Using whey's polluting power

Disposing of whey — the liquid remaining after removal of butterfat and casein from milk — is a headache for the dairy products industry. Australian cheese and casein factories produce about 1600 million litres of the stuff each year, but there's little use for it other than as a pig feed.

To date, such factories have got rid of some 40 % of their whey by dumping it on land, or discharging it into water-courses or the sewer. But this approach is becoming less and less acceptable, yet at the same time the industry is producing more and more.

Whey contains protein, lactose (a sugar), appreciable amounts of non-protein nitrogen-containing compounds, mineral salts, and vitamins. Its contents of organic compounds is so high that its pollution potential is about 100 times greater than that of municipal sewage. Indeed, the 1600 million litres produced each year has the polluting capacity of the discharge from a city of about 2 million people — nearly as big as Melbourne.

A single cheese factory may produce 120 000 litres of whey per day, which contain a pollution load equivalent to the discharge of a town of about 50 000 people. So, if located in a country town, the factory may produce more effluent than the town itself.

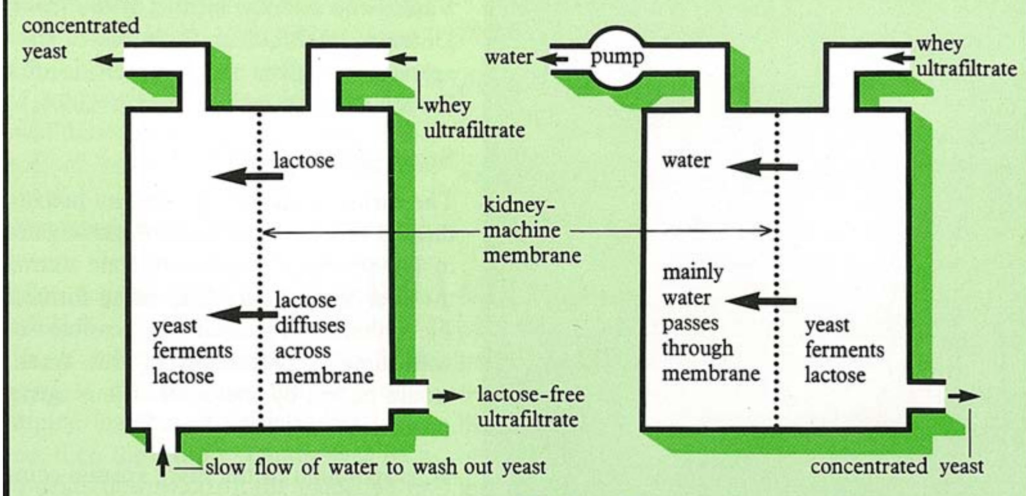
This disposal problem has not gone unnoticed. In 1970 a group of Victorian casein and cheese manufacturers got together and subsequently formed the Victorian Whey Utilization Association, whose aim is to assess the problem and to support research and development relevant to getting whey used.

The protein in whey has considerable nutritional value, and should sell well as a human food. Paralleling research overseas, work within the Victorian Department of Agriculture and CSIRO has developed the technology of ultrafiltration to the point where recovery of this protein is economic.

But this doesn't solve the disposal problem. What's left — a little protein and all the lactose — still has most of the polluting power of the original whey. And surveys have shown that the market for lactose is very limited.

One obvious way of using the lactose is to ferment it, thus converting it into food yeast. A lot of effort has been spent around the world developing suitable techniques. Most of these have used the rather dilute whey as it comes after ultrafiltration, which has meant that even moderately sized cheese factories have needed large fermentation installations.

Our milk-processing plants are nearly all too small for this approach to be economic. Consequently, Australian dairy research laboratories have been looking at ways of concentrating the whey before fermentation.



How dialysis culture and Dr Lane's filtration culture differ

dialysis culture — lactose moves across membrane into yeast culture

Dr Lane's filtration culture — mainly water passes through the membrane

Reverse osmosis, where pressure applied to the whey forces the water it contains out through a membrane, is the method that has been best investigated. It works well, but installing suitable equipment in a factory costs a great deal.

At the North Ryde laboratory of the CSIRO Division of Food Research, Dr Alan Lane has looked at a related process known as dialysis culture. This method has the advantage that it doesn't require application of pressure, which should cut capital costs considerably.

Dialysis, like reverse osmosis, involves molecules passing through membranes. Those used for dialysis have pores large enough to allow sugar molecules to pass through. If whey ultrafiltrate is put on one side of the membrane and water on the other, lactose molecules will diffuse through until the lactose concentration is the same on each side.

But if the water on the opposite side of the membrane to the whey is circulated through a culture of yeast, then the yeast cells will feed on the lactose molecules that come through the membrane. In the end, therefore, all that will remain is lactose-free whey and yeast, which can be sold.

Suitable membranes are nowadays commercially available for use in kidney machines in hospitals. (These work on the same principle. The small molecules of urea waste diffuse out of the blood through the dialysis membrane, leaving the blood's protein molecules, which are too big to pass through the membrane's pores, behind.)

Using spray-dried whey supplied by the Gilbert Chandler Institute of Dairy Technology, Werribee, Vic., Dr Lane set up a dialysis culture system using yeast and commercial membranes. This was only a feasibility study aimed at proving that the system would work, and it did this very successfully. However, these early experiments used relatively fine-pored membranes, and the dialysis process proceeded too slowly to allow the system to be upgraded to an industrial scale.

Dr Lane then tried using membranes with larger pores, but with rather mixed success. The problem here was that water from the whey passed through too. Controlling this process required application of a back pressure to slow it down. As with reverse osmosis, this application of pressure would be difficult and expensive under industrial conditions.

Because of this, Dr Lane now intends to try another twist. In effect he will use the same equipment and membranes. However, he will pump the whey directly into the fermenter. Here the yeast will remove the lactose. The membranes will be used as filters to remove the lactose-free liquid (which by now will have a much reduced pollution potential), while the yeast cells remain in the fermenter. The excess yeast will be tapped off as a concentrate.

If Dr Lane can make this system work, then he will have eliminated the need for applying high pressures — along with all the expensive industrial equipment this entails. Instead of high pressure, only a small amount of suction will be needed to draw water out of the yeast suspension through the membrane. Dr Lane intends to try out the system shortly.

Production of food yeast from whey ultrafiltrate by dialysis culture. A.G. Lane. *Journal of Applied Chemistry and Biotechnology* 1977, **27**, 165–9.
Tackling the whey problem. *Rural Research* No. 84, 1974.