PRACTICAL BIOTECHNOLOGY

Better milk for cats

LACTASE ENZYME catalyses the hydrolysis of lactose (milk sugar) to glucose and galactose. Both of these sugars taste sweeter than lactose and are more readily-digestible than them. Despite their traditional liking for milk, cats are unable to digest large amounts of lactose. Milk can be treated with the enzyme to make a lactose-reduced milk suitable for cats or humans who are lactose intolerant. Although the production of a special 'cat milk' may seem trivial, an estimated 75% of the world's population are intolerant of lactose in adulthood — so the potential scale of this problem is very great.

Commercially, the milk is treated by injecting enzyme into the carton as UHT milk is packaged, or by using an immobilised enzyme — an enzyme which has been trapped on an inert material so that it can be used repeatedly.

In this activity, students immobilise the lactase in calcium alginate beads held within a small column, over which the milk is passed.

Materials

Lactase enzyme, Novo Nordisk *Lactozym*®, 2 cm^3 (available from the NCBE)
2% sodium alginate solution, 8 cm^3
1.5% calcium chloride solution, 100 cm^3
Milk, 50 cm^3 (not UHT)
Semi-quantitative diabetic glucose test strips e.g. Boehringer Mannheim *Diabur-Test*®*5000* or Ames *Diastix*
Small piece (about 1 cm^2) of nylon gauze e.g. net curtain
10 cm^3 plastic syringe (without a needle)
4 mm diameter aquarium airline tubing to fit syringe, about 10 cm in length
Aquarium airline tap or adjustable laboratory tubing clip (Hoffman clip)
Retort stand, boss and clamp (to support enzyme column)
Small beakers (e.g. 100 cm^3) or disposable plastic cups, 2
Tea strainer

Practical details

All solutions *must* be made up using distilled or deionised water (calcium ions in tap water will cause the sodium alginate to 'set').

Sodium alginate is not readily soluble, and requires both warm water and stirring to dissolve it. Have patience — it will dissolve!

Immobilise the enzyme by mixing it first with the sodium alginate solution, then adding it a drop at a time from the syringe to the calcium chloride solution. Do not allow the tip of the syringe to come into contact with the calcium chloride solution. The beads, which contain the enzyme immobilised in a matrix of calcium alginate, should be allowed to harden for a few minutes before separating them from the liquid with the tea strainer.

The accompanying worksheet shows how to set up the immobilised enzyme column using a syringe barrel. It is important to use a small piece of nylon gauze inside the barrel, as the beads are just the right size to block the syringe outlet.

Glucose may be detected in the whey leaving the column after a few minutes using the glucose test strips.

Safety

This practical work may be carried out in a food preparation area if clean equipment reserved exclusively for food use is employed. In such circumstances, the liquid leaving the column may be tasted if food grade reagents have been used. (Novo Nordisk *Lactozym*® is a food-grade enzyme.)

Lactase is a relatively safe enzyme (it is produced naturally by babies to digest their mother's milk). However, unnecessary contact with the enzyme or inhalation of dust from dried-up enzyme spills should be avoided. In case of spillage or contact with the eyes, rinse by flushing with water.

Further activities

The immobilised enzyme column may also be used to treat whey, producing a sweet whey syrup, which is widely used in confectionery (it is usually described on labels as 'hydrolysed whey syrup' or just 'whey syrup').

Lactase (or β-galactosidase) is strongly inhibited by galactose (one of the prodcts of its action on lactose). Hence the flow rate of the substrate over the column is critical to the rate of the enzyme-catalysed reaction: too fast and there isn't time for the reaction to occur; too slow a rate and galactose will accumulate and then inhibit the reaction. Students can therefore investigate the effect of flow rate on the conversion of lactose to glucose and galactose.

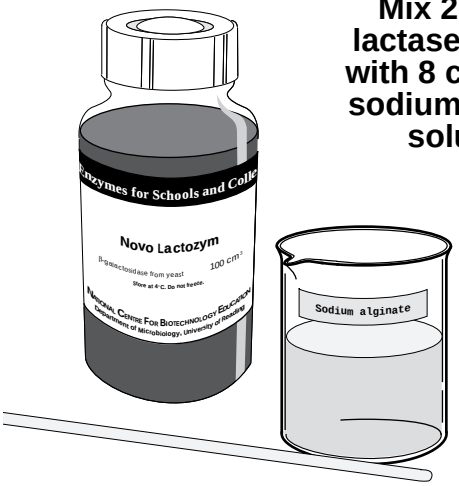
Additional Information

Enzymes in industry and medicine by Gordon Bickerstaff (1987) Edward Arnold (New Studies in Biology). ISBN: 0 7131 2935 2.

Whey National Dairy Council information sheet, available from the National Dairy Council, 5–7 John Prince's Street, London, W1M 0AP.

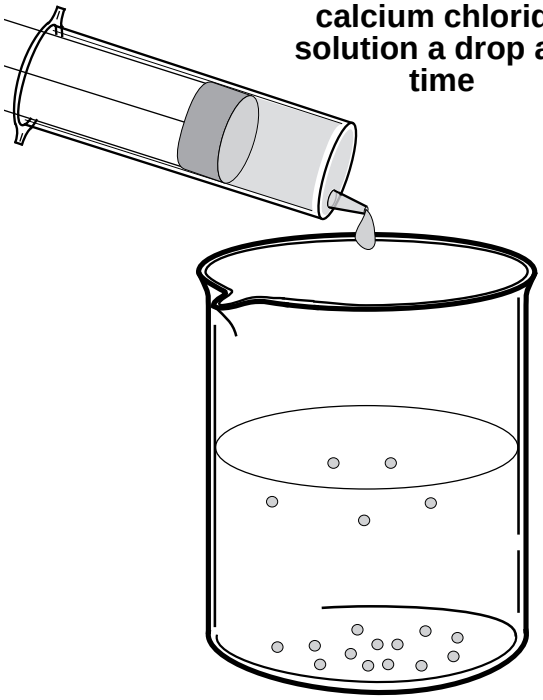
Making a better milk for cats

1



Mix 2 cm³ of lactase enzyme with 8 cm³ of 2% sodium alginate solution

2



Add the alginate / enzyme mixture to 1.5 % calcium chloride solution a drop at a time

Allow the beads to set for a few minutes

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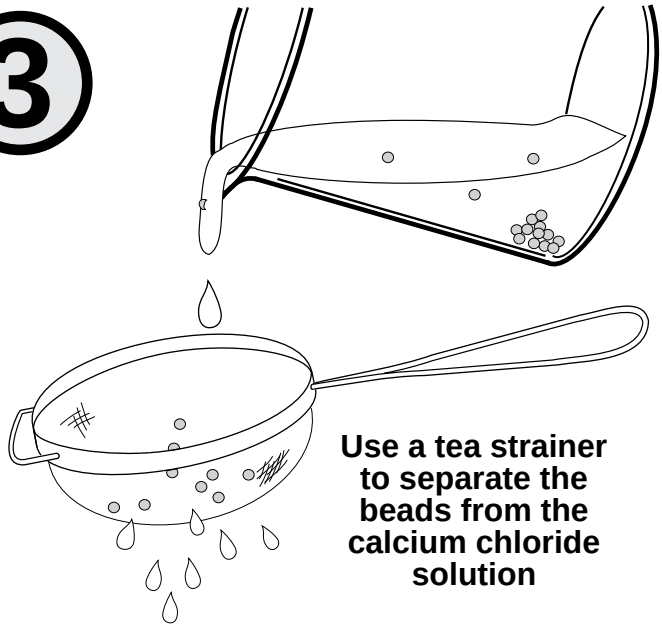

Use a tea strainer to separate the beads from the calcium chloride solution

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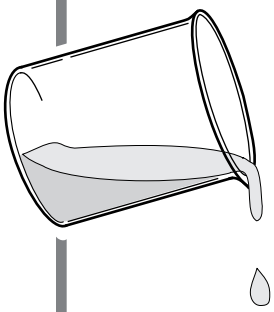
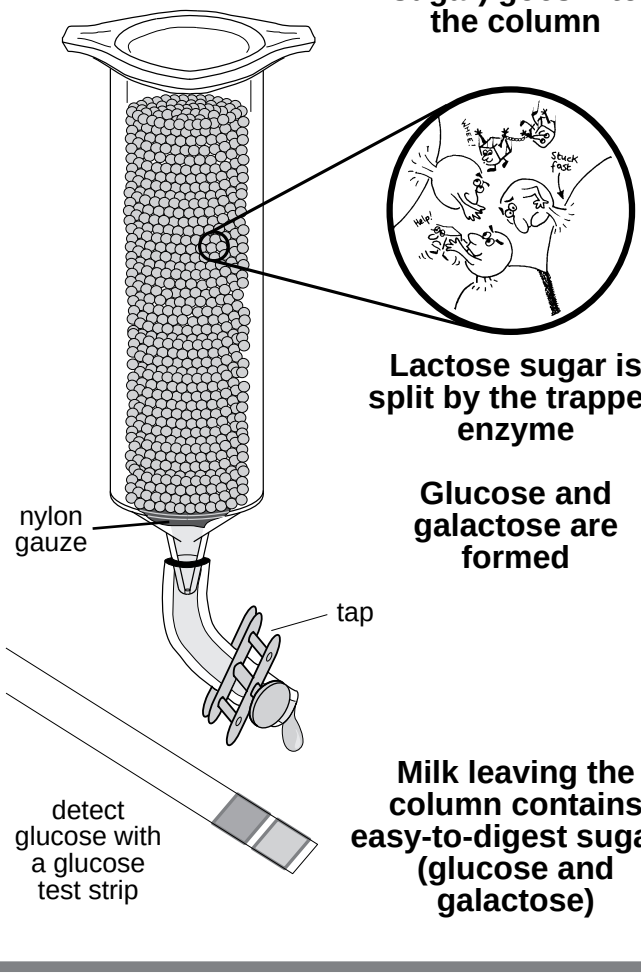


Pack the beads into a column made from a syringe barrel

Ordinary milk (containing lactose sugar) goes into the column



Lactose sugar is split by the trapped enzyme

Glucose and galactose are formed

Milk leaving the column contains easy-to-digest sugars (glucose and galactose)