Higher Yeast Concentration and Warmer Water Temperatures Increase CO_2 Production During Fermentation

Richardson, N., Jirbi, A., Luna, E., Cho, C., **Opara, C.** Lab Section A: 04/08/2025

Introduction: Yeast fermentation is a metabolic process in which yeast cells convert sugars into ethanol and carbon dioxide (Bryan et al., 2018). Temperature plays a key role by affecting enzyme activity within yeast cells, with higher temperatures, increasing enzymatic reactions and speeding up fermentation (Yilmaztekin et al., 2013). Similarly, higher sugar concentrations provide more substrate for fermentation, leading to increased CO_2 (Bryan et al., 2018). This experiment looks to determine how varying yeast concentrations and water temperature affect the rate of fermentation, measured through CO_2 displacement, as yeast metabolizes corn syrup under different environmental conditions. An increased yeast concentration with higher water temperatures should lead to a higher rate of CO_2 production during fermentation.

Methods: 2 trials were conducted for each yeast concentration. Fermentation mixtures were prepared by combining 3mL of corn syrup (glucose solution) with different water temperatures and yeast concentrations (Opara, 2025). Each mixture was placed in a 250 mL Erlenmeyer flask sealed with a rubber stopper and tubing leading to a submerged collection tube. CO_2 displaced water in the tube, and measurements were taken every 5 minutes by marking the water line from a baseline. All solutions used distilled water, and variables such as container type, environment, altitude, yeast source, and corn syrup concentration were held constant.

Tube	Concentration
Tube 2 **(4mL glucose solution)**	6 tsp yeast per 8 mL water
Tube 2 **(4mL glucose solution)**	6 tsp yeast per 8 mL water
Tube 3 **(3mL glucose solution)**	2 tsp yeast per 8 mL water

Results: Varying the yeast suspension and corn syrup in a constant hot water temperature gave conclusive results, showing an increase in fermentation over the course of 30 minutes, especially with 10tsp/8mL and the 6tsp/8mL, exceeding the volume of the cylinder.

Discussion: The results supported the initial hypothesis. The first trial led to linearly increasing amount of CO_2 displacement in the cylinder. This supports results from previous experiments that suggest a greater sugar concentration leads to greater and faster fermentation in yeast (Bryan et al, 2018). An increased temperature in water also contributes to yeast fermentation, supporting previous experiments that state that higher temperatures activate enzymes within the yeast cells, accelerating their metabolic process, including reproduction and fermentation, leading to faster growth and activity (Gay et al, 2018; Yilmaztekin et al, 2013). The second trial of the experiment yielded the most displacement in carbon dioxide, suggesting that a combination of hot water and a high corn syrup intake leads to the most displacement. With more time, more trials per experiment could have been done per experiment, but due to time constraints, this was not able to be done.

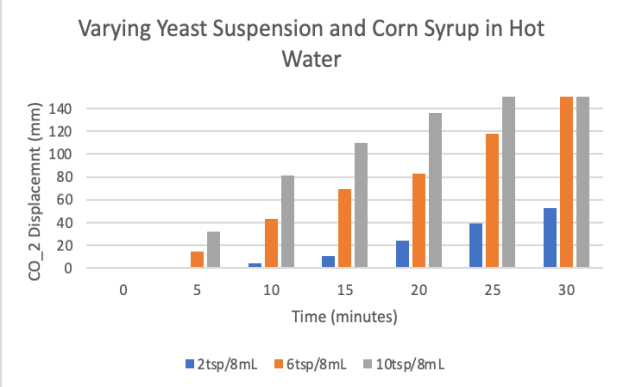

Figure 1. Trial 1. Results at 150mm exceeded cylinders volume capacity, including 10tsp/ 8mL and the 6tsp/ 8mL of suspension past 25 and 30 minutes respectively. The 2tsp/ 8mL suspension resulted in the lowest displacement. No suspensions appeared to show decrease in CO_2 displacement over time.

Literature Cited:

Bryan, A., Hart, C., Howell, A., Wise, M., Roberts, B.* 2018. Glucose Concentrations Effect on Rate of Fermentation in Yeast. Journal of Undergraduate Biology Laboratory Investigations.

Gay, C., Duda, A., Garner, E., Harp, S., Mueller, K. 2018. Effects of Temperature on the Fermentation Rate of Baker's Yeast (Saccharomyces cerevisiae). Journal of Introductory Biology Investigations. 9.

Opara, C. 2025. Lab 3: Experimental Design. University of St. Thomas, Houston, TX, pp. 1-3

Yilmaztekin, M., Cabaroglu, T., Erten, H. 2013. Effects of Fermentation Temperature and Aeration on Production of Natural Isoamyl Acetate by Williopsis Saturnus Var. Saturnus. BioMed Res Int.