SOFT TOUCH

Turn your lab into a chocolate factory – and turn your students on to problem solving with enzymes, says Mike Cole!

TODAY YOU WILL...

- INVESTIGATE THE FUNCTION AND USES OF THE ENZYME INVERTASE
- APPLY UNDERSTANDING OF PARTICLE THEORY
- EXPLORE A NUMBER OF 'HOW SCIENCE WORKS' LINKS

Linking key concepts to products and activities that we all tend to take for granted is always a powerful way of engaging pupils in the process of scientific exploration and discovery. In this instance, students will be asked to consider a question that may never have occurred to them before: how do confectioners get soft centres into chocolates?
Using the enzyme invertase, learners will work to create soft centred chocolates of their own, develop an understanding of 'How Science Works' – including the application of science in the 'real world' – and then compare the use of enzyme technology with more modern techniques used by the confectionary industry.
These activities could be used to reinforce or help develop an understanding of enzymes, particle theory and a range of 'How Science Works' links, and are easily tailored for a KS3 or KS4 cohort.

STARTER ACTIVITY

It probably will not take too much encouragement to get pupils thinking and talking about chocolate. To kick things off, for example, students could be asked to list a range of chocolates with both hard and softer runnier centres. From memory (or from a few samples) pupils could be asked to describe the properties of the chocolate with softer centres – hopefully remembering (or observing) that these tend to be sweeter. Ask pupils to consider how softer centred chocolates are made; particularly in relation to the likely issues involved with wrapping a runny fondant mixture within chocolate. If discussions related to enzymes are not forthcoming then you might like to prompt pupils with an example of a stiff fondant mixture (before treatment with invertase) and a runnier mixture, once invertase has acted on the sucrose substrate.
If pupils have learnt about the role of digestive enzymes in earlier topics then there are clear opportunities here to link back to this understanding. If, however, this is the first time pupils will have encountered enzymes then Activity 1 (right) may help in developing an understanding of enzyme function.

MAIN ACTIVITIES

1 MODELLING

Introduce the role of enzymes (or summarise if already covered). A molymod molecular kit, Lego, or similar plastic blocks could be used to demonstrate enzymatic reactions. Reference to the invertase enzyme and visual demonstration of its effect on breaking down sucrose in to two smaller molecules of glucose and fructose could be used. It can be useful to refer back to the starter activity and ask pupils how this reaction could help explain properties of the softer runnier fondant.

MAIN ACTIVITIES

2 INVESTIGATING

Invertase is an enzyme derived from yeast, and it is used by confectioners to catalyse the breakdown of sugar (sucrose) by hydrolysis into fructose and glucose. The products are usually produced with a more syrupy texture than the original sucrose. The optimum temperature of invertase is 60C, and it has an optimum pH of 4.5. Therefore noticeable effects in consistency of the sugar (fondant) mixture at room temperature may take a couple of weeks to develop.

Prepare sugar fondant mixture by boiling 800g of sugar (sucrose) in 200 ml of water. Continue to stir the mixture as it cools. The end product should be quite a stiff mixture, but one that can be pushed into moulds of various shapes and sizes. An alternative way to produce a 'fondant' is simply to make use of sugar cubes, allthough of course this means that you will be restricted in the shape of the sweet you make.

For each class demonstration or practical activity the fondants should be split into two groups – control and treatment group. Add two or three drops of invertase enzyme (use food quality invertase if you'd like pupils to eat the chocolates) to each of the fondants in the treatment group, and 2-3 drops of water to each fondant in the control group. Fondant can now be covered in chocolate by adding each to a bowl of melted chocolate (skewers or cocktail sticks can help handle the fondants when dipping). Place chocolates onto a non-stick surface such as foil or grease proof paper.

You may prefer to leave out the chocolate stage. In which case, control and treatment group fondants could simply be added to test tubes or small beakers. The chocolates should be stored in a cool area of the room and within one to two weeks a difference in consistency between the control and treatment groups of fondants should be noticeable.

Pupils may wish to explore the effects of temperature on the time it takes for changes in fondant consistency to occur. Room temperature, fridge and freezer temperatures could be investigated for their effects on invertase activity.

Discussion should be encouraged to link findings and observations from this investigation to pupils' knowledge of the optimum temperature of the enzyme.

Safety

The sugar fondant should be made and cooled in advance of the lesson. A water bath could be used melt beakers of chocolate. To avoid any potential allergic reactions to invertase pupils should avoid contact with skin and eyes. Rubber gloves and safety goggles should be worn.

If you would like pupils to eat the chocolates at the end of the investigation then food quality ingredients should be used, with food safe equipment and within a food safe environment, and strict hygiene guidelines followed.

HOME LEARNING

Pupils could be asked to:
> Explore the function of the enzymes within the human body – particularly the digestive system.
> Explore a number of commercially important uses of enzymes and be prepared to present findings to the rest of the class.
> Develop their own model to communicate the way in which enzymes function

4 PRESENTING

Explain to students that they will be producing a scientific poster, in groups, outlining the aim of their investigations in activity 2, their chosen methods, results and conclusions. Pupils should be encouraged to represent as visually as possible the enzyme reaction – you might like to revisit activity 1, and use models as a stimulus, before learners get started.

Before embarking on this activity pupils may also need to be reminded of the differences between a scientific and a display poster; reference could be made to an example of each type, and pupils encouraged in small groups to highlight the differences they observe.

On completion of the finished posters, each group of pupils should present their poster to the rest of the class, and answer questions relating to validity of study, and repeatability of their findings – what is meant by 'softness' or 'runniness', for example, and how could this be measured scientifically?

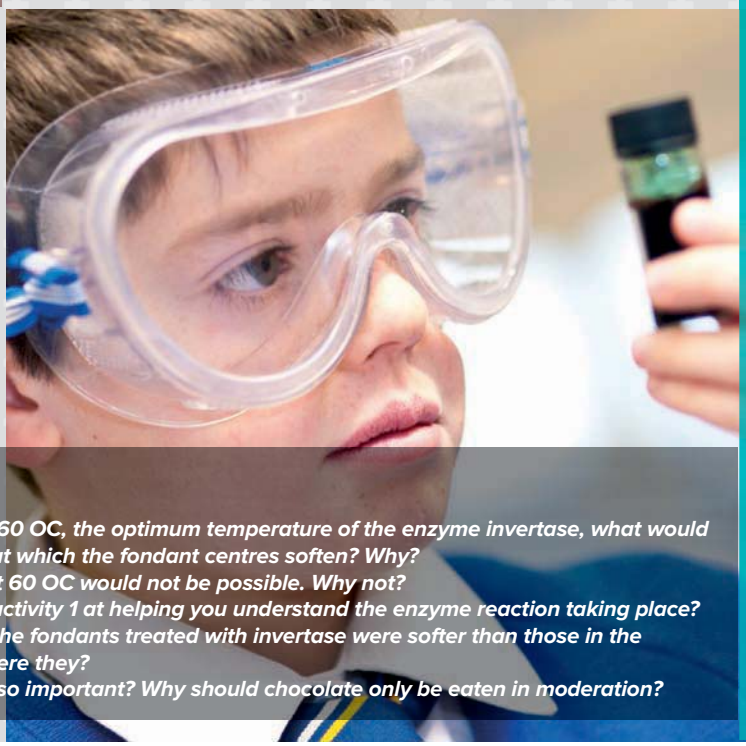
5 DEBATING

Encourage pupils to consider some of the issues surrounding eating too much chocolate. Reference to library resources, or internet searches could be used for useful sources of information.

If students discover articles that have been published extolling the virtues and health benefits of eating chocolate, careful unpacking and analysis of these articles will be important – even when scientific evidence is offered in support of any such claims. It will be important to make clear to pupils the problems associated with an unbalanced diet, such as one too rich in sugar and chocolate.

3 RESEARCHING

Pupils could be encouraged to investigate the history of the use of enzymes in confectionary, and compare this with more modern techniques such as freezing or chilling the fondant before adding to pre-cast chocolate shells. Discuss the advantageous and disadvantages of each of the techniques – drawing on knowledge of enzymes and particle theory.



SUMMARY

Q If chocolates could be stored at 60 OC, the optimum temperature of the enzyme invertase, what would you expect to happen to the time at which the fondant centres soften? Why?
Q In practice, storing chocolates at 60 OC would not be possible. Why not?
Q How useful were the models in activity 1 at helping you understand the enzyme reaction taking place?
Q How could you be so sure that the fondants treated with invertase were softer than those in the control group? How much softer were they?
Q Why is food safety and hygiene so important? Why should chocolate only be eaten in moderation?

INFO BAR

+ ADDITIONAL RESOURCES

+ YOUTUBE.COM/WATCH?V=N3IDAR249CE

NHS.UK/NEWS/2011/09SEPTEMBER/PAGES/DARK-CHOCOLATE-AND-FITNESS.ASPX

+ STRETCH THEM FURTHER

MORE ABLE PUPILS COULD BE ENCOURAGED TO DISCUSS THE FOLLOWING SCENARIOS:

+ IT CAN TAKE APPROXIMATELY TWO WEEKS AT ROOM TEMPERATURE, USING THE ENZYME INVERTASE FOR THE FONDANT CENTRE TO SOFTEN. EMMA WOULD LIKE TO SPEED THIS PROCESS UP BUT IS AWARE SHE CANNOT STORE CHOCOLATE AT 60°C, THE OPTIMUM TEMPERATURE FOR INVERTASE. INSTEAD SHE HAS SELECTED A DIFFERENT ENZYME, WHICH HAS AN OPTIMUM TEMPERATURE CLOSER TO ROOM TEMPERATURE. CAN YOU EXPLAIN WHY A LOWER OPTIMUM TEMPERATURE WOULD BE ADVANTAGEOUS? IS EMMA'S METHOD LIKELY TO SPEED UP THE PROCESS OF FONDANT SOFTENING? EXPLAIN YOUR REASONING.

+ DAVID HAS BEEN ASKED TO INVESTIGATE FACTORS, OTHER THAN TEMPERATURE, THAT COULD INFLUENCE THE TIME IT TAKES FOR THE FONDANT CENTRE TO SOFTEN. UNFORTUNATELY HE IS HAVING DIFFICULTY THINKING WHAT THESE OTHER FACTORS MIGHT BE. CAN YOU HELP HIM OUT? WHAT OTHER FACTORS MAY INFLUENCE THE TIME IT TAKES FOR THE ENZYME INVERTASE TO SOFTEN THE FONDANT CENTRE OF CHOCOLATES? HOW MIGHT THE EFFECT OF THESE FACTORS BE INVESTIGATED?

+ ABOUT THE EXPERT

Mike Cole has a background in secondary science education, and more recently in teacher education as a professional development leader in secondary science.