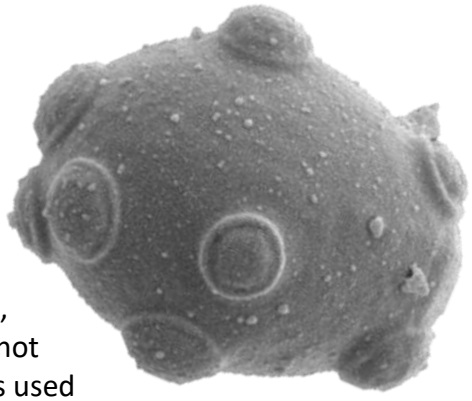
ARTIS MICROPIA

Yeast

Airy fungi



If there were no microbes, your breakfast would look very different. Then there would be no bread, cheese or yoghurt, for instance. A lot of other foods and drinks, such as wine, beer, coffee, olives and chocolate would not exist without microbes, either. One of the key microbes used for making foods and drinks is yeast. It is a tiny single-celled fungus you can simply buy at the supermarket. You need it if you bake your own bread at home, for example.

Here we will explain three experiments in which we will discover all the things yeast is capable of doing. The experiment components can be conducted separately and have gradually increasing levels of difficulty. In the first experiment, we will look at what yeast does to sugar water. In the second experiment, we will take a look at how we can use yeast to make wine from grape juice. In the third experiment, we will look at how yeast is immobilised and used to break down sucrose.

Part 1 (simple)

Fermentation

How does yeast work? What exactly does it do? To find out, in this experiment we are going to look at what happens when you mix yeast and sugar water and let the mixture sit.

What do you need?

- a half sachet of yeast (Dr. Oetker)
- three tablespoons of sugar (45 gr)
- two transparent half-litre plastic bottles
- a tablespoon
- a funnel (or roll up a piece of paper in the shape of a funnel)
- lukewarm water (approximately 25 degrees ^{0}C)
- two balloons
- a waterproof marker

Getting started!

1. Pour half a sachet of yeast into each bottle. Use the funnel for this to prevent spillage.
2. Put three teaspoons of sugar in one of the two bottles and use the waterproof marker to write a large cross on the bottle. That way, you won't forget which bottle you put the sugar in.
3. Pour eight centimetres of lukewarm water in each bottle.
4. Screw the cap on both bottles, shake, and remove the cap.
5. Stretch the balloons a bit, blow them up and let the air out again. This will make them a bit more flexible. You can also use latex gloves and a rubber band.
6. Place the balloon over the neck of the bottles.

Hypothesis

What do you expect to happen to the balloons?

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7. Let the bottles sit for a half hour and check them afterwards. You can shake the bottles carefully from time to time.

Question 1: What happened to the balloons? And do you see any difference between the two bottles?

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Question 2: What accounts for this difference?

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Question 3: Why do bakers use yeast for making bread?

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Part 2 (average)

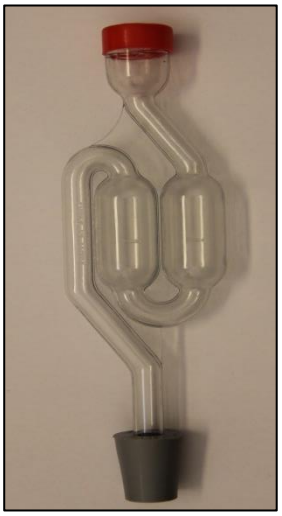
Making wine

Wine is made from grapes, but so is grape juice. So what is the difference? In this experiment, we are going to make wine with yeast. You do this by sealing a bottle containing grape juice and yeast with an airlock.

What do you need?

- two sachets of yeast (Dr. Oetker, 7gr.)
- 6 tablespoons of sugar (90 gr)
- 1L of white or red grape juice (without any added ingredients!)
- lukewarm water (approximately 25 degrees ^{0}C)
- two bottles
- an airlock with a cap
- a glass
- a funnel
- a tablespoon

Getting started!



1. Put one sachet of yeast and three tablespoons of sugar in a glass. Add a bit of lukewarm water and stir well until the yeast has dissolved.
2. Pour the sugar water with the yeast into the bottle.
3. Then add a half litre of grape juice and stir well.
4. Do the same with the second bottle.
5. Place the cap with the airlock on one of the two bottles (see image). Leave the other bottle open.
6. Fill the airlock up to the lines and loosely place the cap on it.
7. Check after about a half hour what has happened.

Questions

Question 1: What does the yeast do with the sugar?

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Question 2: What effect does the airlock have?

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Question 3: What is the difference between the living environment of the yeast in an open bottle and the bottle with the airlock?

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Question 4: In which bottle will wine be made? Why?

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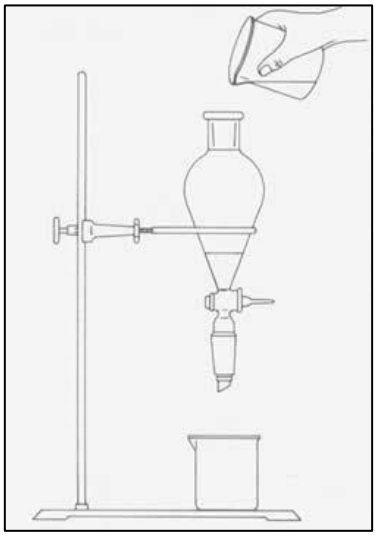
Part 3 (advanced)

Making glucose from sucrose



Yeast cells break down large sugar molecules (sucrose) into smaller ones, such as glucose. Then they absorb the glucose and use it as a source of energy. These small sugars are sweeter than sucrose and are also used as preservatives in jams and sweets. Sucrose is usually chemically hydrolysed into glucose molecules, but purifying the product of the chemical reaction mixture is difficult. Sucrose can also be enzymatically hydrolysed with the help of yeasts. In this test, we will immobilise yeast cells by entrapping them in beads and using these beads to break sucrose down into glucose.

step 1: immobilising yeast

This step can be carried out in two different ways. The yeast beads can be made with the aid of a separating funnel or a syringe. If there is no separating funnel available, you can follow the instructions under ‘without separating funnel’.

With separating funnel

What do you need?

- a tripod with clamps
- a separating funnel 100ml
- a scale (with 2 decimals of precision)
- 0.25 grams dry baker's yeast (Dr. Oetker)
- 0.375 grams sodium alginate
- 50ml calcium chloride solution 0.1M
- demineralised water
- a beaker 250ml
- two conical flasks (at least 50ml)
- a stirring rod
- a tea strainer
- a magnetic stirrer with two stir bars (optional)

Getting started!

1. Weigh 0.25 grams of baker's yeast and dissolve it in 25 ml of demineralised water in a conical flask. Mix well with the stirring rod.
2. Weigh 0.375 grams of sodium alginate and dissolve it in 25 ml of demineralised water in the other conical flask. Mix well using the stir bar or a stirring rod.
3. Mix the yeast solution and the sodium alginate solution together and stir well.
4. Attach the separating funnel to the tripod and fill it with the yeast/alginate suspension. Make sure that the valve is closed!
5. Pour 50 ml of calcium chloride solution into the beaker.
6. Slowly add the yeast suspension to this, drop by drop, while stirring very slowly! Each drop will turn into a small bead.
7. Allow the beads to harden for 10 minutes in the calcium chloride solution.
8. Use the tea strainer to strain the beads and rinse them thoroughly with demineralised water.
9. Store the beads under 150 ml of water in a refrigerator set at 4°C.

Questions

Question 1: How can yeast use sucrose as a nutrient?

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Without separating funnel

What do you need?

- a scale (with 2 decimals of precision)
- 0.25 grams dry baker's yeast (Dr. Oetker)
- 0.375 grams sodium alginate
- 50ml calcium chloride solution 0.1M
- demineralised water
- a plastic syringe 10 ml
- a beaker 200ml
- two conical flasks (at least 50ml)
- a stirring rod
- a tea strainer
- a magnetic stirrer with two stir bars (optional)

Getting started!

1. Weigh 0.25 grams baker's yeast and dissolve it in 25 ml of demineralised water in a conical flask. Mix well with the stirring rod.
2. Weigh 0.375 grams of sodium alginate and dissolve it in 25 ml of demineralised water in the other conical flask. Mix well using the stir bar or a stirring rod.
3. Mix the yeast solution and the sodium alginate solution together and stir well.
4. Fill the syringe with the suspension
5. Pour 50 ml of calcium chloride solution into the beaker.
6. Slowly add the yeast suspension to this, drop by drop. Allow the drops to fall next to each other. Each drop will turn into a small bead.
7. Allow the beads to harden for 10 minutes in the calcium chloride solution.
8. Use the tea strainer to strain the beads and rinse them thoroughly with demineralised water.
9. Store the beads under 150 ml of water in a refrigerator set at 4°C.

Questions

Question 1: How can yeast use sucrose as a nutrient?

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Step 2: breaking down sucrose

The yeast beads can now be used to break sucrose down into glucose. You can also do this with a separating funnel or with a syringe and a beaker. You will measure the amount of glucose using a Fehling's solution.

What do you need?

- Sucrose solution 3%
- Fehling's solution A (look up how to prepare this, or ask your teacher)
- Fehling's solution B (look up how to prepare this, or ask your teacher)
- a tripod with clamps and a separating funnel 100ml
  OR
- a beaker 200ml and a syringe 10ml
- two plastic measuring cylinders, 10ml and 100ml
- cotton wool
- six test tubes with a rack
- a water bath at 80°C

Getting started!

1. Code the test tubes.
2. Fill the separating funnel with the yeast beads, without water!
3. Fill a test tube with 2 ml of the sucrose solution. *This is for verification purposes.*
4. Add 100 ml of the sucrose solution to the yeast beads in the separating funnel or the beaker.
5. After 30 seconds, remove 2ml of liquid from the solution and put this in a test tube.
6. Repeat this after 1, 3, 5 and 7 minutes.
7. Add three drops of the Fehling's solution A and Fehling's solution B to each test tube.
8. Place the test tubes in the warm water bath for 10 minutes.

Questions

Question 2: What are the differences between the tubes? What does this mean?

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Question 3: Yeast breaks sucrose down into glucose and fructose. Look up the structural formula of sucrose and indicate the ‘cleavage sites’ of the yeast enzymes.