BREAD BONANZA

What is the role of yeast in baking bread?

What effect does kneading the dough have?

What is the difference when the dough is left to prove?

Equipment required:

Bowl

Kitchen scales

Mixing spoon

Oven

500g plain flour

2 tsp salt

7g sachet fast-action yeast

Can you explain the findings?

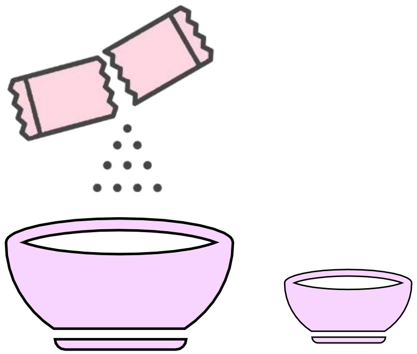
Kitchen Chemistry: Bread Bonanza

DEPARTMENT OF CHEMISTRY

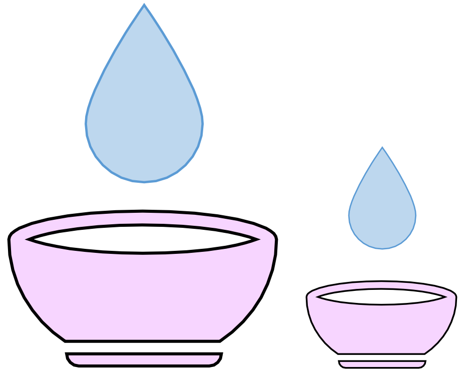
UNIVERSITY OF OXFORD

1 Pre heat the oven. Mix together flour and salt in bowl.

2 Take small portion out into separate bowl. Add yeast to large portion.

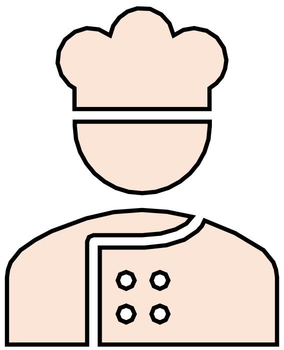


3 Add water to both mixtures to form doughs.

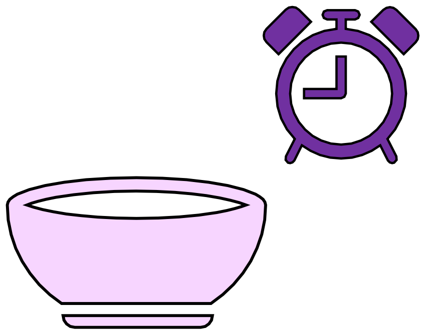


4 Remove a portion from yeast dough and put aside. Knead remaining dough for 10 minutes.

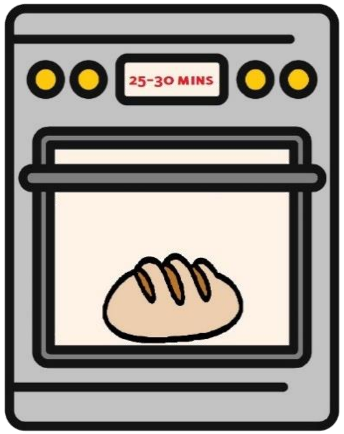
5 Remove portion of kneaded yeast dough to form a roll. Bake.



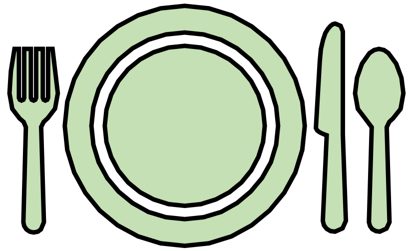
6 Leave all remaining dough to prove for 1 hour. Make note of which dough is which.



7 Form rolls from dough. BAKE! (Make a note to remember which is which).



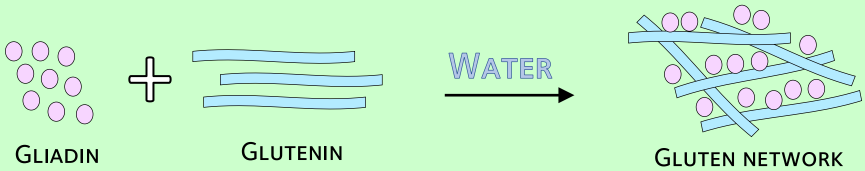
8 Taste Test!



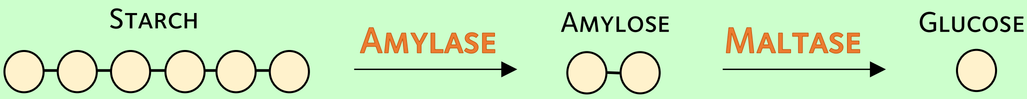
The science behind the scenes...

The chemistry behind baking bread is a fascinating story. Each ingredient and each step plays a vital role in forming what we know as bread.

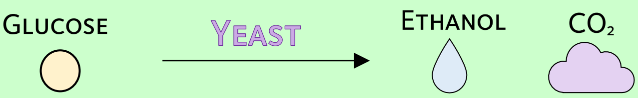
Flour contains the coiled **proteins** glutenin and gliadin. When water is added to flour, it promotes the mixing and joining of the proteins in flour to form a **"gluten network"**. The process of **kneading** aids this process by helping the proteins to uncoil and interact with each other to strengthen the gluten network.



The key to making spongy bread lies with **yeast**. Yeast contains **enzymes**, which break down **starch,** found in flour, into **glucose**. Two key enzymes found in yeast involved in the breakdown of starch are amylase and maltase:



The glucose formed is a source of food for the yeast, acting as the energy source for the yeast to **respire** (breathe). Yeast undergo a process called **anaerobic respiration** (anaerobic = without presence of oxygen). This uses glucose to form **carbon dioxide** gas (CO_2), which forms the bubbles and airy texture of bread, and ethanol by-product, which evaporates during baking. This process is known as **fermentation**.



The proving step in bread making allows time for this fermentation to occur, allowing the bread to rise by producing enough CO_2 gas.

The last step in making bread is baking in the oven. During this time, the ethanol and any water **evaporates** to produce more gases, which causes the bread to rise further. At 46 °C, the yeast die. Sugar production continues from 46-75 °C, which gives a natural sweetness to the bread.

At temperatures above 140 °C, a series of reactions called the **Maillard reactions** occur, in which sugars and amino acids (proteins) react to produce browning- which is how we get the formation of a crispy brown crust. The browning reaction also adds flavour to the bread as the reaction proceeds!

Practical investigation:

Equipment:

- ☐ Bowl
- ☐ Kitchen scales
- ☐ Oven
- ☐ Mixing spoon
- ☐ 500g plain flour
- ☐ 2 tsp salt
- ☐ 7g sachet fast-action yeast
- ☐ Water

Method:

1. Pre heat oven to 220°C/fan 200°C/gas 7.
2. Mix together 500g flour and 2 tsp salt in a bowl.
3. Take out small portion of flour mixture and transfer to a separate bowl. Add the dried yeast to the remaining flour mixture in original bowl.
4. Add tepid water (lukewarm) to both flour mixtures until a dough forms.
5. Take out a small portion of the yeasted dough and set aside. Knead the remaining dough for 10 minutes. Repeat with the yeast-less dough.
6. Take out portion of kneaded, yeasted dough, form into ball and bake straight away for 25-30 minutes, until golden brown.
7. Leave the remaining dough to prove for 1 hour. Make a note of which dough is which (yeast-less, un-kneaded, normal) to identify each dough later.
8. Roll the dough into uniform balls. Place on a baking tray, making a note of which dough is which, and bake for 25-30 minutes, until golden brown.
9. Leave bread rolls to cool.
10. Taste test! Test the four types of dough: yeast-less, un-kneaded, un-proved and normal.

Questions:

(a) What do you observe when you add water to the flour mixture?
[The flour mixture, which is dry and crumbly, comes together to make a sticky dough as the gluten network forms.]

(b) What was the effect of not adding yeast to the dough?
[Do not get rise in bread, end up with stodgy, dense roll. Yeast is crucial for the production of CO_2 gas which gives the bread its light and airy texture. Without yeast, the gas cannot be produced and the dough cannot rise.]

(c) Why do you think we knead the dough? What was the difference in the bread that had not been kneaded?
[Kneading the dough promotes the formation of the gluten network, and aids with the rising of the dough. Dough that has not been kneaded will be less airy and stodgier.]

(d) What was the effect of proving the dough?
[Proving the dough allows time for the yeast to respire and produce CO_2 gas. Dough that has not been allowed time to prove will not produce sufficient CO_2 so will not have the desired airy texture.]

(e) How does the dough change upon baking?
[The dough rises as the liquids evaporate, and the crust browns as a result of the Maillard reaction]

Challenges (stretch your knowledge) ...

(f) Why do you think the temperature of the water is important? What would happen if the water was too warm/too cold?
[Temperature affects how fast a reaction happens, so increasing the temperature the water affects the rate of gluten formation; the enzymes can digest starch faster to produce glucose.
If the temperature of the water is too high, this can kill the yeast, and can destroy the enzymes found in yeast so they cannot produce glucose (=denaturing the enzymes). As glucose is not formed, CO_2 is not produced and the bread will lack the airy texture.]

(g) Do you think the temperature at which the dough is left to prove at has an effect? Maybe next time you could try leaving dough at different temperatures to rise and determine the effect...
[Warmer temperatures increase the rate of activity of yeast, so the yeast produces CO_2 more quickly. This would result in a better rise after the 1 hour proving time, and an airier texture to the bread.]

Science isn't just useful in the lab...

One of the main things we've learnt about in bread making is the importance of the **gluten network**, which binds together the dough, provides structure, and traps the gases to create the spongy, airy texture of bread. However, not everyone can eat gluten, so what do they do?

It is estimated that around 10% of the UK population follow a **gluten-free** diet, whether by choice, due to a gluten sensitivity (have unpleasant side effects after eating gluten containing products), or as they have **coeliac disease**. Coeliac disease is a serious **auto-immune disease**. This means your **immune system** (the system in our body that protects us against viruses, bacteria and other potentially harmful cells) mistakenly think of your body cells as a threat, and so attacks them. For someone with coeliac disease, their immune system starts to attack the cells lining the **small intestine** when they eat gluten. The small intestine is responsible for absorbing nutrients out of our foods, so damaging the small intestine is harmful and means a sufferer cannot absorb essential nutrients they need for their body to function. Therefore, there is a huge need for gluten-free alternatives to all the gluten containing products we love, like bread, cakes, pastries etc. To do this, the ingredients used need to be able to **mimic** the role of gluten to make the alternative as much like the real deal as possible.

Most gluten free flours contain less proteins than the usual gluten-containing wheat flour. Proteins are involved in **binding** the dough, so **binders**, such as egg, are added to gluten-free starch flour to make the **elastic** texture. The interlocked bonds in the gluten network trap gas bubbles created. Without the gluten network, less gas will be trapped by simply replacing wheat (gluten containing) flour with starch (gluten-free) flour. So, extra **raising agents** like baking soda, which will produce more gas, is added to products in order to maintain the airy texture.

Photo citations:
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