The Erosive Potential of Additive Artificial Flavoring In Bottled Water

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Abstract

Introduction: Acidic beverage consumption contributes to extrinsic dental erosion. This includes some commercially available water bottles (WB). To modify the taste of water, different artificial flavoring liquids or powders called water enhancers (WE) can be added to WB. The purpose of this study was to measure pH, titratable acidity and perform gravimetric analysis of WE mixed with WB of different initial pH to determine their erosive potential. Materials and Methods: Using a calibrated pH meter (buffer solutions pH 4.00, 7.00 and 10.00 at 23°C), pH and titratable acidity was performed for three lot numbers of 7 WE added to 20mL solutions of 3 brands of WB: Penta, Nestle PureLife and Alkalife10 (pH 5.3, 7.3 and 10.0 respectively), resulting in 21 combinations. pH values were repeated 3 times for each solution and then titrated with 0.1M NaOH to pH 7.0. The measuring probe was rinsed with deionized water and dried between recordings. Human molar roots were submerged in 20mL solutions of each combination for gravimetric analysis. Measurements were recorded for baseline, 24, 48, 96 hours, 1 week, 2 weeks and 1 month. Distilled water (DW) was used as positive control and citric acid (CA) as negative control. Results: Data was analyzed using two-way ANOVA and post-hoc Tukey/Kramer test (p=0.05). pH values (2.9-3) and titratable acidity (20.9-50.5mmol OH/L) of tested beverages were all considered acidic regardless of the initial pH of WB when compared to controls: DW (pH 5.4 and titratable acidity: 0.04mmol/ L) and CA (pH1.8 and titratable acidity: 510mmol/L). Exposure of extracted molar roots to tested beverages resulted in surface changes consistent with erosive dissolution. Tooth structure loss ranged between 3-6% compared to DW: 2% and CA: 50%. Conclusion: Addition of artificial flavoring powders and liquids to water significantly increases its erosive potential with CA listed as their main ingredient. Caution should be taken in their use to prevent dental erosion.

Materials & Methods

pH and titratable acidity: analysis was performed using a calibrated pH meter (buffer solutions pH 4.00, 7.00 and 10.00 at 23°C) for 7 commercially available brands of water enhancers (fig. 1 & Table 1) added to 3 different brands of water bottle (fig. 2) resulting in 21 combinations of brands. Distilled water was used as positive control and citric acid as negative control. The recommended ratio of 2mL of liquid enhancer for 240mL of water and 2.1g of powder for 500mL of water were calculated for 20mL of water in this study. (fig. 3) Three lot numbers of each water enhancer were obtained, accumulating nine pH recordings and three titratable acidity measurements for each of the 21 combinations of brands (fig. 4). Solutions were titrated with 0.1M NaOH to pH 7.0. The measuring probe was rinsed with deionized water and dried between recordings.

Erosive potential: gravimetric analysis was determined for 130 human molar roots divided into 26 groups of 5 each. Roots were sectioned at the cemento-enameled junction. A self-etching dentin bonding agent was applied at the coronal and apical portions of the specimens to avoid influx of the solution into the pulp chamber. Specimens were thoroughly dried for 1 minute with oil-free air from an air/water syringe and weighted on a calibrated analytical balance to obtain a baseline recording (fig. 5). The specimens were then submerged in 20 mL of solution (fig. 6) and weighted at 24, 48, 96 hours, 1 week, 2 weeks and 1 month after drying them as previously described (fig. 7), re-submerging them each time in newly mixed solutions.

Results

Data was analyzed using two-way ANOVA and post-hoc Tukey/Kramer test (p=0.05). Regardless of the initial pH of water (pH 10, 7.3 or 5.3), pH and titratable acidity values for all brands of water enhancers tested made the water significantly more acidic compared to controls with pH ranging between 2.9-3 and titratable acidity between 20.9-50.5mmol OH/L (fig. 8 & table 2). Exposure of extracted molar roots to tested beverages resulted in surface changes consistent with erosive dissolution. At 1 month, average tooth structure loss was 4% compared to 2% for distilled water and 50% for citric acid (fig. 9 and table 1).

Conclusions

Within the limitations of this study, the use of water enhancers significantly increases the erosive potential of water even when the initial pH is alkaline. This is to be expected since their main flavoring component, similarly to soft drinks, is citric acid. Although they are sugar free, water enhancers are not harmless to teeth and caution should be taken in their consumption to prevent dental erosion.

References