

Coloured Chemistry and Sour Foods



Make a coloured dye and test household materials for their acid-base chemistry

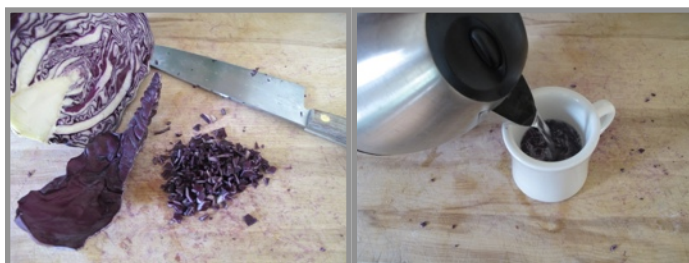
You will need:

- piece of red cabbage (included in kit)
- sharp knife and chopping board
- heat resistant small mug or bowl
- teaspoon
- white ice cube tray, or paint tray, or a white plate will suffice if you don't have these
- vinegar and baking soda (included in kit)
- other kitchen liquids and powders to test

Chop a red cabbage leaf into small pieces, and put in the mug/bowl.

Pour boiling water over the cabbage pieces.

Let the cabbage pieces soak in the hot water for half an hour or more - the longer it soaks, the darker the dye will become. Overnight will give the darkest dye.



Strain off the juice if you have a strainer, or carefully pour the juice out without the cabbage pieces. This red cabbage juice dye can be stored in the fridge for at least a week.

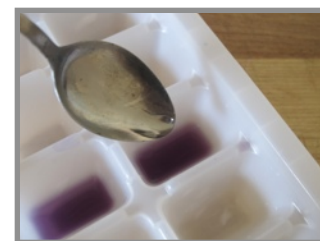
(Or you can leave it in the fridge with the cabbage pieces still in it, and the dye will get darker.)

Use the spoon to put a little red cabbage juice dye in each of a few wells of an ice cube/paint tray. If you don't have a tray, make separate puddles on a white plate (White is best for seeing dye colour.)

You will now add different substances to the different wells of the dye.

Start by adding a drop of water to the dye using this method:

Add a little water to the teaspoon then pour off the excess. The liquid that remains clinging to the spoon will be a drop - shake this off into one well of the dye.



Add a drop of vinegar to a new well of dye.

The dye will turn pink (top left in the photo).

The dye turns pink when an "acid" is added to it.

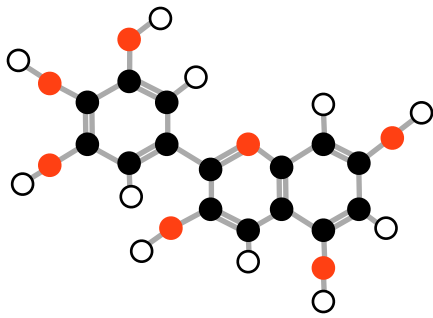
Now add a pinch of baking soda to another well of the dye. The dye will turn blue or even green (bottom left in the photo). The dye turns these colours when a "base" is added to it.

Something that is neither acid or base ("neutral") will leave the dye purple (top right in the photo).

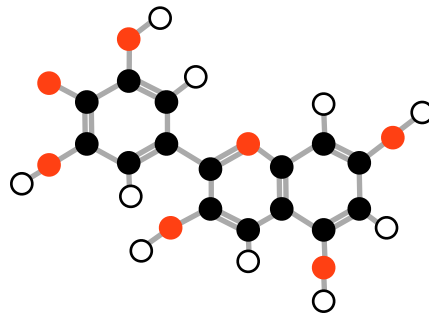
Try adding other household materials to the dye and watch for colour changes, and so find out if the materials are an acid (turns it pink), a base (turns it blue or green), or neutral (leaves it purple).

The chemistry of the dye colour

The coloured molecules in red cabbage dye are anthocyanin molecules, which can take two forms:



pink anthocyanin molecule



blue anthocyanin molecule

Key:

- carbon atom
- oxygen atom
- hydrogen atom
- bond

Can you find the difference between the two forms? (hint: look at the white hydrogen atoms)

The dye molecules move between these forms, depending on whether they are in acid or base:

Acids contain a lot of hydrogen atoms, which can attach to other molecules.

When acid (e.g. vinegar) is added to the dye, its hydrogen atoms add on to the anthocyanin molecules (at top left of the molecule, if you didn't find it already!) until most of the anthocyanin molecules are the pink form. Hence the dye becomes pink.

A base soaks up hydrogen atoms.

When a base (e.g. baking soda) is added to the dye, most of the anthocyanin molecules lose a hydrogen atom to the base, and become the blue form of the molecule. The dye turns blue.

So... depending on the amount of acid or base added to the red cabbage dye, the anthocyanin molecules are pink, blue, or a mixture of both (which looks purple).

Sour foods and acidity

This chemistry of acids and bases is also related to why some foods taste sour.

Foods that are acid taste sour i.e. foods with a lot of hydrogen atoms taste sour.

The more sour a food is, the more hydrogen atoms it will have and the more "acidic" it will be. Hence, lemon juice is more acidic than orange juice.



lemon
juice



orange
juice

Key: ○ hydrogen atom

Note: in this illustration the hydrogen atoms are magnified millions of times - they are really too small to see with the naked eye.

You can test foods for how sour they are without tasting them: just use your red cabbage dye, and the pinker the dye turns, the more sour the food is.

(One complication: some sour foods e.g. lemonade contain a lot of sugar, which masks the sour taste.)