Aaron Shavitz 10/8/15
Lab Section: L14

Impact of Sodium Chloride on Yeast Fermentation[1]

Introduction[2]

Fermentation[3] is a biological process performed in order to allow organisms to produce energy without cellular respiration. There are two types of fermentation, alcoholic fermentation and lactic acid fermentation. Many organisms, including yeast, are known to undergo alcoholic fermentation. One notable byproduct of alcoholic fermentation is carbon dioxide (CO_2). While fermentation itself does not produce energy, it allows for a process called glycolysis to continue, which forms an energy storing molecule called ATP. Typically, fermentation occurs under anaerobic conditions, conditions without oxygen present. This is because when oxygen is present organisms can undergo cellular respiration in addition to glycolysis, which is a far more efficient method of producing ATP than glycolysis alone (Morton, et al. 1980).[4] However, some organisms even go through fermentation when exposed to oxygen, such as the yeast cultures used to make bread.

Fermentation's[5] ability to allows the production of energy under anaerobic conditions yields fascinating questions about energy production in various organisms. If there are environments in which fermentation cannot occur, those environments would be fatal to cells and organisms without available oxygen. The ability of cells to function within different environments opens up many doors of research.

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[1] Title concisely describes experiment.
[2] Each section is labelled with a clear heading.
[3] This paragraph describes background information relevant to the experiment.
[4] Source is cited using APA style.
[5] This paragraph introduces the significance of research in this area.

In order[6] to exam how different environments affect fermentation, the presence of sodium chloride during fermentation was examined[7]. Yeast was allowed to ferment in different anaerobic environments with varying levels of salt concentration in order to determine the salt concentration's impact on fermentation. Fermentation rates were measured by evaluating the quantity of CO_2 released from yeast solutions, which was measured by finding the masses of yeast solution samples before and after they were allowed to ferment. It was anticipated that increasing the salt concentration would decrease the fermentation rate of yeast cells.[8]

Materials and Methods[9]

A 10% salt solution was prepared from solid NaCl and 20mL of 5% glucose solution in a small beaker. 0.8mL of this solution, containing both glucose and salt, was added to each of twenty small plastic tubes labeled to differentiate them by time interval and trial. Each of these tubes had a small hole poked in the top that would allow for gas to escape.

0.8mL of 7% yeast solution was then placed in four of the tubes, creating a total salinity of 5% within the tube. Each tube was weighed immediately after the yeast was added. These four tubes were then placed upside down in a floating rack, the rack was dipped in 40-

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[6] This paragraph introduces the experiment conducted. Very little detail is required, all that is needed is a few VERY general sentences explaining how and why the experiment was done.
[7] Lab reports are written in passive voice, do not use "we" or "I."
[8] Hypothesis. The hypothesis does not need to be at the end of the introduction, but it is critical and must be included. A hypothesis is a testable statement. Typically, in BIO001, the hypothesis will be clear and short with identifiable independent and dependent variables (ex. salt concentration and fermentation rate).
[9] The Materials and Methods section describes in detail how you conducted your experiment. However, do not describe insignificant details that don't enhance the reader's ability to repeat the experiment such as "the data was recorded on a blue piece of paper." The goal is to enable another researcher to be able to replicate the experiment purely based on the information in this section.

degree Celsius water, and immediately removed. The four tubes were then flipped right side up and re-weighted.

This procedure was then repeated for the remaining sixteen tubes, without removing them from water immediately. Four tubes were removed every five minutes for twenty minutes, and the masses were collected. All supplies were then cleaned and dried. The entire experiment was then conducted twice more, once adding 5% sodium chloride solution to each of the twenty tubes resulting in a total salt percentage of 2.5% after the yeast solution was added, and once adding 0% sodium chloride solution (only glucose). The data for the 0% sodium chloride solution was collected on a separate day by a laboratory teaching assistant, and provided for use in this experiment. All masses throughout the entire experiment were recorded.

Results

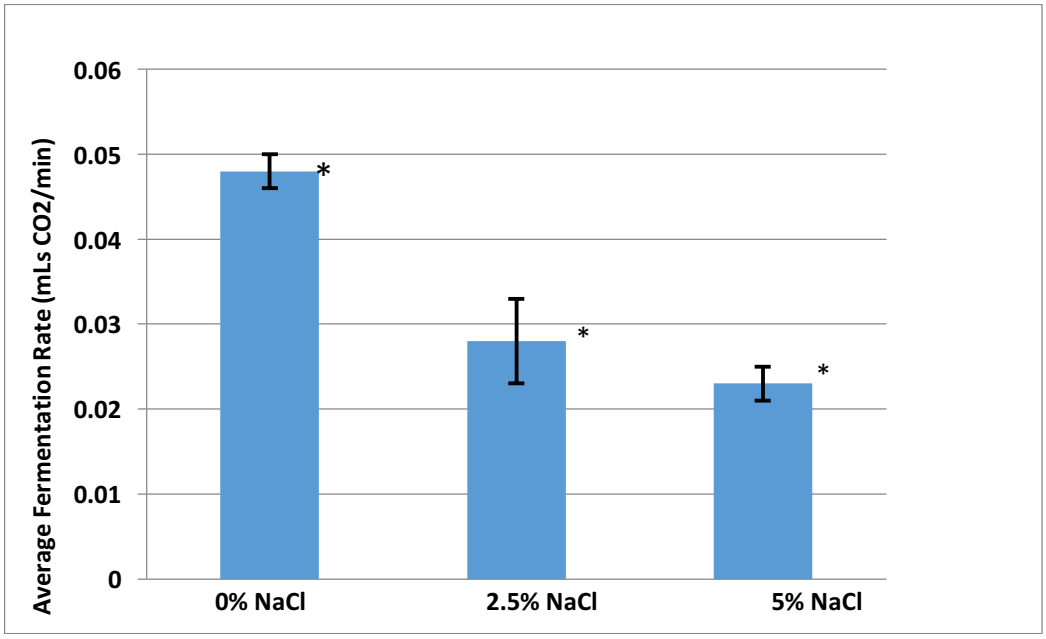
Table 1 – Rates of Fermentation[10] [11]

Replicate	**Rate of Fermentation 0% NaCl (control)** *mL CO_2/min*	**Rate of Fermentation 2.5% NaCl** *mL CO_2/min*	**Rate of Fermentation 5% NaCl** *mL CO_2/min*
A	0.046	0.0323	0.0253
B	0.0482	0.0309	0.0237
C	0.0498	0.025	0.0222
D	0.0492	0.0222	0.0216
Average	**0.048**	**0.028**	**0.023**
SD	**0.002**	**0.005**	**0.002**
t-test p-value	**N/A**	**0.0008**	**3.44E-07**

[10] All tables and graphs are assigned a number and are given a short descriptive title.
[11] Tables should be formatted in a way that is easily understandable. Ask your friends if they can understand the information!

Table 1 displays[12] the rates of fermentation undergone by yeast for all replicates under each of the three experimental conditions. Average values and standard deviations are included for each condition. It is clear that as the salt concentration increased, the fermentation rate decreased. This is displayed in Table 1 and Figure 1, as the average fermentation dropped from 0.048 *mL CO_2/min* to 0.028 *mL CO_2/min* to 0.023 *mL CO_2/min* with each successive increase in salt concentration. P-values were calculated for each of the two variable conditions by comparing their data sets to the control data set. Both p-values are smaller than 0.05, showing that the results were statistically significant. The control condition of 0% NaCl yielded the fastest rate of fermentation, followed by the 2.5% NaCl condition and then the 5% condition respectively.

Figure 1 - Yeast Fermentation Rates Under Various Salt Concentrations[13]



[12] In your results section you should refer to your tables and graphs, explaining the data within them.

[13] Tables and Figures are numbered in separate categories, as can be seen by Figure "1" following Table "1." Titles on graphs should be located outside and above the figure.

Figure 1 compares the average fermentation rates undergone by yeast under each of the three experimental conditions: 0% NaCl, 2.5% NaCl, and 5% NaCl. The black error bars seen represent the standard deviation for each set of data that factored into the averages seen. There was no error greater than ± 0.005 *mL* CO_2*/min.*[14]

Discussion[15]

After being assessed under three levels of salt concentration, 0%, 2.5%, and 5%, yeast was observed to undergo fermentation the quickest under lower salt concentrations.[16] This data supports the hypothesis that increasing salt concentration decreases the fermentation rate of yeast cells.[17] There was a distinct decrease in the yeast's fermentation rate for each of the two successive levels of salt concentration.[18]

One limitation[19] of this experiment was the number of conditions tested. In order to more concretely determine whether or not increasing salt concentration decreases the fermentation rate of yeast cells, a greater quantity of NaCl concentration intervals should have been tested. If more were tested and the data still supported the hypothesis, the results of the experiment would be more significant. A source of error in this experiment was that liquid within the tubes often spilled out of the tops or out of the holes made to allow for CO_2 release. This

[14] Remember!! - The Results section does not analyze or explain the potential reasoning or significance of your data, it purely states what was found.
[15] Here, in the Discussion section, is where you can interpret your results.
[16] Begin with an extremely brief recap of your experiment.
[17] The results must be compared to the hypothesis in this section.
[18] Also include extremely brief description of your results.
[19] The Discussion section is a more flexible area than your M&M or Results. Here you can discuss significance of your data, limitations of your experiment, sources of error, and explanations potential of your results.

escaped fluid decreased the mass of the tubes, which likely resulted in increased calculations of released CO_2, and consequently increased calculations of fermentation rates.

While the results of this experiment successfully shed light onto the impact of salt on yeast fermentation, it does provide evidence that the same results would be found for fermentation undergone in other types cells, such as lactic acid fermentation. Analysis of the impact of salt on lactic acid fermentation in human or other cells would be a useful expansion on this research.

Supplemental Data[20]

Figure 2 - Amount of CO2 Produced

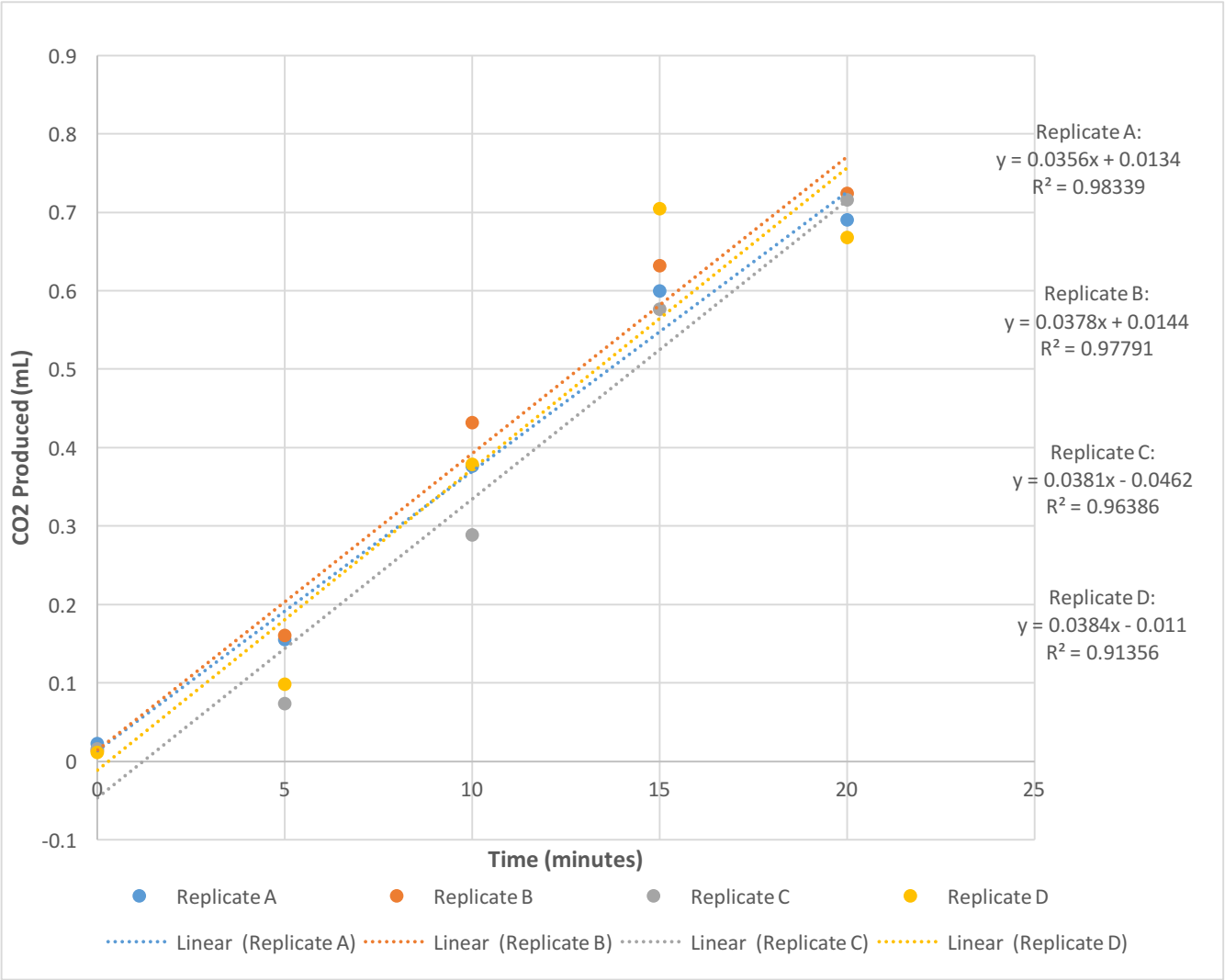


Table 2 – Raw Data

Sample	Pre-Weight (g)	Post-Weight (g)	CO_2 produced (mL)
0A	2.65	2.62	**0.03**
0B	2.68	2.66	**0.02**
0C	2.67	2.66	**0.01**

[20] Some teaching assistants or professors will ask for supplemental data. No explanation of your tables and graphs is necessary here, but remember to always number and title.

0D	2.65	2.64	**0.01**
5A	2.71	2.61	**0.1**
5B	2.7	2.59	**0.11**
5C	2.71	2.63	**0.08**
5D	2.7	2.61	**0.09**
10A	2.67	2.38	**0.29**
10B	2.7	2.46	**0.24**
10C	2.67	2.4	**0.27**
10D	2.68	2.39	**0.29**
15A	2.69	2.28	**0.41**
15B	2.66	2.22	**0.44**
15C	2.69	2.32	**0.37**
15D	2.69	2.35	**0.34**
20A	2.67	2.21	**0.46**
20B	2.66	1.98	**0.68**
20C	2.66	2.26	**0.4**
20D	2.67	1.88	**0.79**

References[21]

Morton, J. S. 1980. Glycolysis and Alcoholic Fermentation. *Acts & Facts.* 9 (12). http://www.icr.org/article/glycolysis-alcoholic-fermentation/

[21] Any references used must be included in full APA citation at the end.