The use of salt in cooking (2)

Introduction

Heston Blumenthal is one of the top chefs in the country – his restaurant, The Fat Duck, has three Michelin stars, the highest rating. He is noted for his scientific approach to cooking – he regularly asks the question '*why?*' rather than accepting what other chefs say, and he devises and carries out experiments to try to find answers.

Heston Blumenthal in The Fat Duck

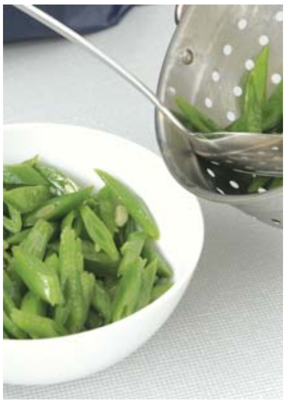
One question posed by Heston Blumenthal early in his career as a 'scientific chef' was '***Why do cooks add salt (sodium chloride) when cooking vegetables, for example green beans?***' Possible reasons suggested by cooks included:

- it keeps the beans green
- it raises the boiling point of water so the beans cook faster
- it prevents the beans going soggy
- it improves the flavour.

A scientist colleague replied that there seemed to be no good reason because:

- only the acidity and calcium content of the water affect the colour of the beans
- adding salt does increase the boiling point of water but by such a small amount that it will make no difference to cooking times
- vegetables will go soggy if cooked for too long whether salt is added or not
- very little salt is actually absorbed onto the surface of a bean during cooking – typically 1/10 000 g of salt per bean which is too little to be tasted by most people.

You are going to do an experiment to measure the concentration of salt (sodium chloride) in the water used for cooking beans before and after the cooking. This may help to confirm or otherwise the fourth point above.



Cooking with salt

Is salt absorbed by beans during cooking?

Apparatus and equipment

Your group will need:

- burette stand or retort stand, boss and clamp
- 50 cm^3 burette
- 10 cm^3 pipette
- pipette filler

Cooking with salt

- white tile
- two or three 250 cm^3 conical flasks
- 100 cm^3 beaker
- saucepan or 1 dm^3 beaker in which to cook the beans
- access to a top pan balance
- access to a cooker or other means of boiling the beans
- colander, sieve or similar for straining the beans
- 1 dm^3 measuring cylinder
- 1 dm^3 volumetric flask
- wash bottle containing deionised water.

Chemicals

Your group will need:

- 0.05 mol dm^{-3} silver nitrate solution (silver nitrate solution is dangerous to the eyes and blackens skin)
- sodium chloride – about 6 g
- potassium chromate indicator (5 g potassium chromate (toxic) dissolved in 100 cm^3 water), ideally in a dropping bottle
- fresh green beans (approximately 125 g or about 50 beans).

Safety

- Wear eye protection.
- Do not taste the beans, and ensure that after the lesson all beans are disposed of so that other students are not tempted to taste them.

Method

Weigh accurately about 6 g sodium chloride and make it up to 1.00 dm^3 with deionised water in the volumetric flask. Titrate 10.00 cm^3 portions of this solution with 0.05 mol dm^{-3} silver nitrate solution using about 10 drops of potassium chromate solution as the indicator. A white precipitate of silver chloride will form as the silver nitrate is added. The end point is when the white precipitate acquires an off-white colour (a permanent red colour shows that you have overshot the end point). Continue titrating samples until you have two titration results within 0.1 cm^3.

Now add the beans to the remaining salt solution in a saucepan or large beaker. Bring the water to the boil and simmer for about 5 minutes. Strain the beans, saving the cooking water and record the volume of water recovered. Titrate 10.00 cm^3 samples of the cooking water as before until you have two titration results within 0.1 cm^3.

Use your results to calculate the concentration of salt in the water before and after cooking. Compare the concentration of salt in the water before cooking calculated from your titration with that calculated from the mass of sodium chloride you weighed out. This will give you an estimate of how accurate your titration was.

Calculate the total mass of sodium chloride in the cooking water before and after cooking. Remember to allow for the fact that there will be less water after cooking because of the samples you removed for the original titrations and because some will have been lost by evaporation.

Do the results suggest that salt has been transferred from the cooking water to the beans?

Doing the titration

Calculation

Sodium chloride (NaCl) dissociates fully when dissolved in water:

$NaCl(s) + aq \rightarrow Na^{+}(aq) + Cl^{-}(aq)$

So measuring $[Cl^{-}(aq)]$ tells us how much sodium chloride is dissolved in the water.

The equation for the titration reaction is:

$NaCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

So the number of moles of silver nitrate is the same as the number of moles of sodium chloride.

Potassium chromate (yellow) can be used as an indicator; it goes red at the end point because of the formation of red silver chromate as soon as there are free Ag^{+} ions in the solution.

To calculate the number of moles of silver nitrate used in the titration use the equation

no. of moles = M x v/1000

where M is the concentration of the solution in mol dm^{-3} and v is the volume in cm^3.