INTRODUCTION

The aim of the experiment: To investigate the effect of different glucose concentrations on the rate of fermentation.

Research question:How does changing the concentration of the glucose solutions will affect the rate of fermentation.

Background Information:

There are various factors that affect the rate of fermentation.

These are;

"Fermentation time
This factor determines the amount of time yeast gets to act on the sugars present in the ferment, whether it be a sponge, brew, or a straight-dough. While the rate of fermentation declines with time at a constant temperature, it does not completely stop. However, the longer the fermentation time, the higher the degree of fermentation.

Fermentation temperature
Like any other living cell, the various enzymatic activities of the yeast cell are closely tied to the temperature of the environment. Therefore, higher ferment temperatures increase yeast activity, and vice-versa. Published literature indicates that within the range of temperatures in which yeast is operative, every one degree rise in temperature increases the rate of yeast fermentation by 3-5%.

Level of water:
Generally, stiffer dough take longer to ferment as compared to slacker ones. With additional water, the soluble solids are diluted and the osmotic pressure on the yeast cells is reduced. This causes an increase in yeast activity and the overall rate of fermentation.

Level of sugar and salt:
It is well known that yeast fermentation is retarded in the presence of high concentrations of sugar and salt. This inhibitory effect is related to the high osmotic pressure gradient created outside of the yeast cells due to high concentrations of sugar and/or salt .But in presence of appropriate sugar concentrations rate of fermentation will increase , but it will eventually stop."(1)

1 http://www.dakotayeast.com/help-fermentation.html

Ethanol fermentation

"Ethanol fermentation (performed by yeast and some types of bacteria) breaks the pyruvate down into ethanol and carbon dioxide. It is important in bread-making, brewing, and wine-making. Usually only one of the products is desired; in bread-making, the alcohol is baked out, and, in alcohol production, the carbon dioxide is released into the atmosphere or used for carbonating the beverage. When the ferment has a high concentration of pectin, minute quantities of methanol can be produced.

The chemical equation below summarizes the fermentation of glucose, whose chemical formula is $C_6H_{12}O_6$. One glucose molecule is converted into two ethanol molecules and two carbon dioxide molecules:

$$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$$

C_2H_5OH is the chemical formula for ethanol.Before fermentation takes place, one glucose molecule is broken down into two pyruvate molecules. This is known as glycolysis." (2)

CONTROLLED VARIABLES:

The time each for each fermentation to occur with different glucose concentrations.
The temperature of the water bath.
The mass of yeast used.
The volume of deionized water used in each trial.

DEPENDENT VARIABLES:

the height of the CO2 produced after heating the test tubes for fermentation to occur.

INDEPENDENT VARIABLES:

The %5,%10,%15,20 and %25 glucose concentrations that are used.

MATERIALS

- 100mg yeast
- 4 beakers (100ml)
- 1 beaker(200 ml)
- 1 beaker(500 ml)
- 800 ml deionized water
- 100 ml % 5 glucose solution
- 100 ml % 10 glucose solution
- 100 ml % 15 glucose solution
- 100 ml % 20 glucose solution
- 100 ml % 25 glucose solution

- Ruler
- Thermometer
- Chronometer
- Bunsen burner
- Water bath

2 http://en.wikipedia.org/wiki/Fermentation_%28biochemistry%29

PROCEDURE:

- In a 200ml beaker, 2,5g of yeast was added to 75ml of deionized water. The solution was mixed completely and set aside.
- Then the solution is seperated and put into 5 test tubes with 15ml in each.
- Then 5 ml of %5 glucose solution is added to each test tubes.
- The top of the test tubes are covered with parafilm so that the CO2 won't be released after fermentation.
- The initial height of solution in each test tube is measured with a ruler and noted.
- A 500 ml beaker which is filled with 200ml water,is placed on the burner turner and heated to 30 degree Celcius .
- All 5 test tubes are placed inside the 500 ml beaker and heated for 10 minutes.
- In order to keep the temperature around 30 degree Celcius(which is the most propriate temperature for fermentation)water is added to the 500 ml beaker.
- The final height of the gas bubble was recorded at the top of the tube for all 5 test tubes after 10 minutes.
- The carbon dioxide produced by fermentation was determined by subtracting the initial height from the actual height.
- This process was continued for different glucose concentrations like %10,%15,%20 and %25 glucose solutions for 5 times for each.

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
%5 glucose concentration	5	6,8	1,36	0,018
%10 glucose concentration	5	11,6	2,32	0,032
%15 glucose concentration	5	16,8	3,36	0,043
%20 glucose concentration	5	21,1	4,22	0,057
%25 glucose concentration	5	26,3	5,26	0,088

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit

Between Groups	47,0776	4	11,7694	247,2563	1,01E-16	2,866081
Within Groups	0,952	20	0,0476			
Total	48,0296	24				

Table 1:anova table for different concentrations of glucose(%) to determine the whether different glucose concentrations cause difference in rate of fermentation by the p-value.

Hypothesis:Using different concentrations of glucose will give a significant difference in rate of fermentation.

Null Hypothesis:As using different glucose concentrations there will be no significant difference in rate of fermentation.

p-value < a hypothesis is rejected and hypothesis is accepted.

the glucose concentration used(%)		final height-initial height of solution (volume of CO2 produced)(cm) (±0,1)	the initial height of solution (±0,1 cm)	Temperature (±1C°)	volume of glucose used (±0,1ml)	volume of yeast used (±0,001g)
5	trial 1	1,5	10	30	5	0,500
	trial 2	1,3	10	30	5	0,500
	trial 3	1,5	10	30	5	0,500
	trial 4	1,2	10	30	5	0,500
	trial 5	1,3	10	30	5	0,500
10	trial 1	2,2	10	30	5	0,500
	trial 2	2,3	10	30	5	0,500
	trial 3	2,5	10	30	5	0,500
	trial 4	2,5	10	30	5	0,500
	trial 5	2,1	10	30	5	0,500
15	trial 1	3,1	10	30	5	0,500
	trial 2	3,5	10	30	5	0,500
	trial 3	3,4	10	30	5	0,500
	trial 4	3,6	10	30	5	0,500
	trial 5	3,2	10	30	5	0,500
20	trial 1	4,2	10	30	5	0,500
	trial 2	3,9	10	30	5	0,500
	trial 3	4,1	10	30	5	0,500
	trial 4	4,5	10	30	5	0,500
	trial 5	4,4	10	30	5	0,500

25	trial 1	5,6	10	30	5	0,500
	trial 2	5,3	10	30	5	0,500
	trial 3	5,4	10	30	5	0,500
	trial 4	5,2	10	30	5	0,500
	trial 5	4,8	10	30	5	0,500

Table 2: The table for the volume of CO2 gas produced for %5,%10,%15,%20 and %25 glucose concentrations and the constant values for temperature,volume of yeast and volume of glucose used.

Examples for Calculations of Statics;

Mean= a+b+c+d+e/5

(1,5+1,3+1,5+1,2+1,3)/5 =1,36

Variance=

a-mean=x b-mean=y c-mean=z d-mean=t e-mean=u
Variance=$x^2+y^2+z^2+t^2+u^2/(n-1)$

example; 1,5-1,36=0,14 1,5-1,36=0,14 1,3-1,36=-0,06 1,3-1,36=-0,06 1,2-1,36=-0,16 n=5

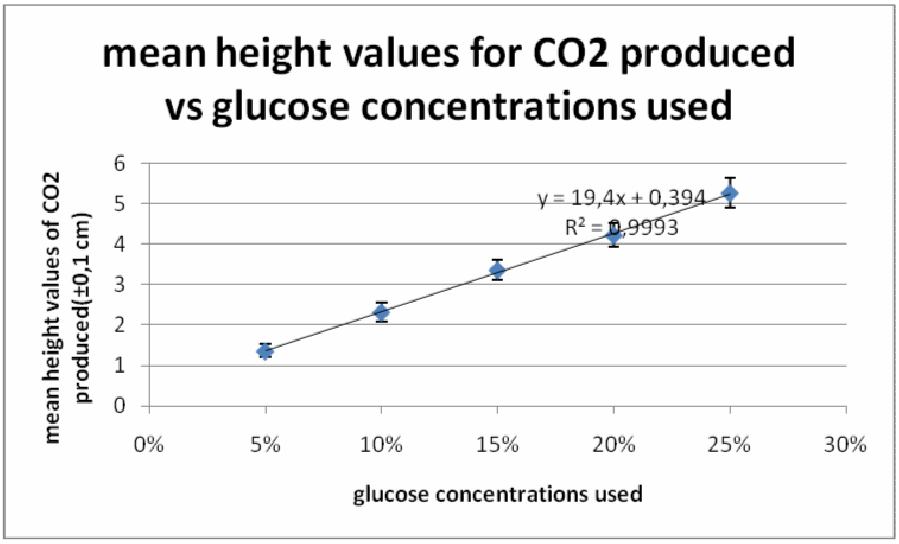
Variance=$(0,14)^2+(0,14)^2+(0,06)^2+(0,06)^2+(0,16)^2/4=0,018$

Standart deviation=$\sqrt{variance}$ =0,1341

Standart error= standart deviation/$\sqrt{n}$ = 0,06

	the glucose concentrations used(%)				
	5	10	15	20	25
mean	1,36	2,32	3,36	4,22	5,26
std	0,134164	0,178885	0,207364	0,238747	0,296648
variance	0,018	0,032	0,043	0,057	0,088
se	0,06	0,08	0,092736	0,106771	0,132665
t	2,776445	2,776445	2,776445	2,776445	2,776445
%95 cl	0,166587	0,222116	0,257477	0,296443	0,368337

Table 3:The mean,standart deviation ,variance and standart error statics for each glucose concentration used.(%5,%10,%15,%20 and %25 glucose concentrations are used)



Graph 1:The mean graph for CO2 gas produced in each different concentration of glucose solution used.

CONCLUSION ▲ND EV▲LU▲TION

In this experiment the effect of different glucose concentrations on the rate of fermentation is observed.5 ml of %5,%10,%15,%20 and %25 glucose solutions are added to 15 ml water and 0,500 g yeast by order and heated. The test tubes are covered with parafilm so that the CO2 released by the fermentation won't be lost. The reason that the test tubes are heated because fermentation best occurs at 30C°.

By the ▲nova test it is seen that the p-value 1,01E-16 < 0,05 so the hypothesis is accepted.Which shows that by changing the glucose concentration there will be a significant difference seen in the rate of fermentation .

"The rate of fermentation will increase proportionally as concentration increase but it will eventually stop."(3)

3http://www.megaessays.com/viewpaper/61901.html