P2. Food preservation

Pupils store frozen peas with a variety of preservatives in order to investigate their effects.

KS3
science and food technology

Timing - 15 minutes *to set up apparatus;*
tubes to be left at least 24 hours.
Two Pupil activity P2 sheets (plus optional table sheet) accompany this activity.

SAFTEY NOTES:

SOME ASTHMATICS ARE VERY SUSCEPTIBLE TO SULPHUR DIOXIDE VAPOURS; THE SODIUM META BISULPHITE SOLUTION MUST BE PREPARED BY A TEACHER OR TECHNICIAN.

SODIUM NITRITE SOLUTION IS TOXIC; WEAR GLOVES WHEN HANDLING THE CONTAINER AND TRANSFERRING THE LIQUID. ALL THE SOLUTIONS MUST BE PREPARED BY A TEACHER OR TECHNICIAN.

THE TUBES MUST NOT BE OPENED BY THE PUPILS.

THE TUBES SHOULD BE DISPOSED OF BY AUTOCLAVING.

A table for results is provided (third page of P2) for those pupils unable to design one easily.

Peas are used here merely as an *easily available medium*. Alternatively, you could try cooked rice, cooked and pulped apple or cooked and pulped tomato. None of these foods are ever preserved by the methods investigated in this practical; in commercial food processing they are either dried, canned or frozen.

After 24 hours the liquid in tubes C and E should already have gone cloudy (check this). It is possible to stop the experiment at this point. Leaving the tubes for 72 hours merely increases the cloudiness of these two tubes. Leaving the tubes for a week will show the growth of mould. You may like to prepare such a tube a week before it is needed.

Tube G tends to look green as the colour is removed from the peas.

Answers to questions on Pupil sheet P2:

1. Tube 2 should show more signs of spoilage than tube A. Tube A was at a lower temperature and thus microbial growth is slowed down.

2. Salt solution, vinegar, sodium nitrate solution and sulphur dioxide solution act as preservatives. The liquid in these tubes remain clear. After 24 hours the liquids in tubes C and E go cloudy; this shows the presence of fungal (mould) growth.

   Note: peas in the acidic vinegar and dilute sulphur dioxide solution have discoloured. In alkali the colours would have been much brighter (see C1 *It looks good enough to eat!*, page 55). As preservation methods may well alter the natural colour of foods, certain foods have colours added to them after processing.

Requirements

- *test tubes or boiling tubes*
- *marker pens or labels*
- *distilled water*
- *salt solution - 20 g of sodium chloride in 100 cm^3 of distilled water*
- *sugar solution - 10 g sucrose in 100 cm^3 of distilled water*
- *vinegar*
- *sodium nitrite solution - 0.1M maximum concentration*
- *sodium metabisulphite - to give a dilute solution of sulphur dioxide use 2 g in 100 cm^3 of water*
- *goggles*
- *cotton wool*
- *frozen peas*
- *forceps*
- *access to a refrigerator (not one where food for consumption is stored)*

3. Strong salt solution removes, by osmosis, the water necessary for microbial growth.

   Vinegar is acidic; microbial growth is retarded at pH below 4.5; at certain concentrations acetic acid is bactericidal.

   Sodium nitrite and sulphur dioxide both kill microbes. Sodium nitrite is particularly important for inhibiting the growth of *Clostridium botulinum* (the bacterium responsible for botulism) in meat products. Its level is strictly controlled in food products.

4. Salt imparts a particularly strong flavour which would be undesirable for many products and tastes.

5. The most obvious are fruits and vegetables in jams, marmalades and pickles.

6. Sodium nitrite (E250) is used mainly for preserving meat products.

7. Sulphur dioxide (E220) is used to preserve soft fruits and alcoholic beverages.

8. Drying removes the water necessary for microbial growth.

   Freezing places microbes at a low enough temperature to slow down and sometimes completely stop microbial growth. It is important to remember that low temperatures do not kill microbes and that the normal processes of decay will begin as soon as the food is warmed up.

In canning, food is heated to a temperature at which microbes are killed. The cans are then sealed to prevent the entry of new microbes.

Further investigations

Some of the following suggestions may be suitable for the assessment of Sc1 skills. The last two may be homeworks or projects.

a. High salt concentrations are effective preservatives. However, pupils will realise that this may produce unpalatable results and the lowest concentration which still gives some preserving power may be desirable. A range of concentrations between 0 and 20% could be investigated. If pupils have some scientific knowledge of osmosis, then this could be an investigation suitable for a complete Sc1 investigation.

b. Sugar, when used in high enough concentrations, can act as a preservative because it binds (i.e. inactivates) the water necessary for microbial growth. This fact is used in jams, etc. Pupils could design a similar experiment to the original which investigates concentrations of sugar above 10%.

c. Artificial sweeteners do not have osmotic activity and hence are not capable of copying the preserving properties of sugar. A simple investigation similar to the original one with peas may show this. You may like to use visking tubing to demonstrate that osmotic activity is indeed absent. The labels from diabetic (low sugar) jams may be used to help point out that these products do not have keeping qualities as good as traditional jams.

d. KS3 pupils should use sodium nitrite solution with a maximum concentration of 0.1M. Keeping this constant and adding salt to other tests will find out whether salt does enhance the performance. A range of salt concentrations could be investigated.

e. Cook a few slices of raw apple for about 10 minutes in plenty of water. When cool rub through some muslin or a sieve or liquidise to produce a smooth pulp. This can then be used to see if the addition of cloves prevents the apple from going off.

f. Most households will have food stocks which are preserved by a variety of methods. A lot of information can be gained as to the keeping qualities of these products.

g. Louis Pasteur developed the process which now bears his name when he was approached by the wine producers of France. Many producers were finding that wine was turning into vinegar and hence the wine became an unacceptable product. The solution to the problem was to heat the wine to a temperature of around 60 °C which killed the majority of the microbes responsible for the spoilage. Pasteur was responsible for saving the French wine industry.

The pasteurisation process is applied to milk. The most common method is to heat milk to 72 °C , for not less than 15 seconds. After treatment, the milk is rapidly cooled.

The heat treatment kills most microbes but does not alter the flavour of the milk. Milk which is heated to a high enough temperature to sterilise it, results in a flavour that is not to the liking of the majority of consumers.

We have a constant demand for safe and nutritious food. However, most production of raw food, such as fruit and vegetables, is seasonal. There are times of the year when such food is plentiful and other times when certain foods are scarce.

Food may have to be transported over large distances from the site of production to the places where it is to be eaten. Imported food may travel thousands of miles over several days before it reaches our tables.

We have been developing methods of food preservation for thousands of years. Preserving meat using the smoke from wood fires was probably one of the earliest methods as was drying food in the sun. Irradiation is often thought of as the preservation method of the future.

Preservatives are food additives which are numbered from E200 to E283 (you may find some antioxidants here as well). They are chemicals which destroy or slow down the growth of bacteria and fungi.

There are many traditional ways of preserving food. You will probably be familiar with most of these.

In this investigation you will be looking at some ways of preserving food.

SAFETY NOTE

SODIUM NITRITE SOLUTION IS POISONOUS; USE WITH EXTREME CARE AND WEAR GLOVES.
SULPHUR DIOXIDE SOLUTION IS HARMFUL; USE WITH EXTREME CARE.
ASTHMATICS MAY BE SENSITIVE TO SULPHUR DIOXIDE.
WEAR GOGGLES WHEN USING THE SOLUTIONS.

Method

1. Label eight test tubes A - H. Put your initials and the date on each tube.
2. Use forceps to put three peas (these were frozen peas) in each test tube.
3. Treat the tubes and the peas in the following ways:

   Tube A - add nothing to this tube

   Tube B - add nothing to this tube

   Tube C - half fill with distilled water

   Tube D - half fill with a strong salt solution

   Tube E - half fill with a strong sugar solution

   Tube F - half fill with vinegar (this is acetic acid (E260))

   Tube G - half fill with sodium nitrite solution (E250)

   Tube H - half fill with a dilute sulphur dioxide solution (E220)
4. Put a cotton wool bung in each tube.
5. Put tube A in the refrigerator.
6. Leave tubes B - H in a warm place until next lesson.

Results

1. Construct a results table into which you will be able to put your observations from each tube. You will be looking at what has happened to both the peas and the liquid. You will need to decide whether the peas look different to normal. A cloudy liquid shows that mould is beginning to grow.
2. Look at the peas and the liquid in each tube after 24 hours and 72 hours. You may also like to leave the tubes for a week and then examine them again.

Questions

1. Compare tubes A and B. What differences are there? How can you explain these differences?
2. Which of the solutions used in tubes C - H act as preservatives? How were you able to tell this?
3. Why are these solutions able to act as preservatives? You will have to do some research to find this out. Your teacher may discuss this with you.
4. A very strong salt solution may act as a very good preservative. Why might it be an unsuitable preservative for some foods?
5. What sort of foods are preserved using a strong sugar solution?
6. What sort of foods are preserved using sodium nitrite?
7. What sort of foods are preserved using sulphur dioxide?
8. Other methods of preservation include drying, freezing and canning. Explain how these processes prevent food from going bad.

Suggestions for further investigations

a. Design an experiment to find out the lowest concentration of salt solution which will stop a particular food from going bad in a particular length of time.

b. Design an experiment to find out at what concentration sugar will act as a preservative.

c. Sugar is being replaced in some food situations by artificial sweeteners. Do these sweeteners have similar preserving properties to sugar? Design an experiment to find out.

d. It has been suggested that the antimicrobial action of sodium nitrite can be enhanced (made even better) by the presence of salt. Design an experiment to investigate this.

e. Design an experiment to find out whether cloves added to cooked apple pulp have a preservative effect or not.

f. Make a survey of the sorts of foods you and your friends have at home. What methods of food preservation are used? For how long will the different foods using the different methods of preservation stay fresh?

g. One of the most important methods of food preservation is pasteurisation. Find out the history behind this method and the details involved in its modern day usage.

Results - after 24 hours

Tube	What do the peas look like?	What does the liquid look like?
A **in refrigerator**		
B **room temperature**		
C **distilled water**		
D **salt solution**		
E **sugar solution**		
F **vinegar**		
G **sodium nitrite solution**		
H **sulphur dioxide solution**		