

A Tasty Profit

You can use the pupils' experimental results to deliver the next project. A tasty profit? Students use the data they have collected to work out the profit that might be made by popping and selling popcorn in the cinema. They are also asked to consider other costs which might be incurred by the retailer.

The following is a worked example of the calculation. If pupils don't know how much items cost, they can be encouraged to guess. The following are approximate figures:-

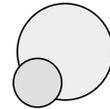
Cost of bag of cinema popcorn is £3.10 = 310 p

Volume of bag is 2 litres = 2000 cm³

Cost per cm³ = Cost of whole bag ÷ volume of bag = 310 ÷ 2000 = 0.155 p/cm³

Cost of bag of unpopped supermarket popcorn = 55 p

Volume of bag = 0.5 litres = 500 cm³



Using the results from the experiment:

If each 1 cm³ of unpopped maize produces 15 cm³ of popcorn, then 500 cm³ of unpopped maize will produce 500 × 15 = 7500 cm³ of popcorn.

Profit = (selling price of popped corn × volume sold) — (original price of supermarket bag)
= (0.155 × 7500) — 55
= 1107.5 p
= £11.08

Answers will depend on volumes obtained during the experiments.

Other costs that will affect the producer's final profit include transport costs, maintaining hygiene standards, overheads in cinema including rent, staffing, heating, equipment, lighting also advertising, toppings, wastage, cost of oil packaging etc. The students may come up with many more.

Extension Activities

You might like to encourage students to look for maize (often called corn) in ingredients lists on food packaging.

Both maize starch, derived from the endosperm, and maize oil, from the embryo, are used in food products.

Some examples include:

Maize oil — cooking oils.

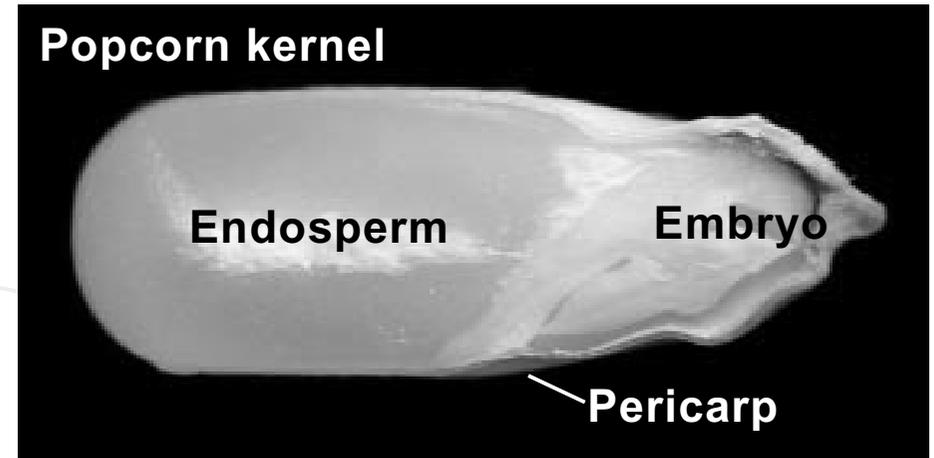
Maize starch — custard powder, maize derived snacks, tortillas.

Other uses for starch — as a biodegradable alternative to polystyrene packaging, to produce the gloss on magazines and as bulking agents in medicines.



Explaining the Popcorn Explosion

The explosion of hard kernels of sorghum to produce a light, foamy, protein-rich product has been investigated at the Institute of Food Research as part of a project to investigate the digestibility of this important African staple food. By using a high powered electron microscope, we are able to look at the factors that are important to the production of good-quality popcorn.



The maize kernel consists of the embryo (from which the new plant develops) and the endosperm. The cells of the endosperm contain both starch and protein. These are needed for the early growth of the embryo during germination. When we eat products made from endosperm flour, our bodies digest some of this starch and protein.

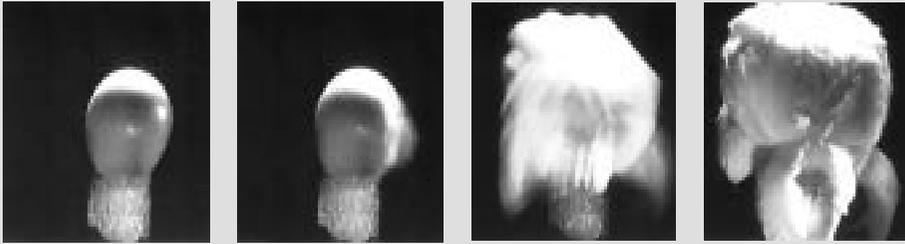
Glossary

Pericarp — outer casing of the kernel, derived from the ovary wall.

Embryo — early stage of the developing plant.

Endosperm — energy store for the growing plant during germination.

Kernel — the grain of a cereal consisting of the seed in a hard pericarp.



What is so special about popcorn?

You can't pop just any kind of maize. There are lots of different varieties which are used for canning, freezing, eating off the cob or feeding to animals. You can only pop specific varieties because the explosion relies on particular features of the maize.

In this experiment you will look at what makes popcorn pop. You will be using four types of maize:

- Hydrated popcorn maize
(maize which has absorbed extra water)
- Maize that is used for feeding animals
- Broken popcorn maize
(maize which has been damaged)
- Normal popcorn maize

It's a squeeze

In raw popcorn kernels, the starch granules in the endosperm are packed tightly together and the small protein bodies completely fill up the spaces between them. This tight packing is the first requirement for good popcorn. Varieties of maize with loosely packed starch granules do not pop.

A strong case

The strength of the casing around the kernel, the pericarp, is the second important factor in good popcorn maize. When we pop corn, we heat the kernels to a high temperature in a popcorn maker or a saucepan with the lid on. The pericarp must be strong enough to resist the high pressure which builds up in the kernel as it is heated. If the pericarp is weak or damaged, the pressure within the kernel would be released gradually rather than building up to an explosion.

H₂O

Good quality popcorn maize should contain about 14% water. In the centre of each tightly packed starch granule is a small hole. As the popcorn kernel is heated, water begins to vaporise, filling the hole with steam and softening the starch. Unlike a boiling kettle of water where the steam escapes out of the spout, in popcorn, the steam is trapped inside the starch granules and so the pressure starts to build up in the kernel. The temperature increases to 180°C and the pressure reaches 9 atmospheres (similar to the pressure inside a steam engine). At this point the kernel is ready to burst.

Ready to burst

Suddenly the pericarp yields to the pressure and splits, allowing each softened starch granule to be inflated by the steam inside it, like lots of tiny balloons suddenly being blown up. The contents of the kernel burst out of the pericarp and within milliseconds the hot kernel is turned into a flowing white foam, which quickly sets as it cools. The foam appears white because it contains thousands of tiny air bubbles, rather like clear egg white which becomes white when beaten.

You are going to pop samples of maize and compare the results you get from different types. You are going to measure the volume of popped maize in each case and look for any differences.

1. What equipment will you need?

2. What do you predict will happen?

3. Briefly describe what you are going to do.

4. Why is it important to know the change in volume per cm³?

5. What comparisons can you make? What is your control?

A Tasty Profit

Having popped some maize yourself you will have noticed that there is a large change in volume of the maize during popping. Using the results from your experiments, together with some additional information, you can work out the profit that might be made by buying raw popcorn and selling it popped at the cinema.

Results

	Hydrated Popcorn	Broken Popcorn	Animal feed Maize	Normal Popcorn
Initial Visual Observations				
Initial Volume				
Final Visual Observations				
Final Volume				
Change in volume (Final volume ÷ Initial volume)				
Change in volume per cm ³ (Change in volume ÷ Initial volume)				

6. From your experiments, explain what you think are the most important factors for maximising popcorn volume?

7. How could you make your experiment more accurate next time?

Additional Information

1. How much does a bag of popcorn at the cinema cost?

p

2. What is the approximate volume of the bag?

cm³

3. How much does popcorn at the cinema cost per cm³?

(cost of whole bag ÷ volume of bag)

p/cm³

4. How much does a bag of unpopped maize cost at the supermarket?

p

5. What is the approximate volume of the bag?

cm³

Using your results for the normal popcorn from your experiment:

6. What volume of popcorn can you make from 1 cm³ of unpopped maize?

7. What volume of popcorn could you make from the entire original supermarket bag?

8. What profit could you make if you sold all the maize from the supermarket bag as popped maize at the cinema?

(selling price of popped maize x volume sold) — (original price of supermarket bag)

9. Food products are usually produced on a much larger scale. Can you work out the profits you would make if you started with the following volumes of unpopped maize?

A. 10000 cm³ B. 1 m³ C. 1.5 m³

10. What is the catch? If it is this easy to make money on popcorn, wouldn't we all be doing it? What other costs will affect the producer's final profit?

