The Effect of Flour Type on Yeast Fermentation: A Search for the Optimal Substrate

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Abstract

This experiment investigated how different flour types affected yeast fermentation and protein concentration. Yeast cultures were mixed with all-purpose, whole wheat, dark rye, spelt flour, and sucrose as a control. Fermentation was measured by CO_2 production, and protein concentration was determined using a Bradford Protein Assay at 595 nm. We hypothesized that flours with higher protein levels would produce greater CO_2 volumes. Our data refuted this hypothesis, since protein content did not predict fermentation rate. These findings show how nutrient availability and starch complexity affect the way yeast uses food, which matters for baking, brewing, and understanding how organisms use food sources.

Introduction

Yeast (*Saccharomyces cerevisiae*) is a tiny single-celled fungus that makes CO_2 and ethanol during fermentation. It ferments simple sugars fast, but with flour the starches first have to be broken down into usable sugars by enzymes, so how much fermentation happens may depend on the flour's composition (Gobbetti & Ganzle, 2012). Because flours vary in their nutrients and protein, we asked whether the type of flour (and its protein content) affects how much CO_2 yeast produces. Here, flour type and protein content are the independent variables, and CO_2 volume (fermentation rate) is the dependent variable. We hypothesized that flours with higher protein levels (Bradford absorbance values) would produce greater CO_2 volumes.

Materials & Location:

This experiment was conducted during Spring 2026 at Whatcom Community College. Materials used included all-purpose flour, whole wheat flour, dark rye flour, spelt flour, sucrose solution (control), yeast, distilled water, fermentation tubes, test tubes, microcentrifuge tubes, glass beads, phosphate-buffered saline (PBS), Bradford reagent, cuvettes, a vortex mixer, and a spectrophotometer set to 595 nm. A 37°C incubator was also used during the fermentation portion of the lab. Data was collected during scheduled biology lab sessions in Spring 2026.

Procedure:

Five test tubes and fermentation tubes were labeled for all-purpose flour, whole wheat flour, dark rye flour, spelt flour, and sucrose (control). Yeast solution (yeast + water) was combined with each substrate (10 mL each), mixed, and incubated at 37°C for 20 min in fermentation tubes. CO_2 production was measured and fermentation rate calculated (CO_2 volume/20 min). For protein analysis, yeast samples (1 mL) were vortexed with glass beads. Then 100 µL of each sample was added to Bradford reagent, and absorbance was measured at 595 nm after color change.

Average CO_2 Production and Protein Concentration by Substrate

Substrate	Avg CO_2 Volume (ml)	Avg Protein Concentration (mol/L)
Sucrose (control)	8.50	1.546
Dark Rye	2.57	1.367
Whole Wheat	2.23	1.605
All Purpose	0.55	1.519
Spelt	0.63	1.350

Table 1. Average CO_2 volume (ml) and protein concentration (mol/L) for each substrate. Sucrose served as the positive control. Protein concentration was calculated from Bradford absorbance at 595 nm.

CO_2 Production and Protein Concentration by Substrate

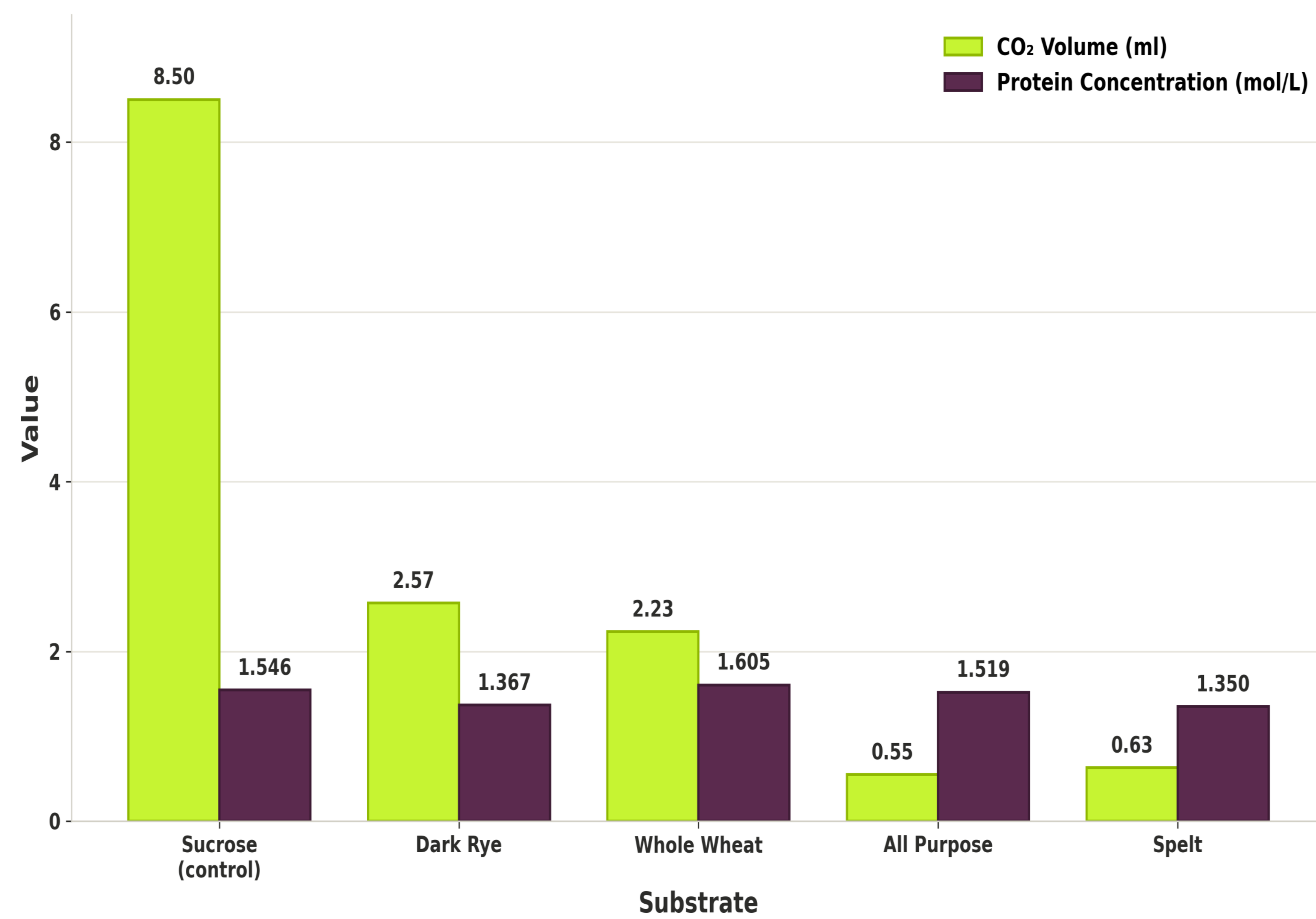

Figure 1. Average CO_2 volume (ml) and average protein concentration (mol/L) for each substrate. Sucrose served as the positive control. Protein concentration was calculated from Bradford absorbance at 595 nm. CO_2 output and protein concentration did not follow the same pattern across substrates.

Discussion

The results of this experiment did not support our hypothesis. We predicted that flours with higher protein concentrations would produce greater CO_2 volumes, but the data did not show a consistent relationship between protein content and fermentation rate. Sucrose produced the most CO_2 at around 8.5 ml even though its Bradford reading was similar to all-purpose flour (the sucrose reading reflects yeast protein, since sugar has none of its own). Whole wheat had the highest protein of all substrates but was not the top fermenter, and spelt produced very little CO_2 despite having protein levels comparable to dark rye. This suggests that sugar availability and starch complexity have a greater influence on yeast fermentation rate than protein content alone.

The most likely reason sucrose performed so much better than the flours is that it is a simple sugar that yeast can use right away without any extra breakdown. Research has shown that simple sugars like glucose and sucrose produce more CO_2 than complex carbohydrates because yeast can access them much faster (Crancer et al., 2018). This lines up with what other researchers have found as well, since studies on yeast fermentation consistently show simple sugars outperform complex ones in short time frames. Flours are mostly starch, and yeast cannot break starch down on its own. It needs enzymes like alpha and beta amylase to do that first (Bakeinfo, 2022), which likely slowed down fermentation across all the flour substrates regardless of how much protein they had (Gobbetti & Ganzle, 2012). The differences we saw between flour types might have more to do with how easily their starches can be broken down than with protein content.

One limitation of our study was that we only measured fermentation for 20 minutes, which probably was not enough time for the amylase enzymes in the flour to fully break down the starch. This could be why the flour substrates all performed similarly and why protein did not predict CO_2 output the way we expected. In future studies it would be worth running fermentation for a longer period to give the enzymes more time to work and see if the flour results spread out more. It would also be interesting to pretreat the flour with amylase before adding yeast, since amylase breaks starch down into simpler sugars that yeast can actually ferment, which could help show whether starch complexity was really what was limiting our results (ArhFoundation, 2026).

References/ Work Cited

ArhFoundation. (2026). How amylase breaks down starch into sugars. https://www.arhfoundation.org/amylase-starch-sugar-industrial-bread-making

Bakeinfo. (2022). Enzymes in breadmaking. Baking Industry Research Trust. https://www.bakeinfo.co.nz/facts/bread/bread-ingredients/enzymes-in-breadmaking/

Crancer, A. et al. (2018). Analyzing the rate of carbon dioxide created by fermentation in yeast with different types of sugars. *Journal of Undergraduate Biology Laboratory Investigations, 1*(1). https://undergradsciencejournals.okstate.edu/index.php/JUBLI/article/view/8728

Gobbetti, M., & Gänzle, M. (Eds.). (2012). *Handbook on sourdough biotechnology.* Springer.