Genie in a bottle – kitchen experiment

Did you ever wonder where the small holes in bread come from? Doing a simple experiment, we can get to the bottom of this phenomenon. Using ingredients from the kitchen, you can make processes visible which happen during bread making but can usually not be observed – and by doing so you will discover a very special genie in a bottle.

MATERIALS

- 1 sachet of dried yeast
- 2 teaspoons of sugar
- 6 teaspoons of flour
- 100 ml water
- 0.75 or 1 L glass bottle (white glass without labels)
- 2 teaspoons
- 1 fork
- 1 small bowl
- 1 measuring cylinder
- 1 kitchen thermometer
- 1 kettle or pan to heat water
- 1 funnel
- 10 cm piece of sticky tape
- 1 balloon
- permanent marker to draw on balloon

PROTOCOL

1. Using the measuring cylinder, measure 100 ml of water and heat the water to 50° C. Check the temperatur using the kitchen thermometer. The water should not be above 50° C.

2. In a little bowl, mix the sachet of dried yeast, 2 teaspoons of sugar and 6 teaspoons of flour.

3. Add the 50° C-warm water to the bowl.

4. Using the fork, mix all ingredients together to make a smooth dough-like mixture. Make sure there are no clumbs left.

5. Put the funnel onto the neck of the glass bottle and pour the mixture through the funnel into the bottle.

6. Immediately, put the balloon over the bottle neck, taking care not to topple over the bottle in the process. The bottle neck should be closed airtight by the balloon.

7. Using the sticky tape, fix the neck of the balloon to the bottle neck.

8. Now watch the daugh-like mixture and the balloon closely for several minutes.
   - What kind of changes can you observe in the mixture?
   - What happens to the balloon?
   - How long does it take for the changes in the mixture and balloon to appear?
   - What could be the reason for those changes?
   - Can you already guess what causes the small holes in the bread?

9. As soon as the balloon has inflated properly, you can draw a face of your genie using the permanent marker. Take care not to topple over the bottle in the process.

Congratulations! You have brought your genie in a bottle to life!

TIP

In case the balloon inflates very slowly, you can put the bottle into a big bowl of warm water. This ensures that the water temperature inside the bottle does not drop. Use a sufficient amount of water so that the mixture in the bottle is surrounded by the water in the bowl. Take care not to topple over the big bowl or the bottle in the process.

CAUTION

You should empty the bottle as soon as the first bubbles reach the lower end of the bottle neck. Empty the bottle over the sink and take care the daugh-like mixture does not splash in your face when you remove the balloon.

WHAT HAPPENS DURING THE EXPERIMENT?

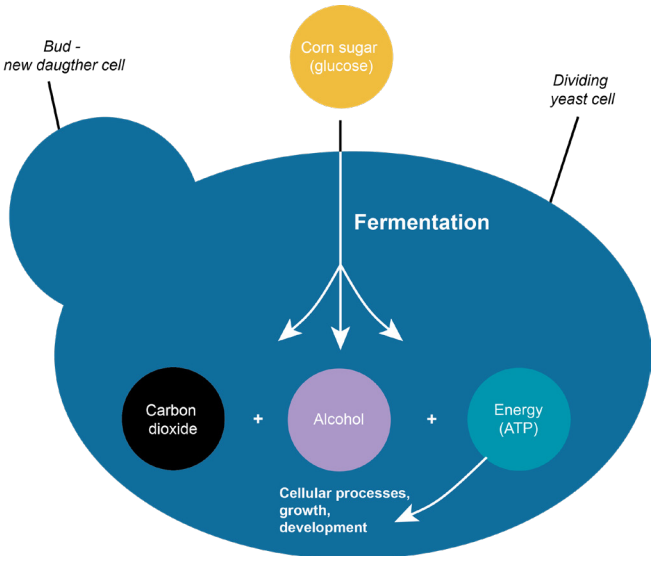
How does the genie in a bottle come about? And why are there small holes in the bread? The answers to those two questions are directly connected. Let's take a closer look at the ingredients of our experiment: sugar, flour, warm water and dried yeast.

Dried yeast sachets contain baker's yeast, also called *Saccharomyces cerevisiae* by biologists. Yeast is a living organism made of a single cell (single-celled organism). It has a round or oval shape and is between 5–10 micrometers (µm) in size, that's 5–10 millionths of a meter. You can observe the yeast cells, for example, using a light microscope, which shows the little organism in a magnified manner. Baker's yeast belongs to the family of budding yeasts. When the yeast multiplies, a small budding daughter cell develops on the dividing cell. During the multiplication process, the bud completely separates from the mother cell and becomes a new yeast cell . This is how one cell becomes two cells – biologist call this 'doubling'.

The yeast in the dried yeast sachet is not active while being stored in the sachet, you could say it's sleeping – it does not grow nor multiply. When preparing the daugh-like mixture in the experiment, the other ingredients wake up the sleeping yeast. The warm water provides a temperature at which the yeast likes to multiply. The actual optimal temperature for yeast is 30° C, but as we wanted to carry out the experiments in several minutes rather than hours, we sped up the growth of the yeast by increasing the temperature a little.

The flour provides the yeast with important substances such as nitrogen and minerals which it needs to grow and multiply. Like humans, yeast also needs energy to grow. It gets this energy by eating sugar. Inside its cell, the yeast converts the sugar into chemical energy (also called ATP), which is then used for growth and multiplication.

Did you spot the small bubbles in the daugh-like mixture during the experiment? Besides producing chemical energy during energy metabolism, the yeast cells produce two other substances: alcohol and the gas carbon dioxide. So, consuming sugar provides the yeast with energy to grow and multiply by budding. At the same time the yeast is producing carbon dioxide. The gas is responsible for the bubbles in the daugh and for blowing up the balloon to a genie in a bottle in your experiment. If you were to bake the daugh, the gas bubbles would become small holes in the bread. In this experiment you have made the energy metabolism of baker's yeast visible – a process that happens every time when you make bread.



Energy metabolism of baker's yeast. *Copyright: ELLS*

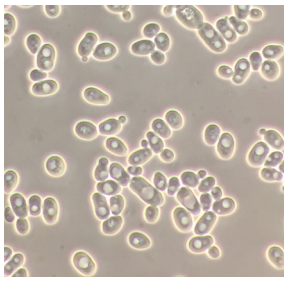


Image of baker's yeast taken by a light microscope. *Source: Pilarbini / CC BY*

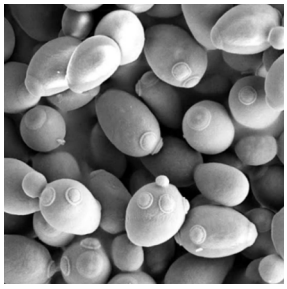
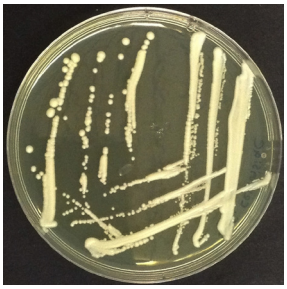


Image of baker's yeast taken by an electron microscope. You can see dividing cells with buds of new daughter cells. *Source: Mogana Das Murtey and Patchamuthu Ramasamy / CC BY-SA*



Colonies of baker's yeast on nutrient medium in lab. *Source: A doubt / CC BY-SA*

DID YOU KNOW?

Baker's yeast is not only used for making bread or beer but it's also used frequently in biological research. Baker's yeast does not need much to thrive and is easy to grow in simple laboratory conditions. As the hereditary information of baker's yeast and humans is identical by 20% and many structures inside their cells are similar to those in humans, baker's yeast is used by biologists to study important processes taking place inside of cells.

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