

Introduction

Chocolate is a datalogging investigation activity. It is set in the context of helping the McChocs company to make better quality dark chocolate. Pupils investigate a new way to crystallise liquid chocolate. Checking the quality of chocolate means accurately measuring its melting point – better chocolate is harder to melt. For this, pupils use temperature sensors and datalogging. This could also allow pupils to explore the ‘melting curves’ for chocolate. They present their findings, with a scientific explanation in terms of particles, to the company directors.

Running the activities**Preliminary Activity**

Introduce the context. Ideally, get pupils’ interest by having them taste McChocs dark made by the standard method - cooling quickly to freeze/crystallise it. They could compare its taste and texture with a premium chocolate such as Lindt (see technician notes). However, this must be done without compromising lab safety. You might wish to use the OHT at the end of these notes to explain how chocolate is made. This could be used to reinforce pupils understanding of the process of melting and solidifying. Pupils should be encouraged to start to using the particle theory to explain what is happening.

Some questions for pupils to discuss

- Where else have they seen crystals?
- Is all chocolate solid?
- Is it easy to say whether chocolate is solid or liquid?
- How large are the crystals in chocolate are.

Pupils then read through worksheet and answer some basic questions about melting and how they could measure melting points. Please note that the crystals pictured are not chocolate crystals – we couldn’t find any.

Demonstration

You then demonstrate how pupils can measure the melting point of chocolate. By first cooling liquid chocolate supplied by the technician until it solidifies. By putting a temperature sensor in tube as it cools, the chocolate can solidifies around it – ready for the melting point quality test.

Experiment

Pupils then make a ‘different’ type of chocolate using a method, called tempering (similar to the one real chocolate makers use) which is more involved. And use the same procedure to measure the melting point. If the datalogging equipment can be connected to a computer then pupils can also produce graphs of the process. You could remind the how cooling curves show the process of melting - substances have different curves, with different melting temperatures. Here they are doing the reverse experiment – a melting curve. However, for reasons described below, the melting may not be as well defined as with a simpler substance like stearic acid.

When chocolate solidifies, it is the fat (cocoa butter) that crystallises. The crystals exist in several forms – each with a different melting point. If chocolate is solidified quickly old method it ends up mostly as crystals which melt at 25-29°C This creates poor chocolate – McChocs, which melts in the hand. When chocolate is tempered (the ‘new method’) it produces a different crystal form, version V, which melt at 34-35°C. You find this form in good quality chocolate. It just about melts in your mouth, but does not melt in your hand.

The theory of tempering is complicated– it involves understanding ‘supercooling’ and rates. However, for information: cooling to 25°C enables crystallisation to begin (a slow process). Heating to 30°C melts the form of crystals you don’t want. In final cooling, ‘higher quality’ crystals form much faster (the amount of ‘supercooling’ is greater). The final product is almost all this form. An ideal way to finish off would be to taste ‘new’ McChocs dark (the technician’s notes contains instructions), and compare it chocolate made by the old method.

More Ideas

- Look at the cooling curve of wax and how the melting point is related to the burning of a candle.
- Take a video tour of a chocolate factory, at http://cxn.exploratorium.edu/choc_tour.ram (requires plug-in real player).
- You could consider doing this as a joint project with food technology, which would make it easier to taste the chocolate. You could also use this lesson as the basis of a longer investigation into the melting points of different chocolates – milk chocolate should have a lower melting point than dark chocolate.

A useful background paper on the materials science of chocolate can be found at:

<http://www.mrs.org/membership/preview/dec2000bull/Fryer.pdf>

And on manufacturing chocolate

http://www.fmnh.org/Chocolate/making_intro.html

Learning outcomes

- Use particle model to explain change of state
- Relate change of state to energy

(Sc1: investigations)

- Interpret line graphs and measurements to draw conclusions
- Make measurements using ICT (datalogging)

Prior learning

It will help if pupils:

- Can describe differences between solids, liquids and gases
- Know about the particle model of matter

Where the activity fits in

QCA unit 8l *Heating and cooling*

Skills

- ICT: Datalogging and power point to produce a presentation
- Numeracy: Plotting graphs (if not done by computer)

Cocoa beans



Fermenting, roasting crushing
and heating of beans to make
a paste



Beans put under pressure to
separate into coca butter and
cocoa powder



Adding sugar and more
cocoa butter to make liquid
chocolate



Cooling the liquid chocolate
to 20°C until it solidifies