

Food tests

Investigate the use of chemical reagents to identify starch, reducing sugars, proteins and fats

For Edexcel GCSE Biology 1BIO and Combined Science 1SC0. **Triple only** This practical is not in Combined Science. Teacher answers start on a new page.

Name

Date

Aim

To use chemical reagents to test foods for starch, reducing sugars, protein and fat.

Background

Foods contain different biological molecules: carbohydrates (starch and sugars), proteins and lipids (fats and oils). Each can be identified with a chemical reagent that gives a colour change or other visible change when the molecule is present.

Iodine solution tests for **starch**. **Benedict's solution** tests for **reducing sugars** such as glucose. **Biuret reagent** tests for **protein**. The **ethanol emulsion test** tests for **fats** (lipids).

A test only works if the reagent can mix with the food, so solid foods are first crushed and mixed with water (or ethanol for the fat test). A **negative result** is when the reagent stays its original colour, so it is important to know the start colour as well as the positive result.

A control, such as distilled water, shows what a negative result looks like and shows that the reagents are not contaminated.

Equipment

- Food samples such as potato, milk, egg white solution, glucose solution and vegetable oil
- Distilled water (for the negative control)
- Iodine solution in a dropper bottle
- Benedict's solution
- Biuret reagent
- Ethanol (about 2 cm³ per test)
- Test tubes (at least 5 per food, because the fat test uses two) and a test tube rack
- 250 cm³ beaker for a water bath, with a kettle or electric heater, and a thermometer
- Dropping pipettes
- Spotting tile (optional, for the iodine test)
- Mortar and pestle or a glass rod, and a spatula, for crushing solids
- Marker pen for labelling
- Eye protection

Risk assessment

Hazard	Risk	Precaution
Ethanol	Highly flammable. Can irritate the eyes.	Keep away from naked flames and the heater. Use small volumes (about 2 cm ³ per test), keep the bottle closed when not in use and wear eye protection.
Hot water bath	Scalds and burns. Water can spill.	Heat the water before the practical. Do not heat tubes directly over a flame. Keep the bath away from the table edge and clear up spills at once.
Biuret reagent (contains sodium hydroxide)	Irritates eyes and skin. May be corrosive to eyes.	Wear eye protection. Wash splashes from skin with plenty of water. Tell the teacher at once if any goes in the eye.
Benedict's solution	Low hazard, but can irritate the eyes. A heated tube can spit hot liquid.	Wear eye protection. Heat only in a water bath, with the mouth of the tube pointing away from people. Do not taste any of the materials.
Iodine solution	Irritates eyes and skin and stains skin and clothes.	Wear eye protection. Wipe up spills at once.
Food allergens (such as milk, egg or nuts)	Allergic reactions.	Check for known allergies before choosing foods. Do not eat or taste anything in the laboratory.

Method

1. Put on eye protection. Half-fill a 250 cm³ beaker with hot water from a kettle and set it on a heatproof mat. Use a thermometer and top up with hot water to keep it at about 80 °C. This is the water bath.
2. Prepare the food samples. Crush solid foods (such as potato) in a mortar with a little distilled water, then use the liquid. Label one set of four tubes for each food.
3. Starch test: put about 2 cm³ of the food sample in a tube and add 3 drops of iodine solution. Record the colour. A positive result is orange-brown to blue-black.
4. Reducing sugar test: put about 2 cm³ of the food sample in a tube and add about 2 cm³ of Benedict's solution. Stand the tube in the water bath at about 80 °C for 5 minutes. Record the colour.
5. A positive result for reducing sugar is blue turning to green, yellow, orange or brick-red. The more sugar present, the further along the colour sequence the result goes.
6. Protein test: put about 2 cm³ of the food sample in a tube. Add about 2 cm³ of biuret reagent and shake gently to mix. Leave for a minute and record the colour. A positive result is blue turning to purple (lilac). (If your school uses two biuret solutions, add sodium hydroxide solution first and then a few drops of copper sulfate solution.)
7. Fat test: put about 2 cm³ of ethanol and a small amount of the food (for example 2 drops of oil, or crushed food) into a dry tube. Shake the tube well so that any fat dissolves.
8. Pour the ethanol mixture into a second tube containing about 2 cm³ of distilled water. Record whether a cloudy white emulsion forms (positive) or the liquid stays clear (negative).

- 9 . Repeat all four tests using distilled water in place of the food sample, to show what a negative result looks like.
- 10 . Repeat all four tests for each of the other foods, using clean tubes and clean pipettes each time.
- 11 . Record the results in a table, writing the colour of each tube at the end of the test.
- 12 . Use the results to decide which biological molecules are present in each food.
- 13 . Pour the used solutions down the sink with plenty of water, or as your teacher instructs, and wash your hands.

Results

Results of food tests (write the colour or observation in each box)				
Food sample	Starch (iodine)	Reducing sugar (Benedict's)	Protein (biuret)	Fat (ethanol emulsion)
Distilled water (control)				
Potato				
Glucose solution				
Egg white solution				
Vegetable oil				
Milk				

Exam questions 10 questions · 27 marks

- 1** State the positive result for the starch test and the reagent used. [2 marks]

- 2** Describe how you would test a food sample for reducing sugars. [3 marks]

- 3** In the test for reducing sugars, the tubes are heated in a hot water bath and not over a Bunsen burner flame. Suggest two reasons for this. [2 marks]

- 4** A student tested two foods, X and Y. The results are shown in the table. Identify the biological molecules present in each food. **[4 marks]**

Results of food tests				
Food	Iodine solution	Benedict's solution (after heating)	Biuret reagent	Ethanol then water
X	Orange-brown	Brick-red	Purple	Clear
Y	Blue-black	Blue	Blue	Cloudy white emulsion

- 5** Describe how you would test a sample of food for fat using ethanol. **[2 marks]**

- 6** A student repeated each of the tests using distilled water in place of the food. Explain why. **[2 marks]**

- 7** Ethanol is used in the test for fats. State two safety precautions that should be taken when using ethanol. **[2 marks]**

- 8** A student added Benedict's solution to fruit juice, heated it and the mixture turned brick-red. The student concluded that the juice contains glucose. Explain why this conclusion is not valid. **[2 marks]**

Teacher answers

Core practical 3: Food tests. The example results are practice data, not real measurements.

Example results

Example results (practice data)				
Food sample	Starch (iodine)	Reducing sugar (Benedict's)	Protein (biuret)	Fat (ethanol emulsion)
Distilled water (control)	Orange-brown	Blue	Blue	Clear
Potato	Blue-black	Blue	Blue	Clear
Glucose solution	Orange-brown	Brick-red	Blue	Clear
Egg white solution	Orange-brown	Blue	Purple	Clear
Vegetable oil	Orange-brown	Blue	Blue	Cloudy white emulsion
Milk	Orange-brown	Orange	Purple	Slightly cloudy white emulsion

Conclusion

Potato contains starch. Glucose solution contains a reducing sugar. Egg white solution contains protein. Vegetable oil contains fat. Milk contains reducing sugar (lactose), protein and fat, but not starch. The distilled water control kept the original colour of every reagent (iodine orange-brown, Benedict's and biuret blue, ethanol mixture clear), which shows the reagents were not contaminated and that the colour changes in the other tubes were caused by the food. The Benedict's test is only semi-quantitative: milk gave orange and the glucose solution gave brick-red, which suggests the milk contains less reducing sugar than the glucose solution.

Errors and improvements

Error	Effect on the results	Improvement
Using the wrong amount of reagent or sample, or not mixing properly.	A weak positive result can be missed, or the colour is hard to judge.	Measure volumes with a pipette or syringe and mix every tube in the same way.
Not heating Benedict's mixtures long enough, or in water that has cooled too much.	A positive result for reducing sugar may be missed, or the colour is nearer the start of the sequence than it should be, so the amount of sugar is underestimated.	Check with a thermometer that the water bath stays at about 80 °C and heat every tube for the same time (5 minutes).
Dirty tubes or pipettes carry over traces of another food or reagent.	False positive results, for example a trace of starch in the next tube.	Use clean equipment for each test and clean pipettes between samples.
Judging colour by eye (subjective), particularly the Benedict's colours green, yellow, orange.	Different people may record different colours, so the estimate of sugar quantity is not reliable.	Compare with colour standards made from known sugar concentrations, or use a colorimeter.
A solid food is not crushed enough, or not dissolved before testing.	The reagent cannot reach the molecules, which could cause a false negative.	Crush the food with water in a mortar and use the liquid, or filter it.

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [2]

- iodine solution (1) allow iodine; do not accept iodide
- orange-brown to blue-black (1) allow yellow-brown / brown for the start colour; allow black / dark blue for the end colour

2. [3]

- add Benedict's solution to the sample (1) allow Benedict's reagent
- heat in a (hot) water bath (1) allow heat to about 80 °C / for a few minutes; do not accept heating directly over a flame
- positive result: blue turns to green, yellow, orange or brick-red (1) the change must be from blue

3. [2]

- the contents could boil over / spit out of the tube (1)
- the water bath keeps the temperature controlled / heats evenly (1)
- reduces the risk of burns / of the tube cracking (1)
- Max 2

4. [4]

- X contains reducing sugar (1)
- X contains protein (1)
- Y contains starch (1)
- Y contains fat / lipid (1)
- Deduct 1 mark for each molecule named that is not present (minimum 0)

5. [2]

- shake / mix the food with ethanol, then pour the ethanol (layer) into water (1) allow add water to the ethanol mixture
- positive result: a cloudy white emulsion forms (1) allow milky emulsion; ignore 'turns white' alone

6. [2]

- to show what a negative result looks like / the original colour of the reagent (1)
- to show that the reagent or equipment is not contaminated / that the colour change is caused by the food (1)

7. [2]

- keep away from naked flames / heat sources (1) ignore 'it is flammable' alone
- use only small volumes / wear eye protection / keep the lid on the bottle (1)

8. [2]

- Benedict's solution shows only that a reducing sugar is present (1)
- it could be another reducing sugar / fructose / maltose, so the test does not identify glucose (1)

9. [2]

- so the molecules are in solution / the molecules are released from the food (1)
- so that the reagent can mix and react with them (1)

10. [6]

Level 3 5-6	A clear description of all four tests with the correct reagent, the method (including heating for Benedict's solution) and the correct positive result for each. Safety or preparation of the sample may be mentioned.
Level 2 3-4	Three tests described, or all four with some errors or missing detail (for example no heating, or a positive result missing).
Level 1 1-2	One or two tests, or the reagents named with little detail.

Indicative content

- crush the food with water and make a solution / suspension; starch: add iodine solution, orange-brown to blue-black; reducing sugars: add Benedict's solution and heat in a water bath (about 80 °C), blue to green/yellow/orange/brick-red; protein: add biuret reagent, blue to purple (lilac); fat: shake with ethanol then pour into water, cloudy white emulsion; negative results leave the reagent its original colour; use a distilled water control; eye protection, and ethanol kept away from flames.

Exam tips

- Learn the start colour as well as the positive colour: iodine is orange-brown, Benedict's and biuret are blue, and the ethanol mixture is clear.
- For Benedict's solution, always say heat in a water bath. Without heating there is no colour change, so you lose the mark.
- Write colour changes as 'from ... to ...'. For example 'blue to brick-red', not just 'red'.
- The ethanol test result is a cloudy white emulsion. Do not say it turns white or milky without saying it is an emulsion.
- Say 'reducing sugar' and not just 'sugar' for the Benedict's test. Not all sugars give a positive result.