Exploring the Effect of Artificial Sweeteners on *Streptococcus mutans* Growth and pH level

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Abstract:

This study examines *S. mutans* growth in broths containing one of the following artificial sweeteners: sucrose, sucralose, sorbitol, or xylitol. Glucose and fructose broths were used as controls. Using spectrophotometry and pH measurements, correlations between sweetener and colony growth could be made. The results suggest that the high growth rates of glucose and fructose are similar to that of sucrose. Contrastingly, the lowest growth rates and pH drop were noted in Xylitol. Sucrose had visible biofilm formation whereas xylitol did not. These findings contribute to the understanding of the oral microbiome and its response to carbon sources. The potential correlation between high sucrose consumption and increased dental hygiene risk may invoke further studies to investigate the viability of consistent sweetener use with minimal oral detriment.

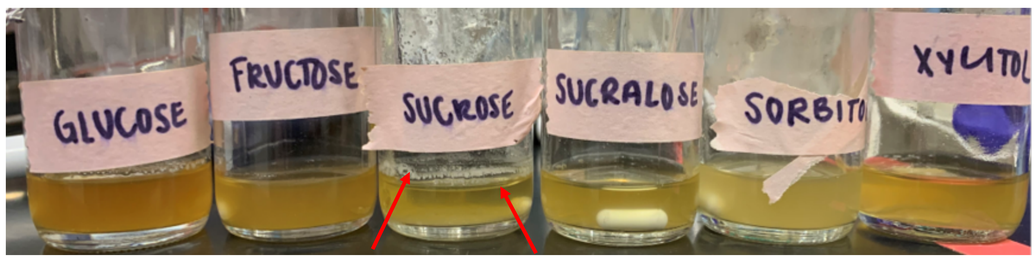
Introduction:

- *S. mutans* have been linked to cavities due to their nature of fermenting sugars and lowering oral pH levels. In the event that biofilms form, the detrimental risk increases (Forssten et al., 2010).
- Different diets include various forms of carbohydrates, many of which are largely unresearched.
- The objective of this study is to analyze the impact that artificial sweeteners have on *S. mutans* growth. With this information, conclusions can be drawn regarding the overall impact of the consumption of these sweeteners.

Materials and Methods:

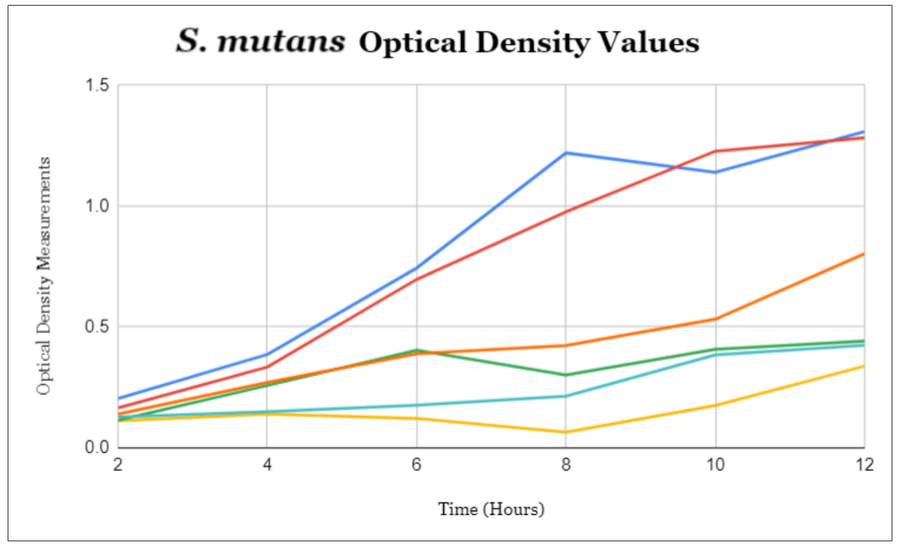
- Sweeteners of interest included sorbitol, sucralose, sucrose, and xylitol. Glucose and fructose were used as controls.
- *S. mutans* were grown in Levure Autolysate Peptone Tryptone Glucose* broth (LAPTg). This consists of one percent of each element dissolved in water with the addition of 0.1% Tween-80.
- *The glucose was swapped with an alternative sweetener for each experimental broth.
- Overnight growth colonies of *S. mutans* were transported into tubes containing each modified broth. 500 µl of each sample was measured for optical density in two-hour intervals for 12 hours. 4 ml of each sample was measured for pH at each interval.
- Optical density was measured using a spectrophotometer at a wavelength of 600 nm. The pH was measured using the Orion Star A214 meter.
- Optical density and pH measurements were tabulated and graphed (see Figures 1 and 2). Visual observations were photographically taken.

Figure 3: Color, Opacity, and Flocculence Levels in Broths



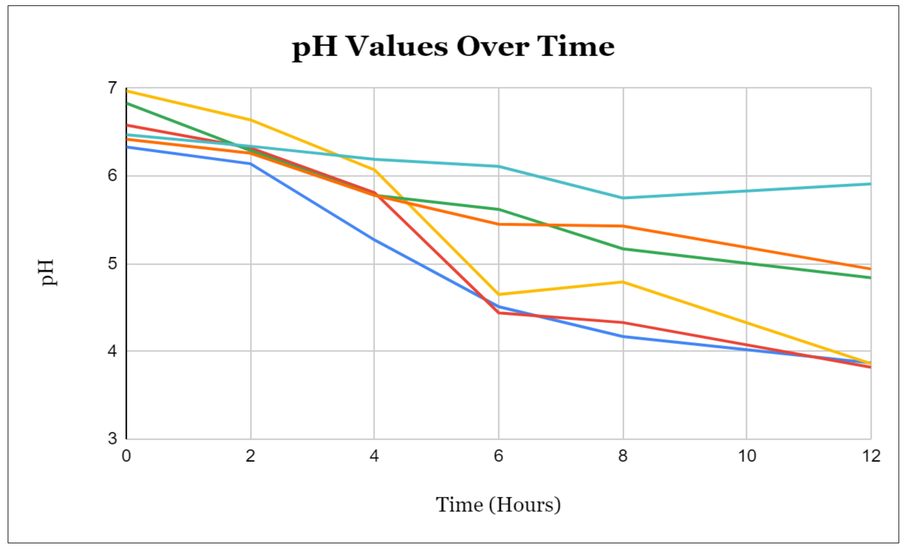
This image displays the biofilm formed on the walls of the flasks of sucrose and glucose. Additionally, the homogenous growth in glucose and fructose is displayed via the darker color.

Figure 1: Optical Density Growth Rates



This chart displays the measurements taken at each time interval for each sample. Notably, the flocculence of sucrose caused inaccurate optical density measurements.

Figure 2: pH Values Over Time



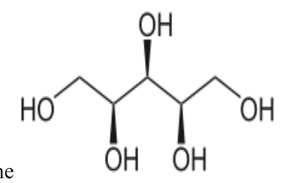
This chart displays the pH values measured at each time interval.

Discussion:

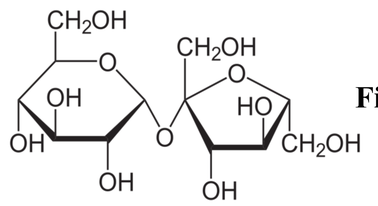
- Bacteria grew best in glucose and fructose.
- High levels of flocculence were observed in the sucrose broth (seen in Figure 3). This flocculence interfered with obtaining accurate optical density measurements. However, the pH data confirmed that the sucrose broth shares close levels of acidity with those of glucose and fructose. This suggests that the growth rates between the three sweeteners are similar.
- Xylitol displays the lowest levels of growth as well as the smallest drop in pH.

Conclusion:

The lack of growth observed in the xylitol broth may be linked to its molecular structure. It is the only 5-carbon non-ring sweetener within the experimental set and thus may be presenting *S. mutans* with challenges in conducting metabolic processes. Alternatively, the most common sugars that bacteria feed on are glucose and fructose (see Figure 4). Sucrose is a disaccharide composed of both a glucose and a fructose molecule, and the close resemblance of the three molecular structures may correlate to the similarity in the observed *S. mutans* growth capability. Potential avenues of future research include the addition of other artificial sweeteners, analyzing specific acid secretion, and conducting biofilm assays.



[Xylitol]



[Sucrose]

Figure 4: Molecular Structures of Xylitol and Sucrose

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