The Effect of Maltose Concentration on Sugar Consumption and Protein Content

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Abstract

This study investigated how sugar concentration affects protein content and sugar consumption in yeast cultures. The hypothesis was that increasing sugar concentration would increase protein content and sugar consumption. Yeast was grown with different sugar concentrations, and both variables were measured over three weeks. The results showed that sugar consumption did not increase consistently with higher sugar concentrations. Protein content did increase but also experienced sudden drops. Therefore, the data refuted the hypothesis. Understanding yeast responses to sugar can help improve fermentation processes and provides insight into baking and brewing. It also shows how cells regulate metabolism in different environments.

Introduction

Sugar is an important energy source for yeast during cellular respiration and fermentation. Research shows that sugar concentration can affect yeast metabolism, while very high concentrations can cause osmotic stress (Timmermans et al., 2022; Hohmann, 2002). In this experiment, the independent variable was maltose concentration (0%, 10%, 20%, 30%, and 40%), while the dependent variables were sugar consumption and protein concentration measured over two weeks. We hypothesized that moderate maltose levels would increase sugar consumption and protein content.

Methods

Materials & Location

This experiment was conducted during Summer 2026 at Whatcom Community College. The materials used during this procedure included maltose solutions of varying concentrations (0%, 10%, 20%, 30%, and 40%), active yeast cultures, Bradford reagent, phosphate-buffered saline (PBS), Benedict's reagent, distilled water, microcentrifuge tubes, cuvettes, vortex mixer, micropipette, and a spectrophotometer. A PCR machine set to 100°C was used to heat the samples when determining sugar consumption rates.

Procedure

Yeast cultures were exposed to 5 maltose solutions (0, 10, 20, 30, 40%). Solutions were monitored weekly for 3 weeks. Protein content was measured by lysing 1.0mL with vortex mixer. 100µL was mixed with PBS, then 100µL PBS-yeast mixture with 900µL Bradford reagent. Absorbance was measured with a spectrophotometer at 595nm. For sugar concentration, 500µL yeast-maltose solution was added to a 2.0mL microcentrifuge and centrifuged for 1 minute. Supernatant was micropipetted and diluted with distilled water. 50µL sample was mixed with 100µL Benedict's reagent and placed in PCR machine at 100°C for 5 minutes. Mixture cooled to 70°C and centrifuged for 3 minutes. 125µL supernatant was diluted with 875µL distilled water, and absorbance was measured at 740nm.

Protein Content According to Different Maltose Concentrations

Sugar concentration (%)	Week 1 protein (mol/L)	Week 2 protein (mol/L)	Week 3 protein (mol/L)
0	0.052	0.052	0.3475
10	0.096	0.218	0.3443
20	0.052	0.149	0.8925
30	0.127	0.318	1.235
40	0.137	0.310	1.370

Table 1: Shows the protein content and protein content over the course of three weeks, with the sudden decreases and increases. The method used to measure protein content was Bradford Assay. The maltose concentrations were 0%, 10%, 20%, 30%, and 40%. Appropriate units would be mol/L, moles per a liter.

Sugar Consumption According to Different Maltose Concentrations

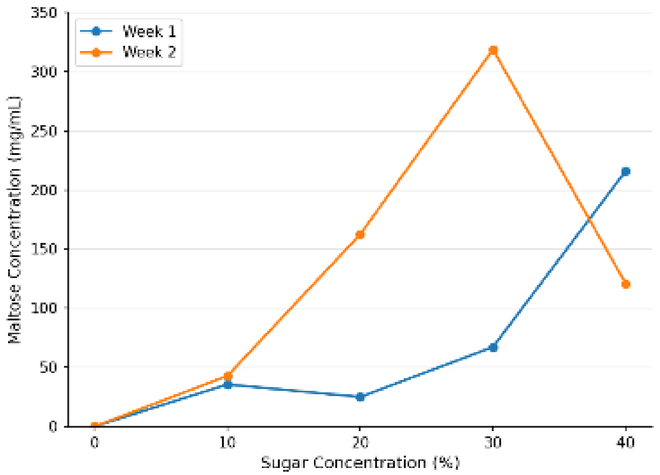

Figure 2: This graph illustrates the rate of sugar consumption compared to the concentration of maltose. It shows the sudden decreases and increases of sugar consumption at the different concentration.

Discussion

The main objective of this experiment was to examine whether high maltose concentrations increased protein content and sugar consumption. The results refuted the hypothesis because increasing sugar concentrations did not consistently increase sugar consumption. It fluctuated, increasing and then decreasing. Protein content had a more consistent relationship between higher maltose concentrations and protein content. However, it also decreased at some higher maltose concentrations. Therefore, the hypothesis was not supported.

The results of this study did not support the hypothesis. Sugar consumption didn't show a clear trend as maltose concentration increased. While it increased at some higher concentrations, it decreased at others. This suggested that maltose concentration alone didn't determine the rate of sugar consumption. Papigianni et al. (2007) found that high maltose concentrations reduced sugar consumption because yeast shifted its metabolism toward fermentation. This was not consistent with our experiment. It may indicate that some yeast cells responded differently to the available maltose. Verhagen et al. (2025) reported that maltose is transported differently than glucose and has a lower maximum uptake rate. This may have limited sugar absorption at certain concentrations, contributing to inconsistencies. The protein content results were also inconsistent with previous research. Hatanaka et al. (2018) reported that high levels of intracellular maltose inhibited protein synthesis. Protein content generally increased at higher maltose concentrations but decreased at 20% maltose. This could indicate that high maltose levels had temporarily inhibited protein production before the yeast adapted. Differences in exposure time, maltose concentration, and experimental conditions may have contributed to the contrasting results.

Future research could test a wider range of maltose concentrations and exposure times to determine how these factors affect sugar consumption and protein production in yeast. Studies could also use larger sample sizes, multiple trials, and a longer trial for more reliable results.

References/ Work Cited

Hatanaka, H., Mitsunaga, H., & Fukusaki, E. (2018). Inhibition of Saccharomyces cerevisiae growth by simultaneous uptake of glucose and maltose. *J Biosci Bioeng.*, 125(1), 52-58. doi: 10.1016/j.jbiosc.2017.07.013. Epub 2017 Sep 15. PMID: 28919251.

Papagianni, M., Boonpooh, Y., Mattey, M., & Kristiansen, B. (2007). Substrate inhibition kinetics of *Saccharomyces cerevisiae* in fed-batch cultures operated at constant glucose and maltose concentration levels. *J Ind Microbiol Biotechnol.*, 34(4), 301–309. doi: 10.1007/s10295-006-0198-9.

Verhagen, K. J. A., Pardijs, I. H., van Klaveren, H. M., & Wahl, S. A. (2025). A Dive Into Yeast's Sugar Diet—Comparing the Metabolic Response of Glucose, Fructose, Sucrose, and Maltose Under Dynamic Feast/Famine Conditions. *Biotechnol Bioeng.*, 122(4), 1035-1050. doi: 10.1002/bit.28935. Epub 2025 Jan 26. PMID: 39865609; PMCID: PMC11895419.

Hohmann, S. (2002). Osmotic stress signaling and osmoadaptation in yeasts. *Microbiol Mol Biol Rev.*, 66(2), 300–372. doi: 10.1128/MMBR.66.2.300-372.2002. PMID: 12040128.

Timmermans, E., Bautil, A., Brijs, K., Scheirlinck, I., Van der Meulen, R., & Courtin, C. M. (2022). Sugar levels determine fermentation dynamics during yeast pastry making and its impact on dough and product characteristics. *Foods*, 11(10), 1388.