Research Plan

Project ID:

Project Title: Yeast Balloon Experiment: Microbial Respiration and CO2 Production

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a. Introduction

Microorganisms such as yeast carry out respiration by breaking down sugars to release energy. One of the by-products of this process is carbon dioxide (CO_2). This experiment will aim to demonstrate microbial respiration by mixing yeast, sugar, and warm water in a bottle sealed with a balloon. The balloon will inflate as CO_2 is produced.

This project will investigate how different factors such as sugar concentration and water temperature affect the rate of balloon inflation.

b. Selection of Problem and Background Information

Cellular respiration is a key biological process through which living organisms release energy from food. In yeast, this occurs through fermentation, especially in anaerobic conditions. The gas produced during fermentation is CO_2, which can be visually observed by capturing it in a balloon.

This project will serve as a low-cost, safe, and hands-on way of understanding microbial activity, fermentation, and the role of respiration in energy release.

c. Objective

Research Problem / Question: How do sugar concentration and water temperature affect the rate of CO_2 production during yeast fermentation?

What will be found out:

- The amount of CO_2 produced under different sugar concentrations.
- The effect of water temperature on yeast activity.
- The approximate rate of balloon inflation as a proxy for gas production.

Variables:

- Independent Variables: Sugar concentration (low, medium, high), water tempera- ture (cold, warm, hot).
- Dependent Variables: Balloon circumference (cm) as a measure of CO_2 produced.
- Controlled Variables: Volume of water, type of yeast, bottle size, amount of yeast.

Control in the Study: A bottle with water and yeast but no sugar will act as the control to confirm that balloon inflation is due to sugar fermentation.

d. Hypothesis

If sugar and yeast are mixed in warm water, then microbial respiration will produce CO_2, inflating the balloon. Warmer water (within optimal range) and moderate sugar concentration will produce faster and greater balloon inflation compared with cold water or no sugar.

e. Procedure

Design of Study: A set of bottles with yeast, sugar, and water will be prepared under different sugar concentrations and temperatures. Balloons will be placed over the bottle openings, and their inflation will be measured at regular intervals.

Materials Required:

- Dry yeast (1 packet).
- Sugar (measured amounts).
- Warm water, cold water, hot water.
- Plastic bottles (transparent, 500 ml).
- Balloons.
- Measuring tape / string (to measure balloon circumference).
- Stopwatch / clock.

Stepwise Procedure:

1. Label bottles according to sugar concentration and water temperature.
2. Add equal amounts of yeast to each bottle.
3. Add measured sugar and water of specified temperature.
4. Mix gently and immediately place a balloon over the bottle mouth.
5. Record balloon circumference every 5 minutes for 30 minutes.
6. Compare results across bottles.

Proposed Data Tables:

Table A: Balloon Inflation with Different Sugar Concentrations

Time (min)	Control (0g)	Low Sugar (5g)	Medium Sugar (10g)	High Sugar (20g)
5 10 20 30				

Table B: Balloon Inflation at Different Temperatures

Time (min)	Cold Water (15°C)	Warm Water (35°C)	Hot Water (60°C)
5 10 20 30			

f. Risk and Safety

- Experiment uses safe, food-grade materials (yeast, sugar, water).
- Balloons will be handled carefully to prevent snapping.
- Hot water will be handled with caution to avoid burns.

g. Data Analysis

- Balloon circumference data will be averaged across trials.
- Growth curves of balloon inflation vs time will be plotted.
- Comparison will be made between sugar concentrations and temperatures.
- Optimal conditions for yeast fermentation will be identified.

h. Bibliography

1. Campbell, N.A. *Biology*, Pearson Education.
2. Madigan, M.T. *Brock Biology of Microorganisms*.
3. Science Buddies, "Yeast and Sugar: Balloon Blow-Up Experiment."