ANSWER KEY.

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Weighing the Invisible: A Yeast Respiration Lab

Biology | ANSWER KEY

Sample answers and data. Accept answers that match the group's own data and reasoning.

Draft lab. This lab has not been tested in a classroom yet. Your teacher may change some steps, times or amounts.

The Puzzle

A bottle of warm, sweet water with yeast sits on a balance. Nothing spills and nothing is taken out, yet the reading slowly goes down. Where is the mass going? In this lab you will "weigh" the gas that yeast releases and test which sweeteners yeast can actually use.

Question

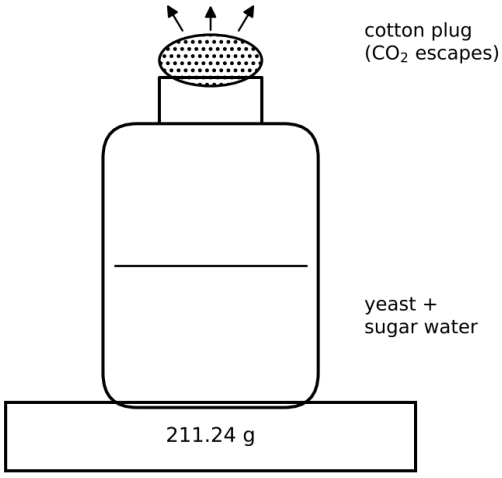
Which sweeteners can yeast use for energy, and how much mass does the bottle lose as they do?

Safety

- Wear goggles. Use warm water only (35 to 40 °C), never hot.
- Do not taste anything. Wipe up spills, especially near the balance.

Materials (per group)

- 3 small plastic bottles (about 250 mL), each with a loose cotton plug
- Packet of dry yeast (use 3 g per bottle)
- Table sugar and one test sweetener from your teacher (5 g each)
- Warm water (35 to 40 °C), graduated cylinder, balance (0.01 g), timer



The cotton plug lets gas out but stops splashes.

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Before the Lab

1. Predict which bottles will lose the most mass. Explain what you think the yeast is doing.

Answers vary. Expected: the table sugar bottle loses the most, because yeast uses sugar for respiration and releases CO_2 gas.

Procedure

1. Label the bottles S (table sugar), T (test sweetener), and N (no sugar).

2. Add 5 g of table sugar to S and 5 g of your test sweetener to T. Add nothing to N.

3. Add 100 mL of warm water to each bottle and swirl until dissolved.

4. Add 3 g of yeast to each bottle, swirl, and push in the cotton plug. Do this quickly for all three.

5. Weigh each bottle right away (0 min), then every 10 minutes for 30 minutes. Swirl gently before each weighing.

Data

Table 1. Bottle mass

Bottle	0 min (g)	10 min (g)	20 min (g)	30 min (g)	Mass lost (g)	Corrected (g)
S: table sugar	**211.46**	**211.41**	**211.32**	**211.24**	**0.22**	**0.20**
T: erythritol	**211.38**	**211.37**	**211.36**	**211.35**	**0.03**	**0.01**
N: no sugar	**206.40**	**206.39**	**206.38**	**206.36**	**0.04**	**0.02**

Your teacher will post the mass lost by a bottle with sugar and water but no yeast (evaporation only). Corrected = mass lost - evaporation.

Table 2. Class data

Sweetener	Table sugar	Corn syrup	Honey	Lactose (milk sugar)	Erythritol	No sugar
Class average corrected loss (g)	**0.20**	**0.19**	**0.17**	**0.01**	**0.01**	**0.02**

Analysis

2. The bottle lost mass, but nothing visible left it. What left, and what process made it?

Carbon dioxide gas left through the cotton plug. Yeast cells made it by breaking down sugar in cellular respiration (mostly fermentation once the oxygen in the bottle was used up).

3. Why do we subtract the evaporation bottle's loss?

Some water vapor escapes through the plug even without yeast. Subtracting it leaves only the mass of gas released by the yeast.

4. In fermentation, 180 g of glucose releases 88 g of CO_2. Use your corrected table sugar loss to estimate how many grams of sugar the yeast used. Show your setup.

0.20 g CO_2 × (180 g sugar ÷ 88 g CO_2) = 0.41 g sugar (sample). That is about 8% of the 5 g added.

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5. Which sweeteners did the yeast not use? Suggest why.

Lactose and erythritol (sample). Baker's yeast lacks the enzymes needed to break down lactose or to use erythritol, so it cannot get energy from them.

6. Atoms are conserved. Where did the atoms in the missing mass come from, and where are they now?

The carbon and oxygen atoms came from the sugar molecules. They are now in CO_2 molecules in the air of the room.

7. Claim, evidence, reasoning: Is the mass lost by the bottle evidence that yeast are carrying out cellular respiration?

Claim

Yes. The yeast broke down sugar and released CO_2, which is why the bottle lost mass.

Evidence

Bottles with table sugar, corn syrup, or honey lost about 0.2 g in 30 minutes; bottles with lactose, erythritol, or no sugar lost almost nothing beyond evaporation (sample).

Reasoning

Respiration breaks the bonds in sugar and releases CO_2 gas and energy. Only sugars the yeast can use lost mass, so the mass loss came from the yeast's respiration.

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