theme: leisure & lifestyle

job:
Emma Snead, Assistant General Manager, Fudges Bakery

activity outline

In the video Emma talks about the process of making biscuits – from sourcing ingredients to packaging. In this activity, pupils test different types of packaging materials. They conduct an experiment to see which materials provide the best barrier to water vapour (keeping the biscuits fresh).

You will need one lesson to set up the experiment and to discuss the underlying science. Pupils then need subsequent lessons to record results.

It is suggested that pupils work alone, although they could work in small groups or pairs. For a wider range of results (and, therefore, more meaningful comparisons) it would help if different pupils were able to test different packaging materials.

The pupil sheet provides an introduction, step-by-step instructions, a results table to complete and some questions to help pupils compare results.

Teacher notes overview

1 Curriculum links: where this activity can fit with the 2008 KS3 Programme of Study and Scottish 5-14 Science Curriculum.

2 The Video: providing a synopsis of the video content and ideas for viewing.

3 The Practical: including Equipment lists, Health and safety notes, a Possible approach (a comprehensive, suggested way of planning the lessons) and an Underlying science section (providing detailed information about the various scientific principles involved).

4 Possible extensions: suggestions for other practical activities using the video, or extending the suggested activity.

5 Associated jobs: guidance on how to deliver a plenary activity (or, if you wish, a stand-alone activity) focusing on the video interviewee, including a photo of the interviewee to place at the centre of a spider diagram.
This lesson can be used to help teach part of the 2008 Key Stage 3 Programme of Study (England and Wales):

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<th>Range and Content:</th>
<th>Key Processes:</th>
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<tbody>
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<td>3.2a</td>
<td>2.1a, 2.1c, 2.2a, 2.2b, 2.3</td>
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<td><strong>Attainment Targets:</strong></td>
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<td>AT1, AT3</td>
<td>4a, c, e, k</td>
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<td><strong>Key Concepts:</strong></td>
<td></td>
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<tr>
<td>1.1b, 1.2a, 1.4</td>
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</tbody>
</table>

This lesson can be used to help teach part of the Scottish 5-14 Science Curriculum:

**Main curricular links**

E&S2 Materials from Earth

**Attainment Targets**

**Knowledge & understanding:**

**Level B**
- make observations of differences in the properties of common materials
- relate uses of everyday materials to properties

**Investigating skills:**

**Level D**
- make an appropriate series of accurate measurements
- draw conclusions consistent with the results
Synopsis of the video

Among other things, Emma makes these interesting points:

- She’s “done her time” in a laboratory plating up samples and testing calorific content of food – now she’s happy in a management role.
- Hygiene levels in a factory are very strict.
- The baking process involves sourcing ingredients, measuring, rolling, cooking and packing.
- There are lots of other food-related jobs, such as the various companies that audit the bakery on an annual basis to check food products meet legal standards.

Watching the video

There are a number of things you might do before showing the video to your class.

1. Preview the video and write a few quick-fire questions. Then you can tell your class that they will be tested on their observation when it’s finished. This is an excellent way of encouraging them to pay attention!

2. Ask pupils to watch the video through once. Then ask them to generate one question that could be answered from the video and one question they would like to ask but the video did not answer. These questions are then exchanged with another pupil and the video is watched a second time. This gives pupils an opportunity to focus on something they may have missed first time, and provides a basis for discussion on what was learnt from the video, and what additional information is needed.

3. Ask pupils what sort of person might become the manager of a food factory. Does anyone in the class think they’d like to work with food? When the video has been watched, ask the questions again. Has anyone changed their mind/opinions?

4. Ask pupils to spot the science in the clip.
the practical

Equipment

(per pupil/pair/group)

- 2 x biscuits of approx equal size, from a freshly-opened packet (*rich tea* type biscuits work well)
- Petri dish (to be used as two halves)
- Sheet of packaging material (large enough to cover Petri dish and be sealed to underside)
- Adhesive tape
- 100 cm\(^3\) beaker
- Plastic box with lid (to hold two halves of Petri dish + beaker)
- Access to top-pan balance weighing to 0.01 g

Between them, the class should use a variety of packaging materials, including PVC and polypropylene film, and others such as:

- Wrapping paper
- Thin card (as used for packaging)
- Thin polythene (disposable sandwich bag)
- Thicker polythene (freezer bag)
- Cling film*
- Cellophane (regenerated cellulose film)
- Actual biscuit wrapping (preferably of an identifiable polymer)
- Petri dish lid

* Note: Cling film may be PE (polythene), PVC or PVdC (polyvinylidene chloride). The first is more permeable to water vapour than the other two.

Health and safety

- Pupils should already be aware of the *no eating in laboratories* rule.

- They should also be warned not to take biscuits for eating elsewhere, since equipment with which they have been in contact could be contaminated.
The video shows Emma Snead, Assistant General Manager at Fudges Bakery. Among other things, she briefly explains the process of baking biscuits – from sourcing ingredients to packaging.

Biscuits must remain crisp between baking and consumption. This requires packaging that prevents, or at least minimises, absorption of moisture from the atmosphere.

Pupils compare the effectiveness of various packaging materials as barriers to water vapour. [Use of the term permeability is left to teachers’ discretion.]

Pupils should be allocated different packaging materials to test. The range of materials should be such that each material is used by as many pupils/groups as possible, to allow for variability in results.

Pupils should set up the boxes and place them where they can remain undisturbed for a week, but accessible for weighing during subsequent lessons. A warm place will help speed up absorption.

The remainder of the lesson can be used to discuss the underlying science, and the significance of such investigations to food manufacturers such as Fudges. Larger manufacturers are likely to perform their own tests on packaging. Smaller ones will rely on other testers, but almost all packaging will have been tested to ensure that it is fit for purpose.

Discussion can be widened to food packaging in general. For instance:

- **What purposes does it serve, besides excluding water vapour?**
  Some pupils may think that if water vapour can get through, then germs may be able to also. Simple explanations in terms of the relative size of water molecules, bacteria and gaps between polymer molecules should suffice.

- **So, what other types of testing need to be done?**

- **Critics claim there is too much packaging. Which bits serve a useful purpose, and which could be removed without affecting product quality? Which bits are recyclable?**

In subsequent lessons, pupils reweigh the dishes and replace them in the box. The dishes should be weighed after a day and then the following week.

After one week, pupils calculate the percentage increase in mass, collect data from other groups and create a bar chart to compare the effectiveness of each packaging material.

Discuss what the charts show and guide pupils to decide which is the most effective packaging for excluding water vapour.

[Note: If appropriate, readings could be entered into a spreadsheet, and graphs displayed for discussion.]

For environmental reasons, Fudges switched from using PVC film to polypropylene (PP). Discuss

- whether pupils’ results show that PP is significantly better or worse at excluding water vapour;

- what other factors Fudges are likely to have considered before switching to PP.

Point out that exclusion of water vapour is also the reason why biscuits should be kept in an air-tight container once the packet is opened.
Underlying science: Basic principles

Flow from high concentration to low
- Moist foods, like bread, dry out by losing moisture to the air
- Dry foods, like biscuits, absorb moisture from the air

[The dishes are placed in a closed box with a beaker of water to increase the humidity of the air, in order to speed up the uptake of water by the biscuits.]

Water uptake and retention
- Sugar and salt are hygroscopic, so the higher their content in the biscuit, the higher the water uptake
- The close/dense structure of biscuits draws moisture absorbed at the surface in towards the centre by capillary attraction – in contrast to the open structure of bread, with a large surface area from which evaporation occurs.

Note: If Extension Investigation 3 below is to be undertaken, postpone discussion of this aspect until afterwards.

Size matters
- Plastics are waterproof to liquid water (in bulk), but not to water vapour. Individual vapour molecules are tiny enough to pass through thin plastic films.
- The gaps between polymer molecules depend on the polymer. So some plastics let water vapour through more easily than others.
- For biscuit packaging, the plastics film must let through little or no water vapour.

[Permeability is not mentioned in the pupils’ instructions. Introduce it in discussions, if appropriate.]

Measurement and recording
- Water uptake will be a fraction of a gram, so careful weighing to 0.01g is essential.
- Pupils should know how to check that the balance is correctly zeroed, and whether to adjust it or call the teacher if it is not.
- Some pupils may need help to ensure that readings are recorded in the correct cells of the table.
- Making the experiment a fair test
- Pupils are asked to suggest what factors affect water uptake by the biscuits. Guide them towards realising that film thickness is important and, therefore, their results are not strictly comparable if the thicknesses differ.

Results for different thicknesses of polythene bags and PE clingfilm should illustrate this.
- Brighter pupils should suggest that the larger the piece of biscuit the more it will absorb, so that is why they had to calculate the increase as a percentage of the initial mass
- or use biscuits of equal mass.
### Underlying science: Polymer nomenclature

At this level it is probably best to use familiar common names for plastics. Chemical names and synonyms are shown below.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Chemical name</th>
<th>Other names</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>polythene</td>
<td>poly(ethene)</td>
<td>polyethylene</td>
<td>PE</td>
</tr>
<tr>
<td>polypropylene</td>
<td>poly(propene)</td>
<td>polypropene</td>
<td>PP</td>
</tr>
<tr>
<td>PVC</td>
<td>poly(chloroethene)</td>
<td>polyvinylchloride</td>
<td>PVC</td>
</tr>
<tr>
<td>polyvinylidene chloride</td>
<td>poly(1,1-dichloroethene)</td>
<td></td>
<td>PVDc</td>
</tr>
<tr>
<td>polystyrene</td>
<td>poly(phenylethene)</td>
<td></td>
<td>PS</td>
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</tbody>
</table>
Possible extensions

1. **Why do biscuits need to be prevented from absorbing moisture?**

   Devise methods to compare the brittleness (or conversely, bendability) of freshly unwrapped biscuits with those that have been left open to the air for various lengths of time – say, from 1 hour up to 1 week.

2. **How much water can a biscuit absorb?**

   Devise methods to measure the amount of water a biscuit can absorb before it becomes semi-liquid and starts to slide apart. Is there much variation between different types of biscuit? Does the water temperature make a difference?

   This has relevance to dunking biscuits in a drink without it falling apart and part of it sinking.

   Why doesn’t the biscuit go this soggy if just left open to the air?

3. **Comparing different types of biscuit**

   Repeat the tests with different types of biscuit. Relate results to the biscuits’ ingredients and texture. Thus deduce what factors cause the differences in water uptake.

4. **What’s in a name?**

   Bis-cuit is French for *twice-cooked*. Investigate whether biscuits are really cooked twice and, if so, why. What is the science involved? Answer for teachers: The first stage is the actual cooking, where chemicals in the ingredients react to form the substances in the final biscuit. These include partially dehydrated starches and sugars, which give the golden brown colour.

   The second *cooking* is really a slow drying out at lower temperature, followed by a gradual cooling. Just as with glass-working, cooling too rapidly sets up tensions which make the biscuit more brittle, and susceptible to breakage. It has been suggested that this is the reason for finding broken biscuits at the ends of a packet – the end biscuits having cooled more rapidly than those packed together in the rest of the packet. The validity of this theory depends on at what stage the biscuits are packed.
A STEM (Science, Technology, Engineering and Maths) education provides pupils with skills and knowledge that are useful in all sorts of careers. The video demonstrates how Emma, Assistant Manager of Fudges Bakery, uses such skills on a daily basis.

Emma works with numerous people – some directly, some indirectly. Some use STEM skills, others don’t. By exploring this network of associated jobs, pupils will, hopefully, begin to see that even those in non-STEM jobs will find STEM skills useful – if they’re communicating with someone “in-STEM”, for example, some knowledge of their work will be a great help.

Emma’s spider diagram

Try placing Emma at the centre of a spider diagram (we’ve provided a photo of Emma which you could use – overleaf). You could either create worksheets for pupils to complete themselves, or create the diagram on your whiteboard and then pool ideas.

Ask pupils: “who does Emma work with”. They may draw information from the video – we see numerous factory workers, and Emma talks about people auditing the factory for example – or they may come up with new ideas, such as the people who provide the ingredients, people who make ovens and other equipment, or health and safety inspectors. Other, less obvious, suggestions might include representatives from their customers (before we filmed, someone from Harrod’s had just paid a visit) or graphic designers – all packaging has to meet the Fudge’s brand.

Now ask pupils which of those jobs are clearly “in-STEM”. Who else might find some STEM skills helpful? Why?

You could extend this by taking any one of the associated jobs and placing them at the centre of a spider diagram, and starting the process again.
Emma Snead, Assistant General Manager, Fudges Bakery

Studying science and maths can transform your career options. Future Morph: become someone.