Journal of Oral Research

ORIGINAL ARTICLE

Enamel erosion caused by the effervescent acid powder in Tiritón ice cream: An *in vitro* study.

Katherine Beltrán.

Facultad de Odontología, Universidad Andrés Bello Sede Concepción. Chile.

Corresponding author: Katherine Beltrán. Covadonga 330, Villa Las Violetas, Coronel. Chile. Phone: (+56-9) 73537192. E-mail: k.beltran.contreras@gmail.com

Receipt: 08/19/2014 **Revised:** 09/04/2014
Acceptance: 11/03/2014 **Online:** 11/03/2014

Abstract: The aim of this article was to see the erosive effect of the effervescent powder acid in Tiritón ice cream (Nestlé Savory, Vevey, Switzerland) on the human tooth enamel. The erosive potential of Tiritón ice cream was determined under in vitro conditions by subjecting five tooth enamel slices from three healthy permanent first molars from healthy patients attending the dental clinic at the Universidad Nacional Andres Bello in Concepción. The samples were exposed to a mixture of saliva from a girl without incidence of dental caries and the effervescent powder in the stick holding the Tiritón ice cream for 10, 20, 30, 40 and 50 seconds. Afterwards, the effect was assessed through a scanning electron microscope (SEM) and pH measurement. All specimens showed a pH of 3.0. The SEM showed increasing levels of erosion for longer periods of exposure time. Tiritón ice cream produces a much more acidic environment than the one required for starting enamel dissolution. This will later cause a higher vulnerability to caries and dental erosion than the reported in other candy. The images obtained through SEM clearly show the erosive effect caused by the effervescent acid powder for periods of exposure time shorter than a minute.

Keywords: *Tooth erosion, acidic candy, salivary pH.*

Cita: Beltrán K. Enamel erosion caused by the effervescent acid powder in Tiritón ice cream: An in vitro study. J Oral Res 2014; 3(4):225-230.

INTRODUCTION.

Currently, the candy industry directs advertising of their products to age groups and children and adolescents are their most important groups of approach. In general, their products are associated with the so-called "compulsive buying", for which the client has a few seconds to decide whether to purchase a product or not. In this case, they have a low price and presentations or gifts are added to make them more attractive for younger people[1].

The etiology of dental erosion is multifactorial; however, the main risk factor is the consumption of acidic foods. Among these, we find candy, carbonated beverages, and citrus fruits[2]. On the other hand, the socio-economic level, oral hygiene and caries are other factors for which the direct association with the loss of substance of the tooth surface has not yet been proved since several studies show conflicting results[3].

In 1984, Smith and Knight *et al*, found that 89% of patients had an erosive etiology alone or combined with another type of injury. Although the exact prevalence of these lesions is not yet clear, a large number of young people have increased their exposure to acidic drinks and foods which makes them vulnerable to the emergence of this type of injuries[4].

Due to the technological and economic development in the last century, different kinds of candies have been created. They have several characteristics among which the increased length of time of the candy in the oral cavity and the adding of acids highlight[5]. This has brought many dental problems including erosion, which occurs with greater frequency and aggressiveness in children due to increased length of time the candy is kept in the mouth and the reduced thickness of their enamel[6].

Children are a very important target for this industry not only for their purchasing power, but also because they become the reason for the family to start buying the product. As a marketing strategy, attractive products are been designed for children which also present a "nutritious" image so that

parents feel that they are giving them more than just candy[7].

There are two main ways for consuming sweets. First, those which are consumed in the same places where they are purchased such as supermarkets, stores, stands, eating establishments and schools (stands, tricycles). A second way is as snacks in places such as kindergartens, schools, work places, at home, stands, parties and strolls. In this case, purchasing is anticipated at the time of consumption and sometimes it is also from storage at home[8].

According to a recent study in La Pintana, Santiago de Chile, adding sweets to children's diet occurs already when they turn six months and in particular during the second year. This study was conducted among school children from 5th to 8th grade and it showed that nearly half of the snacks that children brought to school were candy and, among those who bought some food, the majority purchased candy and soft drinks[8].

In Chile, sweets and fizzy drinks consumption in infant population is high. Therefore, the erosive effects of this type of food on the tooth enamel can become a public health problem. To this we must add the presence of sweets in the domestic market, which used their strong acidity as a promotional element without clarity regarding the effects produced on tooth enamel[9].

The objective of this article was to observe the erosive effect of the effervescent powder acid in Tiritón ice cream (Nestlé Savory, Vevey, Switzerland) on permanent teeth enamel over different exposure times.

MATERIALS AND METHODS.

This is an *in-vitro* study for which five specimens (slices) corresponding to human permanent tooth enamel were considered. They were obtained through the removal of first permanent molars in ASA I adult patients attending the dental clinic of the Universidad Nacional Andres Bello in Concepción, with indication of the extraction due to periodontal disease, after signing an informed consent.

Only the sound parts were included, *i.e.* those without decay, demineralization, fractures, developmental defects, stains or use of bleach.

After extraction, they were cleaned with a pumice stone, distilled water, and a brush to later be stored in clean containers with serum in refrigeration at 4°C to avoid bacterial growth.

In order to prepare the samples, several cuts were made with carborumdum discs and abundant irrigation. The first one was held in a transverse direction to the molars, parallel to the occlusal, to get only the crowns of these molars. Then, it was proceeded to perform a sagittal slice, perpendicular to the occlusal of each crown to achieve cuts with free faces (vestibular, palatine and lingual) in order to obtain a wide area free of the cuts made by the disk.

Each of the specimens of enamel was covered half-way with pink wax in sheet (Plastiwax, Badia Polesine (RO)-Italy) preheated in the burner and placed over the samples with a spatula of wax. The semi-covered specimens were washed with serum and transferred to five Eppendorf tubes labeled by times of 10, 20, 30, 40 and 50 seconds.

The effervescent acid powder to use was obtained after purchasing three Tiritón ice cream (Nestlé Savory, Vevey, Switzerland) from within the popsicle stick in the sealed plastic which holds the ice cream. They were acquired in three different commercial premises in the city of Concepción and Talcahuano.

The ingredients of the effervescent powder identified by the manufacturer are sugar, maltodextrin, fumaric acid, citric acid and tricalcium phosphate, sodium bicarbonate, aspartame (25mg/100mg) acesulfame potassium (100mg/100g) and identical to natural flavoring.

It was obtained a sample of saliva from a voluntary 9 year-old girl without incidence of caries, prior informed consent from her parents. The pH was measured using MColorpHast™ strips (Merck KGaA, Darmstadt, Germany), getting a neutral value (pH=7).

Later, 5ml of saliva were mixed with 1.49 grams of the effervescent powder acid in each Eppendorf tube to completely dissolute the powder. Then, it was proceeded to measure the pH of the mixture with MColorpHast™ strips (Merck KGaA, Darmstadt, Germany).

After the assigned time expired (10, 20, 30, 40 or 50 seconds), each specimen was removed, washed with distilled water and dried. To avoid dehydration, they were put in a new

Eppendorf tube with serum previously labeled with the exposure time to what it had been subjected.

Each slice was then washed with hot water (distilled water at 80°C) to remove all the wax that was previously put on the control side. They were dried out and eventually were placed in distilled water in Eppendorf tubes labeled according to the exposure time.

Each specimen was treated with the following preparation protocol:

1. Mounting: The sample was fixed, hardened and preserved with glutaric aldehyde and osmium tetroxide (OsO_4) and glutaraldehyde. The pH was carefully handled with sodium cacodylate ($C_2H_6AsO_2Na$) to keep the membranes and cellular proteins in a resistant three-dimensional-mesh.

2. Dehydration: it was carried out by the critical point technique using CO_2.

3. Cut: no cuts were made in the sample, but its surface was analyzed.

4. Contrast: the dried sample was coated with a layer of gold and was subsequently analyzed using scanning electron microscopy (Autoscan U-l (SEM), ETEC Systems, USA) with increases of 1500X and 2000X .

RESULTS.

After being submerged in the mixture of powder and saliva, all the specimens showed a pH of 3.0.

In figures 1 through 5, the progressive erosive effect from 10 to 50 seconds respectively can be seen using scanning electron microscope (SEM). In all the images, the connection between the segment subjected to the acid and the one covered by wax can be noticed.

DISCUSSION.

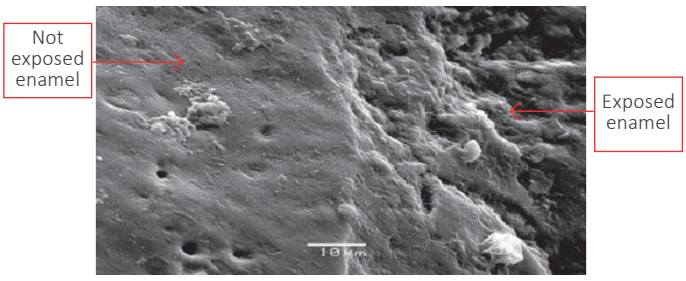

Figure 1. Erosive effect at 10 seconds, scanning electron microscope, 1500X.

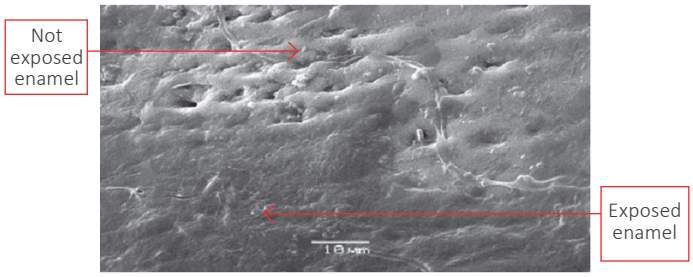

Figure 2. Erosive effect at 20 seconds, scanning electron microscope, 1500X.

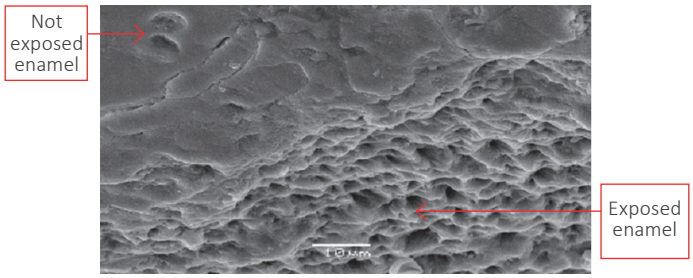

Figure 3. Erosive effect at 30 seconds, scanning electron microscope, 1500X.

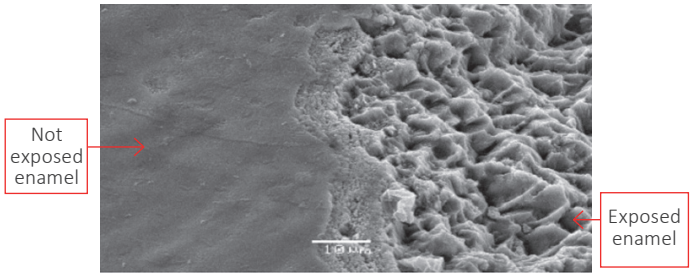

Figure 4. Erosive effect at 40 seconds, scanning electron microscope, 1500X.

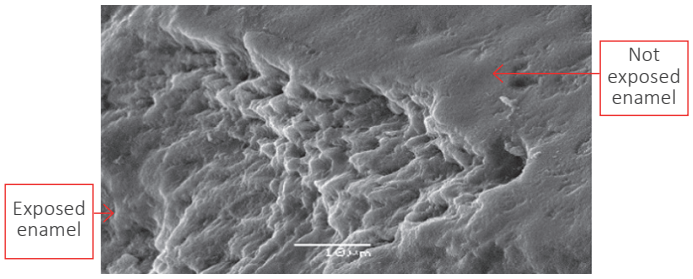

Figure 5. Erosive effect at 50 seconds, scanning electron microscope, 2000X.

The analyzed ice cream produced a much more acidic environment than the required for starting enamel dissolution. This means a subsequent higher vulnerability to caries and dental erosion than the one reported for other sweets[10]. The images obtained through SEM clearly allow appreciating the erosive effect that is produced by the effervescent acid powder over exposure times shorter than one minute. Brought back to reality, this is worrisome because the damage in the enamel can already be seen in very few seconds.

Dental erosion is a pathologic, localized and chronic loss which affects the hard tissues of teeth. It happens through a chemical dissolution of the surface caused by acids and/or chelating agents without the intervention of bacteria. Hence, the exposed demineralised enamel or dentin becomes more susceptible to the effects of abrasion or Wear and to caries[2].

Although the etiology of dental erosion is multifactorial, there is evidence that acidic dietary sources are the main risk factor for its development[11]. In more developed countries, dental erosion prevalence is high in children and adolescents and it seems to be increasing[2]. This situation will not be different in Chile considering consumption of sweets and drinks among the population, including children, and especially if these foods have a high erosive potential as Tiritón ice cream[9].

Temporary or primary teeth are more susceptible to erosion because the layers of enamel and dentin are thinner in comparison with permanent teeth. This means the damage in children can be greater than the one reported in the present study for which permanent teeth were analized[12].

Citric acid is a common ingredient in the production of sour candy and it is the most erosive component found in foods and beverages due to its ability to chelate calcium even in the presence of a higher pH. Candy manufacturers often combine different acids to achieve the desired acidity. Then, candies are filled with either an acid mixture or covered with acid powder. Acids which are commonly used today include ascorbic, acetic, adipic, citric, fumaric, lactic, malic and tartaric acid. Other ingredients included in the labeling are "natural or artificial flavors, organic fruit extracts, pure juice concentrate, pulp juice and extracts as paste"[12].

A study conducted among preschool children from Athens indicated that 69% of children have erosion in their maxillary anterior teeth which were the most affected, followed by the mandibular molars (buccal surfaces). The level of oral hygiene, which seemed to be an important risk factor in this study, in reality is just one more factor associated for which there are no studies to directly relate it. However, some researchers argue that dental plaque can act as a mechanical (protective) barrier for the erosive agents[3].

In 2010, in a study conducted by Brand about a candy called "jawbreaker", it was found that the pH of this candy ranged from 4 to 5.3 depending on its flavor. So, in spite of the fact that its consumption increased salivary flow, the pH was not restored to its normality becoming a potential erosive threat for dental pieces. Therefore, the pH of 3.0 obtained in this study is capable of causing major damage than this candy due to its higher acidity[13].

In 2011, Beyer conducted a study about different acids which caused erosion on the human tooth enamel. It was discovered that the lactic acid, ascorbic acid and phosphoric acid (group I) presented a greater erosive potential ($p<0.05$) and, to a lesser extent, malic acid, citric acid and tartaric acid (group II). The SEM also showed a difference between these two groups, group I being the one with the most marked erosion. Considering this, it was concluded that, in spite of the fact that the acids of the group II did not have marked erosion as the group I, they could join in an easier manner to the Ca^{2+} ions of the hexagonal crystal structure of the enamel, which can lead a more rapid dissolution. According to this, the idea of this study is reaffirmed since the citric acid is presented as one of the components of the effervescent powder[14].

In Chile, ice cream consumption is increasing, in conjunction with its consumption among children due to attractive products and gifts offered by the manufacturer.

It should be noted that this damage, taking into account the years of consumption from childhood, can be very detrimental to permanent teeth which are still growing. It may cause great damage which often results in teeth loss due to susceptibility to dental caries[1].

Among the limitations of this study, it should be considered that the sample is very small, and the approach is merely descriptive. Hence, it makes way for a subsequent larger scale study with a higher number of samples to quantify the suffered loss.

Even though the indices of consumption of foods with erosive potential among the Chilean population are high, there are no reports assessing the impact of other sweets, drinks, or ice cream on tooth enamel. It is, therefore, necessary to carry out assessments to identify those foods which present a potential erosive danger as like the one reported in this study. Finally, it is important to remember that early diagnosis and prevention of the effects of dental erosion are essential for maintaining healthy teeth over the years. Hence, one needs to be aware of this topic[12].

ACKNOWLEDGMENTS.

Thanks to Dr. Christian Valenzuela for his willingness and guidance in conducting this research.

Erosión del esmalte dental producto del polvo ácido efervescente contenido en helado Tiritón: *Estudio in vitro.*

Resumen: El objetivo de este trabajo fue visualizar el efecto erosivo sobre el esmalte dental humano del polvo ácido efervescente contenido en el helado Tiritón (Nestle Savory, Vevey, Suiza). El potencial erosivo del helado Tiritón, se determinó en condiciones in vitro sometiendo 5 cortes de esmalte, de 3 primeros molares permanentes sanos, provenientes de pacientes sanos de la clínica odontológica de la Universidad Nacional Andrés Bello, sede Concepción. Las muestras fueron sometidas a la mezcla de saliva de unaniña sin incidencia de caries y el polvo efervescente contenido en el helado Tiritón, en 10, 20, 30 40 y 50 segundos, posteriormente se visualizó el efecto a través de microscopia electrónica de barrido (MEB) y medición del pH. Todos los especímenes presentaron un pH de 3,0. A través de MEB se observaron grados crecientes de erosión en función del tiempo. El helado Tiritón genera un medio ácido mucho mayor al necesario para el inicio de la disolución del esmalte lo que posteriormente provocará vulnerabilidad a la caries y a la erosión dental, superior al reportado en otras golosinas. Las imágenes obtenidas a través de MEB permitieron visualizar con claridad el efecto erosivo que se produce, por el polvo ácido efervescente en tiempos de exposición menores al minuto.

Palabras clave: *Erosión de los dientes, dulces ácidos, pH salival*

REFERENCES.

1. Jackson M, Castillo M, Castillo-Durán C. Las golosinas en la alimentación infantil: Análisis antropológico nutricional. Rev Med Chile 2004;132(10):1235-42.
2. Brand H, Gambon D, Van Dop L, Van Liere L, Veerman E. The erosive potential of jawbreakers, a type of hard candy. Int J Dent Hyg. 2010; 8(4):308-12.
3. Mantonanaki M, Koletsi H, Mamai E, Papaioannou W. Dental erosion prevalence and associated risk indicators among preschool children in Athens, Greece. Clin Oral Investig. 2013;17(2):585-93.
4. Smith B, Knight J. A comparison of patterns of tooth wear with aetiological factors. Br Dent J.1984;157(1):16-9.
5. Gambon D, Brand H, Veerman E. Dental erosion in the 21st century: what is happening to nutritional habits and lifestyle in our society? Br Dent J. 2012; 213(2):55-7.
6. Taji S, Seow WK. A literature review of dental erosion in children. Aust Dent J. 2010;55(4):358-67.
7. Oto J. Revista Publimark. 141ª ed. Chile: Holanda Comunicaciones S.A.;2001.
8. Castillo C, Romo M.Las golosinas en la alimentación infantil. Rev Chil Pedia-

tr. 2006;77(2):189-193.

9. Vio F, Salinas J, Lera L, González C, Huenchupán C. Conocimientos y consumo alimentario en escolares, sus padres y profesores: un análisis comparativo. Rev Chil Nutr. 2012; 39(3):34-9.

10. da Silva JG, Farias MMAG, da Silveira EG, de Araújo SM, Schmitt BHE. Evaluation of the Erosive Potential of Acidic Candies Consumed by Children and Teenagers. J Pharm Nutr Sci.2013; 3(4):262-5.

11. Feltham E. The power of sour candies: a dental hygienist's battle against dietary dental erosion. J Calif Dent Hyg Assoc.2010; 25(1):16-8.

12. Hamasha A, Zawaideh F, Al-Hadithy R. Risk indicators associated with dental erosion among Jordanian school children aged 12-14 years of age. Int J Paediatr Dent. 2014;24(1):56-68.

13. Brand H, Gambon D, Van Dop L, Van Liere L, Veerman E. The erosive potential of jawbreakers, a type of hard candy.Int J Dent Hyg.2010;8(4):308-12.

14. Beyer M, Reichert J, Bossert J, Sigusch B, Watts D, Jandt K. Acids with an equivalent taste lead to different erosion of human dental enamel. Dent Mater. 2011;27(10):1017-23.