these made up the sample. A pHmeter Quimis 400 A device was used to verify pH. The average pH from each beverage was calculated and submitted to statistical analysis (Variance and Tukey test with a 5% significance level).* ***Results:*** *for groups I, II and III beverages, type x temperature interaction was significant, showing the pH averages were influenced by temperature variation. At iced temperatures, they presented lower pH values, which were considered statistically significant when compared to the values found for the same beverages at room temperature.* ***Conclusion:*** *all dairy beverages, with the exception of the chocolate-based type presented pH below critical level for enamel and present corrosive potential; as to ingestion temperature, iced temperature influenced pH reducing its values, in vitro.*

Keywords: *beverages, dental erosion, deciduous teeth, primary teeth,temperature*
J Clin Pediatr Dent 33(4): 319–324, 2009

INTRODUCTION

Dieting has a fundamental role in the development of dental caries and erosion in all age groups. However, this association of diet and dental caries has greater relevance for children because healthy food-related habits are not inborn but rather acquired from parents and therefore, parents share the greatest responsibility for that matter.

Dental caries is the most usual pathology in the oral cavity, and can occur at any stage of a person's life. Nevertheless, the dissolution of dental tissues can also occur by erosion, which is characterized by mineral loss due to the exposure of acid in a systematic way and without bacterial involvement.[1] Dental erosion is presently considered a worldwide problem and is influenced by personal habits and different lifestyles.[2]

Erosion can be classified as intrinsic or extrinsic. Intrinsic erosion is caused by the acid action of the gastric content (gastric reflux) mainly in patients that regurgitate frequently, sometimes from emotional disorders (bulimia). Extrinsic erosion is caused by external agents in the mouth/organism, such as the abusive use of acidic beverages, certain drugs, acidic food, tooth exposure to an acidic atmosphere, all of which provoke a decrease in the oral pH.[2,3,4,5]

It is worth mentioning that erosion and dental caries cannot be completely isolated; although these conditions have a distinct etiology, they can occur concomitantly, potentiating each other. Because of this, it is important to have a knowledge of the erosive and/or cariogenic potential of acidic beverages and food usually ingested by children.

Although indices referring to the prevalence of dental erosion in children are not available in Brazil, it is known that there are several causes for the increase in the number of cases of dental erosion. The changes in feeding habits that have occurred during the last few decades is one of the causes of dental erosion. Other causes of this erosion include the introduction of fermented foods in the diet which typically occurs during the sixth month but may occur even before that and the effective marketing of these fermented foods, oftentimes associating the foods with fairy tale characters, adding to their consumption appeal. Additionally, the ingestion of processed or fresh juices, sodas and dairy beverages, which is on the increase mainly in tropical coun-

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tries,[6,7,8] erosion progression enhancement due to a great vulnerability of primary teeth,[4,9,10] which present a less thick enamel (1 mm) and a smaller rate of mineral concentration when compared to permanent teeth[4] are contributors of dental erosion. Finally, as stated by Hunter *et al* (2000),[10] the more intense enamel erosion in the enamel and dentin of permanent teeth are hazardous to dental tissues. Thus, the aim at this paper was to assess the pH in processed dairy beverages as well as possible alterations from temperature variations in these beverages.

MATERIAL AND METHODS

The methodology included 50 questionnaires distributed to and answered by the adults responsible for the care of children aged from 2 to 12 year-old. These subjects were randomly selected from among the patients being cared for at Pediatric Clinic and Integrated Child Clinic at the Federal University of Santa Maria (UFSM – RS, Brazil) and an Informed Consent Agreement was signed.

In the questionnaire, the type and flavor of the most frequently ingested processed dairy beverage were asked as well as the preferred ingestion temperature. The beverages were divided into 4 major groups: yogurts (GI), fermented milk (GII), chocolate-based (GIII) and fermented dairy beverages (GIV). From the information obtained, the most frequently ingested beverages were selected, taking also into account flavor and temperature. pH analyses which included the temperature variations room temperature (rt) and iced temperature (it) were performed from the sample. To check pH, a pH meter with glass electrodes and digital face was used. Before each reading, the apparatus was calibrated with standardized solutions of pH = 7 and pH = 4 values. Three pH measurements of each dairy product were performed in a 5-minute period until pH stabilization. After each use, the electrode was washed in distilled water and dried in absorbent paper. The data obtained were submitted to Variance and Tukey statistical tests with a 5% significance level.

RESULTS

Groups GI (yogurts), GII (fermented milk) and GIII (chocolate-based) demonstrated a significant interaction between beverage type X temperature, showing that the relative behavior of the types was not the same for all temperatures, i.e. each beverage type presented a different pH behavior with temperature variation. For the GIV group (fermented dairy beverages), the interaction was not significant, showing an opposite behavior as compared to the other groups. Upon evaluating the effect of temperature on each beverage type for GI, GII and GIII, the pH averages were clearly influenced by temperature variation, that is, these beverages at iced temperature (IT) presented lower pH val-

Table 1. pH averages in each temperature

GROUP	AT ROOM TEMPERATURE	ICED TEMPERATURE	AVERAGE OF pH
GI	4,18a	4,08b	4,13
GII	4,22a	4,04b	4,13
GIII	6,52a	6,32b	6,42
GIV	4,29a	4,23a	4,26
Average	4,93	4,80	

p< 0.05

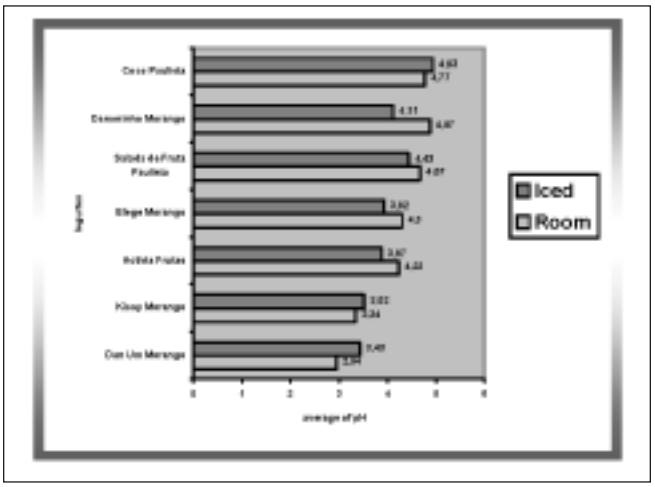

Figure 1. pH average in yogurts'group in each temperature

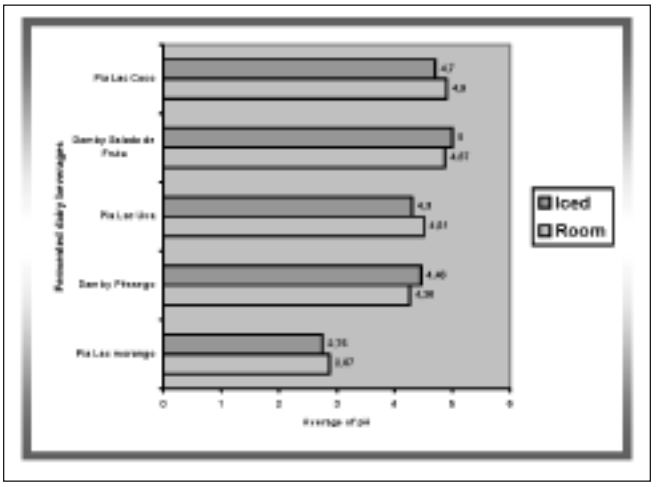

Figure 2. pH average in fermented milk's group in each temperature

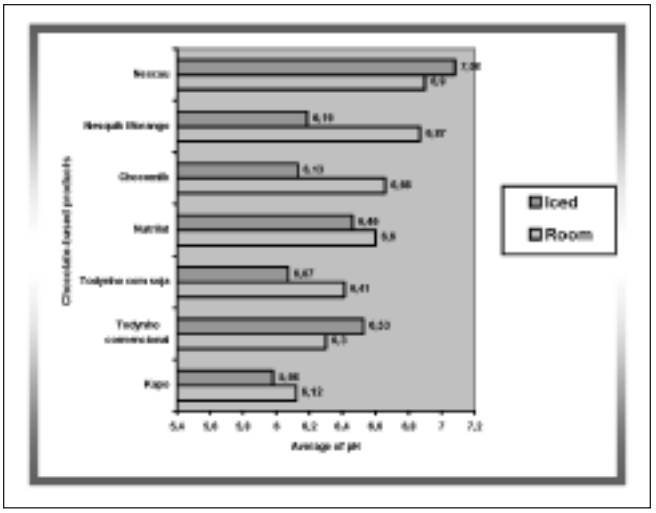

Figure 3. pH average in chocolate-based products in each temperature

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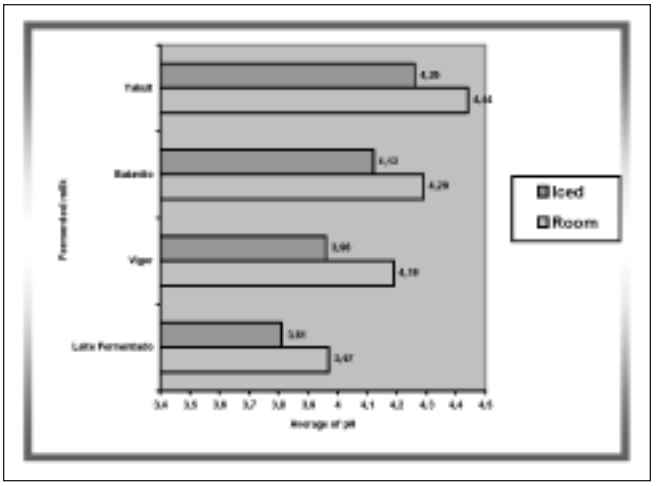

Figure 4. pH average in fermented dairy beverages's group in each temperature

ues which were considered statistically significant when compared to the values found in the same beverages at room temperature (rt) (Table 1, Figures 1 to 4).

DISCUSSION

Dental enamel is the most mineralized structure in the human body, and is susceptible to the acids it is exposed to, whether these originate in the human body or from ingested food.[11] Processed beverages play a fundamental role in this process, inasmuch as they are frequently ingested due to their flavor characteristics, practicality and marketing. Apart from this, primary teeth are more vulnerable to erosion than permanent teeth. The salivary flow of children's enhances this susceptibility, as children present a low salivary flow and their saliva presents a low buffering capacity[4]; However, Lussi *et al* (2000),[6] found no statistically significant difference between primary and permanent teeth as to erosive susceptibility.

A pH lower than 5 is thought to be critical to dental enamel and pH lower than 6,5 is critical for dentin, with both pH levels causing demineralization in their respective tissues. This decrease in the oral environmental pH can occur as a result of the consumption of citrus fruit and beverages having an acidic pH, such as juices and sodas, or it can occur indirectly through the production of acid by caries-provoking bacteria in the presence of fermentable carbohydrates.[6,11,12] It should also be taken into account that both enamel and dentin are exposed to dissolution[10]; therefore, earlier diet orientation and intervention are necessary for children and teenagers. It is also worth mentioning that dental erosion can be the cause of functional and aesthetic alterations and dental sensitivity.[2,8] Additionally, enamel and/or dentin restorative treatment is expensive and requires continuous follow-up,[6] in more severe cases, dental erosion causes crown destruction and premature tooth loss.

Among the beverages consumed by children and teenagers, fermented dairy beverages are more often fruit-flavored,[13] which favors an ever higher consumption but this also makes these beverages more erosive and cariogenic.[14]

The erosive and/or cariogenic potential of food depends on pH value,[3,4,6,8,10,12,15,16] measurable acidity,[15] frequency and time of ingestion,[12,17] time in the oral cavity temperature[8,12,18]; mode of ingestion[8,19] and buffering capacity and flow of saliva.[20,21]

Several studies have been done[4,6,8,10,12,17,22] to evaluate the role of acids found in processed or fresh juices, sodas and processed dairy beverages as dental erosion-causing agents. This is why another element – temperature variation (room and icy) was also included in the current evaluation. When parents and/or accompanying adults were questioned on the ingestion temperature of liquid beverages consumed by the children, the responses were dominated by the icy temperature (63%), whereas only 37% reported ingestion at room temperature. This fact contributed to the study outline. Since the current test population lives in a tropical country with high temperature averages and the ingestion of usually acidic liquids is recommended; the current authors were interested in evaluating whether temperature variation would cause an alteration in the pH value of beverages potentially causing either a higher or lower corrosive potential.

When average pH values were compared for each temperature, the iced temperature (it) influenced pH values negatively, and that this temperature provoked a pH drop at room temperature (rt) for Group GI (pH rt = 4, 18; pH it = 4,08) GII (pH rt = 4,22; pH it = 4,04) and GIII (pH rt = 6,52; pH it = 6,32) and these were considered statistically significant (Table 1). These data are in disagreement with a study published by Amaechi *et al* (1999),[18] who stated that erosion was less intense at low temperatures and that progression was faster in the primary dentition; West *et al* (2000)[12] did an in-vitro evaluation of the influence of temperature on the erosive potential of acids using non-erupted third molars (enamel and dentin samples) and concluded that the increase in temperature intensified enamel and dentin erosion, reaching the same conclusion as Barbour *et al* (2006)[16] who, upon evaluating the erosive potential of sodas at different temperatures, concluded that hardness decreased as temperature increased, indicating a faster dissolution.

When the average pH value for the yogurt group was evaluated, the current data was similar to in the results found by Espezim (2003)[5] and Cavalcanti *et al* (2006).[17] These two studies found pH values of 4,68 for the former study and a pH variation between 3,58 and 4,26 for the latter study. The data are a testimony of the erosive potential of the processed dairy beverage group. Additionally, the erosive potential of these beverages is increased from the addition of saccharose, which makes the product more palatable for children. Saccharose is the prevailing sugar in people's diet and is found in cakes, candies, cookies, chocolate and some milk by-products. The ingestion of yogurt is recommended as it offers better food quality for children since it is a source of several nutrients such as calcium and iron. However, informing parents on the negative consequences of frequent consumption of this kind of beverage that potentiates dental erosion is of utmost importance.

Chocolate-based products can be granulated or powdered,

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and are to be mixed with water or milk.[17] In a study by Cavalcanti *et al* (2006),[17] upon evaluating the total soluble solid quantity through refratometry in the Brix scale, as well as the pH of dairy beverages (yogurt and chocolate- based products), the highest and lowest average values of 3,58 and 7,01 were found. This data is in agreement with the current study, inasmuch as the chocolate-based product group was the only one that did not show a lower-than-critical pH for enamel. Therefore, the chocolate-based products can be recommended for consumption as offering no damage to dental health, such as erosion, though these foods contain saccharose and are therefore capable of presenting of dental caries lesions when associated with other etiological factors.

Despite the fact that processed dairy beverages are usually associated with dental erosion, some authors state that milk by-products contain minerals in their composition that are thought to be dental demineralization inhibitors, such as calcium and phosphate, which reduce the erosive effect of these products. Phosphate reduces hydroxyapatite dissolution rate and plays a part in remineralization; calcium takes part in the remineralization process and caseine decreases bacteria adherence to the dental surface.[5]

It is also known that food cariogenicity is related to its retention and adhesive properties as well as duration of time in the oral cavity. Because of this, the addition of these products to the baby bottle favors a longer contact with the dental structure, potentiating the erosive action of these substances. Gradual cup replacement for the baby bottle must be stimulated, minimizing damage not only to the dental structure but also to the stomatognathic system.

In order to minimize harmful consequences to the primary dentition, early diagnosis of erosion is fundamental so that etiological factors are identified and preventive measures can be taken to avoid the progression of dental caries. Shaw and O'Sullivan[23] recommend that the consumption of acid beverages be limited to the main meals due to the increase in the salivary flow and its buffering capacity. Shaw and O'Sullivan[23] also recommend a reduction in the frequency of ingestion no immediate post-ingestion toothbrushing but rather before or some time later; no food ingestion before or during sleep and short permanence of the food in the oral cavity. Cavalcanti *et al* (2006)[17] recommended a reduction in the frequency of consumption of these products or the use of other kinds of beverages, such as water or milk.

It is recognized that an *in vitro* methodology is incapable of replicating the biological variations of the oral environment and that actual *in vivo* erosion largely depends on consumption practices. Lendenmann *et al* (2000)[24] indicates that tooth surfaces are covered with acquired pellicle, comprising many of the proteins present in saliva. The results of the current study are of limited value if they cannot be correlated with those arising from an in situ or in vivo study. It is recommended that this study be replicated in the oral environment.

Even without a duplication of the current study, paediatric dentists must be aware of the potential demineralization from processed dairy beverages, which can bring consequences deriving from different ingestion temperatures, mainly in relation to an iced temperature.

CONCLUSION

All processed dairy beverage groups, except for chocolate-based group, showed lower than critical pH (5.5) mean values for enamel, in growing order GI and GII (4.13) GIV (4.26) and GIII (6. 42).

The results showed that for GI, GII and GIII beverages, the interaction type x temperature was significant, indicating that the beverage behavior was not the same for all temperatures.

The iced temperature presented a negative influence over pH, reducing values in a statistically significant way.

Generally, processed dairy beverages, with the exception of chocolate-based beverages, are potentially erosive and the iced temperature (it) influenced pH negatively for these beverages, creating a potential source of dental demineralization.

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