Kombucha Leather Durability: Sugar Concentration's Effect on Bacterial Cellulose

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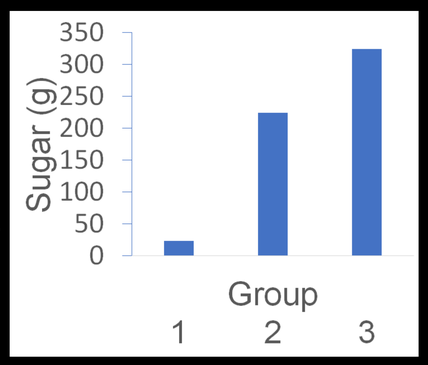
Introduction

Due to its rising popularity many people may now know of kombucha; A fermented tea beverage thought to have originated long ago in the region that is now known as China. Through the same process that this familiar beverage is made, there is also the less familiar production of a polymeric bacterial cellulose pellicle that floats on the surface of the culture. This and other forms of bacterial cellulose are the subject of research for several different applications. Bacterial cellulose has potential for use in medicine, textiles, and as a food additive. The tensile strength of kombucha's leather-like material grown in different sugar concentrations was measured and statistically analyzed. The groups grown in higher sugar concentrations were found to withstand significantly more force before tearing than those grown in low sugar concentrations. Photographs of the pellicles of each group were also taken and compared at 400x magnification.

Methods

Thirty bacterial cellulose pellicles were grown under the same conditions but with varied sugar concentrations. Three 3.78L batches of black tea were brewed in reverse osmosis filtered water. Once cooled to 25°C 32oz (0.946L) of GT's Gingerade Kombucha was added as an inoculant resulting in a total volume of 4.726L.

Figure 1. Depicts the three experimental groups by sugar content. 24g, 224g, and 324g respectively.



15oz (0.444L) volumes were separated into ten bottles labeled with each batch number.

Image 1. Each bottle was covered with tissue paper fastened with a plastic ring. Bottles were arranged sequentially so that no neighboring bottles were immediately adjacent to other bottles of the same group.

After three weeks of ambient daylight and temperatures kept 18°C-22°C bacterial cellulose pellicles were removed from the surface of each bottle and separated into their groups and allowed to dry on wax paper.

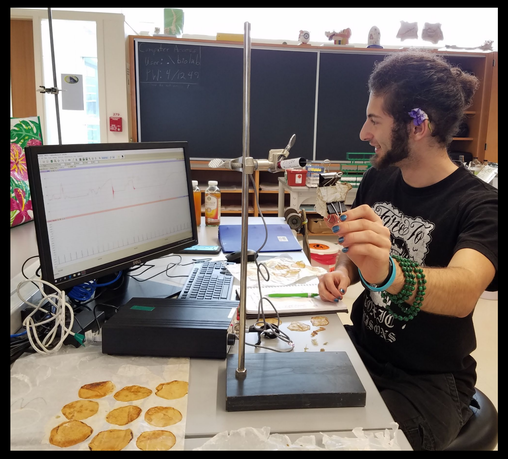
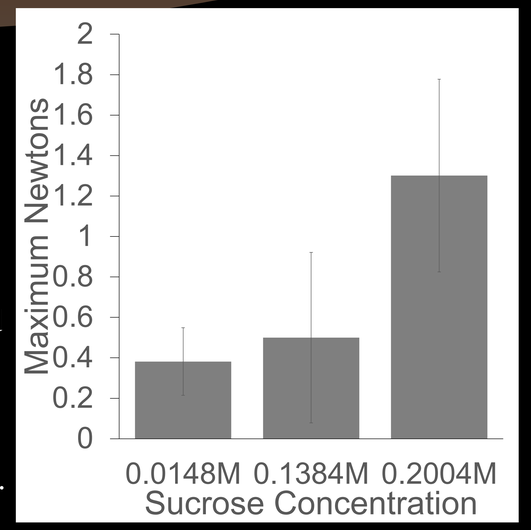


Image 2.Using a force transducer to measure the durability of the pellicles. Dried group 3 pellicles on wax paper shown in lower left.

Standard curve was generated with known weights to calibrate the force transducer. Force transducer used to measure durability of three groups of bacterial cellulose pellicles. Force was applied until the pellicle was torn apart and maximum value was recorded. In the few cases where the range of the force transducer was maxed out and the pellicle still did not tear, those values were not included in the statistical analysis.

Results

Figure 2. The maximum value of newtons applied before tearing disks with an area of 15.9 cm. Error bars represent one standard deviation. ANOVA produced a p value of $1.03*10^{-11}$ indicating statistical significance.



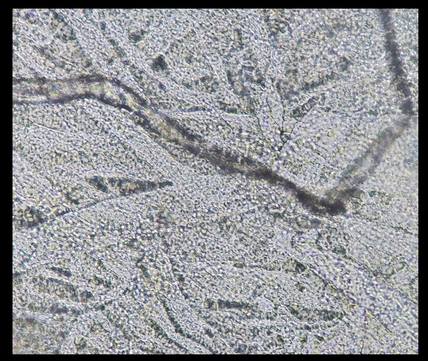


Image 3. 400 times magnification of bacterial cellulose pellicle. The round cellular structures are suspected the cell walls of dead yeast. The dark striations present are wrinkles produced by uneven contraction when drying.

Discussion

Statistically significant differences in durability were observed among the groups. The highest sugar group had the highest max newtons, and two of the pellicles from that group maxed out the force transducer without tearing and were not able to be measured. Further research questions would be to measure the strength at different time points to determine if eventually the measurements would have looked more similar to each other, or if they had reached their peak in the three weeks they were grown. Other chemicals other than sucrose important for bacterial growth could also be controlled and their effects measured. Through staining for chitin more insight into the structure of the pellicle can be gained.

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