Immobilising enzymes

Transcript

The enzyme lactase is used in industry to make lactose-free products for people with lactose intolerance.

The enzyme breaks down lactose into glucose and galactose.

To do this on a large scale, lactase is immobilised by fixing it on small beads that are packed into a reaction vessel. The resulting product is not contaminated with the enzyme, allowing for a continuous processing of the milk. It is possible to model this process in a school laboratory.

The enzyme beads are made by added an enzyme-alginate soltion drop-by-drop to calcium chloride.

Alginate is a polysaccharide that becomes a gel when it comes into contact with calcium ions. The enzyme-alginate drops harden to form spherical beads in which the enzyme is fixed.

The enzyme-alginate mixture is drawn into a syringe.

Small drops of the mixture are carefully squeezed into a beaker containing calcium chloride solution.

About 30–40 beads are produced and left to harden in the solution. This takes about 10 minutes.

Once hardened, the beads are rinsed thoroughly with distilled water to remove calcium chloride from their surface.

A small piece of nylon gauze is placed inside the base of a syringe barrel. This prevents the beads from blocking the outlet and enables the milk to run through.

The beads are carefully placed inside the syringe barrel using a spatula. They should not be packed too tightly as the milk will need to flow between them.

A piece of rubber tubing is attached firmly to the bottom of the syringe outlet. This will allow the milk to run out of the barrel after passing through the beads.

A Hoffman clip is then attached to the rubber tubing just underneath the outlet of the syringe, and tightened to its maximum extent.

A small volume of milk that has been warmed to 40° degrees Celsius, is carefully poured into the syringe barrel. It should completely cover the beads.

The beads and milk are left for 5 minutes, during which time the enzyme has an opportunity to digest its substrate.

The Hoffman clip is slowly unfastened, which allows the milk to leave the syringe barrel and drip slowly through the rubber tubing into the beaker.

To determine if the enzyme-controlled reaction has taken place, the milk in the beaker is tested for the presence of glucose, which is one of the products of lactose digestion.

A sample of milk that has not come into contact with lactase also needs to be tested as a control. Comparing the colour obtained on each dipstick with the manufacturer's chart, will indicate whether lactose digestion has been successful.

Here, it can be clearly seen that while untreated milk tests negative for the presence of glucose, the milk collected in the beaker contains glucose, suggesting that lactase has broken down some of the lactose.

This experiment shows that lactase can be successfully immobilised in beads without preventing it from working. In industry, this allows the continuous processing of lactose in milk into simple sugars to produce lactose-free products.

The productivity of many enzyme-controlled reactions can be enhanced in this way, which improves efficiency in industry and manufacturing.