pH of Still and Carbonated Bottled Water on our Oral Health

Growing up, we are told to avoid certain beverages due to their high sugar content and the effects they can cause on our teeth. But is it the sugar content that we should be worried about for our teeth or the pH level of the drinks? In a study that took place in Birmingham, Alabama, researchers purchased 379 beverages, including soda, juice, and energy drinks, and assessed their pH. Using a pH meter, they measured all the beverages three times, immediately after opening at a temperature of 25°C. They concluded that 93% of the beverages tested had a pH of less than 4, while 7% had a pH of 4 or more. But what does that exactly mean for our teeth?

Our teeth are made up of three layers, with the first layer being the enamel, the second layer being the dentin, and the core being the pulp. Our enamel layer is primarily composed of minerals, with one of the main minerals being hydroxyapatite. Hydroxyapatite is essentially made up of calcium and phosphate ions, causing it to form the hard durable substance that is enamel. Enamel is crucial for our overall dental health as it protects our teeth from decay and external factors, providing both protection and strength for our teeth. But when not properly taken care of, our enamel can demineralize and can lead to greater issues.

What does it ultimately mean to demineralize our teeth? Demineralization is the process of stripping minerals from our enamel, with most of those minerals being calcium and phosphate, ultimately causing our enamel to weaken. When our enamel becomes weak, this allows bacteria and decay to easily access our dentin, which can lead to a cavity. When a cavity goes untreated and is able to access our dentin and slowly erode that dentin, it will then reach the pulp, and at that point, you are no longer able to fix the cavity, and a root canal is typically necessary to treat pulp damage. There are different factors that can demineralize our teeth, whether that is food or drinks, but it is most important to know that demineralization of our enamel occurs between pH 5.2 - 5.5, while demineralization of our dentin is expected to occur under pH 6.8. Avoiding these beverages and only drinking water seems like a simple solution, but how do different types of waters affect our teeth?

In a study done in Portugal focused on the erosion of our teeth and the potential influence still and sparkling water have, researchers examined multiple factors that could be the main cause of dental erosion on our teeth. Focusing on factors like pH levels, buffer capacity, degree of saturation, calcium concentration, phosphate content, and erosion inhibitors like fluoride ions. In the end, the evidence suggested that out of all these factors, pH level plays a leading role in causing erosion. In this study, researchers focused on beverages with a pH range close to 5, as this is where erosion is notably observed. While erosion can occur with liquids with a pH below the neutral value of 7, demonstrating that would possibly involve specific conditions including high area and volume ratio, exposure period ranging from 4-7 days, or the use of precise measurement techniques such as nanoindentation. Because of this, the researchers focused on a slightly acidic pH range for studying tooth erosion, while looking at the erosive effects of liquids with a pH below 7 and incorporating specific experimental conditions and measurement methods.

Since we are drinking liquids at these different pHs, it is important to take into account the pH of saliva. Saliva pH in a healthy individual ranges between 6.2 - 7.6. Saliva plays a crucial role as it provides a harmless environment for our teeth. Saliva is able to achieve this environment through three buffer systems: bicarbonate, phosphate, and protein. These buffers work to regulate and stabilize the pH of saliva, and the body’s ability to do this ensures that we keep our teeth in a safe environment. Overall, saliva is an important factor in keeping a balanced pH in our mouth, but many people often struggle with xerostomia or better known as dry mouth. People who often struggle with xerostomia find relief by drinking water as they are rehydrating the mouth, ultimately wanting to get rid of that dry feeling, leading to a fluid update. Rehydration plays an important role in increasing salivary flow as well as maintaining a neutral pH for the mouth. But what good does water do when it has the potential to be more acidic and potentially harmful to our dentition?

In the study done in Portugal, researchers took 105 common brands of bottled water, testing five from each brand. Of those 105, 73 of those brands were still water while 32 were carbonated water. In total, 525 bottled waters were tested. Of the 73 bottles of still water that were tested, 28 of those were mineral water and 45 were spring water. From the 32 carbonated bottles of water, 16 were gasified, meaning that carbon dioxide gas was dissolved into the water to create bubbles, and the other 16 were gasocarbonated water brands. When looking into the difference between gasified water and gasocarbonated water, it seems as though both terms could be used interchangeably, but the choice of terminology could be influenced by local preferences or the marketing language that specific brands decided to use. Of the 16 gasified water, 13 of those were of natural mineral origin, while the other three were of spring origin. A CRISON Basic 20pH meter with an ORP Sension + pH3 electrode with resolution 0.01pH, 1mV, 0.1°C and measurement error (+1 digit) < 0.01 pH, <1 mV, and <0.2°C was used to analyze the pH values of both the still and carbonated water. This electrode was calibrated to have a pH range of 4.00 – 9.00 using standard buffer solutions, at room temperature. 5 independent pH measurements were recorded for each water brand all 25\*C. Results were broken down into 4 different categories: pH < 5.2 (very acidic), pH between 5.2 (mildly acidic) and 5.5, pH between 5.5 (slightly acidic to neutral) and 6.8, and pH > 6.8 (alkaline).

The results for the 73 bottled still water brands pH value’s varied between 5.02 and 9.61 with a mean pH of 6.81. Breaking that down 50.68% of the bottle still water had a pH mean values between 5.5 and 8.8, 42.47% had mean pH values greater than 6.8, 5.48% had mean pH values between 5.2 and 5.5, and 1.37% had mean pH values below 5.2. In summary, the majority of the bottled still water fell within a slightly acidic to neutral pH range. As for the results for the 32 bottled carbonated water brands tested, the pH values ranged form 4.22 to 6.51, with a mean pH of 5.46. 37.50% of the bottled carbonated water brands had a mean pH value between 5.5 and 6.8, 31.25% had mean pH values between 5.2 and 5.5, and 31.25% had mean pH values below 5.2. None of the carbonated bottled water brands had a pH value greater than 6.8. Results showed that most of the bottled carbonated water brands fell within the slightly acidic to neutral pH range, but unlike the bottled still water none of the bottled carbonated water brands had a pH value greater than 6.8.

Through these results, we can interpret that bottled still water would have minimal erosive potential on our enamel, while the tested bottled carbonated water showed slightly higher erosive potential on our enamel. This study revealed that our enamel can be affected at a pH of 4, particularly in drinks with buffers. When we consume beverages with a low pH, it can lead to enamel demineralization, causing the pH in our mouth to rise. This, in turn, enhances the acid concentration in the drink, intensifying the demineralization in our enamel before the pH in our mouth can neutralize. Conclusively, we observed that when carbon dioxide was added to create carbonated water, the pH of the water became more acidic.

In conclusion, we found that pH plays an important role in our oral health. However, it's crucial to acknowledge the limitations of this study, given that it was conducted only in Portugal, thus limiting the range of data and making it specific to a certain region. Nevertheless, the study raises important considerations about how carbonated waters affect our oral health, especially with the increasing popularity of carbonated beverages, both alcoholic and nonalcoholic.

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