

The Chemistry of your Breakfast

The food we eat is rarely one 'pure' compound and rarely ever an element. In this issue's Science at home we will examine the constituents of two of the components of a standard breakfast, cereal and bread.

Many breakfast cereals claim to contain enhanced levels of iron. Iron is important because it is an essential constituent of haemoglobin, the red pigment in blood. An atom of iron is contained within each of the *Haem* groups in haemoglobin and reduced levels of iron can lead to *anaemia*. Iron is also required for the class of enzymes called the *cytochromes*. Certain foods such as spinach contain high iron levels. We will conduct a simple test to indicate the presence of iron in breakfast cereal.

The bread that is also a common constituent of breakfast is mainly comprised of starch. Starch is made of long branched chains of sugar molecules. The chains are broken down by enzymes during digestion, but this happens surprisingly quickly after ingestion; in fact in the mouth, since saliva contains an enzyme called *salivary amylase* which starts the breakdown of starch into simpler sugar molecules.

Milk; the other staple of a good breakfast can be turned into cheese with a splash of orange juice; the acid in the orange juice causes a hitherto soluble protein to be rendered insoluble. The milk is changed into curds and whey, we have considered the chemistry of milk and cheese in a previous Science at home: Make Modelling Clay out of Milk.

MATERIALS

You will need:

- Breakfast cereal which claims to be high in iron;
- Two small magnets;
- Inexpensive white sliced bread;
- Milk;
- Orange juice.



HEALTH & SAFETY

There are no particular Health and safety issues connected with this experiment.

EXPERIMENT 1

Take a cupful of the cereal and grind it into a fine powder; Add one of the magnets to the dust; stir the dust with the magnet immersed;

After a few good stirs retrieve the magnet;

Observe the grains of cereal sticking to it; you can prove that they are not sticking because of moisture by using the other magnet to remove them; they should jump from one magnet to the other.

DISCUSSION

Perhaps surprisingly the form of iron that is added to cereals is elemental iron. Iron is ferromagnetic which is the most well-known type of magnetism. The other forms are paramagnetism and diamagnetism. The tiny particles of iron react with the hydrochloric acid on the stomach and become soluble Fe^{2+} ions which cross the small intestine and are then shuttled to where it's required by transferrin.

EXPERIMENT 2

Take a bite of white sliced bread and chew but do not swallow the bread. This will take some self-control. After about 5 minutes you will notice that the bread starts to taste sweeter.

DISCUSSION

Starch is the plant equivalent of human body fat. Plants use starch to store sugars which are carbohydrates. These are large chains of sugars which are insoluble in water, whereas the sugars from which they are made are soluble in water. Starch is therefore a convenient storage medium for plants. When the starch comes into contact with amylase the amylase cuts it into molecules of maltose which taste sweet.

EXPERIMENT 3

Half fill a glass with full fat milk. Add orange juice to the glass. You will notice immediately, small particles forming in the body of the liquid. The taste will also have changed, and it should have slightly cheesy overtones when drunk.

DISCUSSION

The particles that form when the orange juice is added to the milk are casein, a protein which is soluble at pH 7 (neutral) and exists in milk as the calcium salt. Casein is insoluble below pH 4.6 (acid), and the orange juice, which is a dilute solution of citric acid, makes the milk acid enough to precipitate out the casein leaving the citric acid as calcium citrate. Casein has a high molecular mass (19,000 – 24,000 depending on which form) which mean it exists as long chains, a bit like the polymers in plastics.