Utilising every drop of milk

Research at TEAGASC is looking at ways to add value to milk co-products.

All milk constituents are not created equal. This is reflected in the milk pricing system used by most Irish co-ops, where price is calculated on levels of protein and fat. Lactose and minerals contribute more than 40% of the milk solids but do not factor in the pricing system. From an economic perspective this reflects the relatively low added value of carbohydrate- and mineral-rich dairy streams.

With global food demand expected to grow by up to 70% over the next 30 years, it is becoming increasingly important for dairy processors to utilise every last drop of milk. In particular, growing volumes of low-protein co-products from the manufacture of protein concentrates will be a challenge for the industry.

Traditionally, these streams were considered waste or by-products; however, co-product is a term that is increasingly applied. This reflects a shift in mentality and a recognition that as supply of and demand for milk grows, it is increasingly important to obtain as much nutritional and economic value from milk as possible.

One does not need to look too far from home for an example of transformation of a waste stream into value-added co-product. Until the late 20th century, whey was considered a necessary nuisance in the manufacture of many cheeses and was largely disposed of as untreated waste. However, increased understanding of the environmental and economic impact of dumping a large proportion of milk solids, in combination with advances in nutritional science and process technology, has transformed whey and its derivatives into a mature market of significant importance to the Irish economy. This article explores how recognition that low-protein and low-fat dairy streams are underutilised, along with technological advances, could turn the by-product of today into the co-product of tomorrow

Background

Increasing production of high-protein dairy ingredients and consumer products, in combination with an expanding dairy market, is resulting in a growing pool of high-lactose streams for valorisation. These streams are generally made through the physical separation of milk proteins from lactose and minerals, usually by means of membrane filtration or coagulation of protein. They are classified into three main groups: milk permeate from standardisation of milk; whey permeate from manufacture of whey protein concentrate; and, acid whey from manufacture of Greek-style yogurt, quark, etc. (despite the name, acid whey contains little whey protein).

High-lactose dairy co-products can be used as the starting material for lactose production, where lactose is crystallised from a solution and separated from the mother liquor by mechanical means before drying. Lactose powder has many applications in the food industry; in particular, lactose is widely used in the infant formula industry as a pure source of lactose, as it contains far less minerals than permeates, etc.

Often dairy co-products are dried as is to produce permeate and/or acid whey powders. Permeate powders have applications in baking and confectionery production, and as a low-cost replacement for whey, lactose or other dairy powders. The market for permeate powders could increase in the coming years with the publication of a CODEX standard, which is currently under preparation. A CODEX standard is often seen as a precursor for regulatory approval of products outside of the EU, and has sparked interest in the potential of selling co-product powders into the Chinese market.

As volumes of high-lactose streams increase, dairy processors will face challenges. This is particularly true in the Irish context, where drying is essential for valorisation of dairy streams. Processors may be faced with scenarios where drying of large pools of permeate-type streams reduces

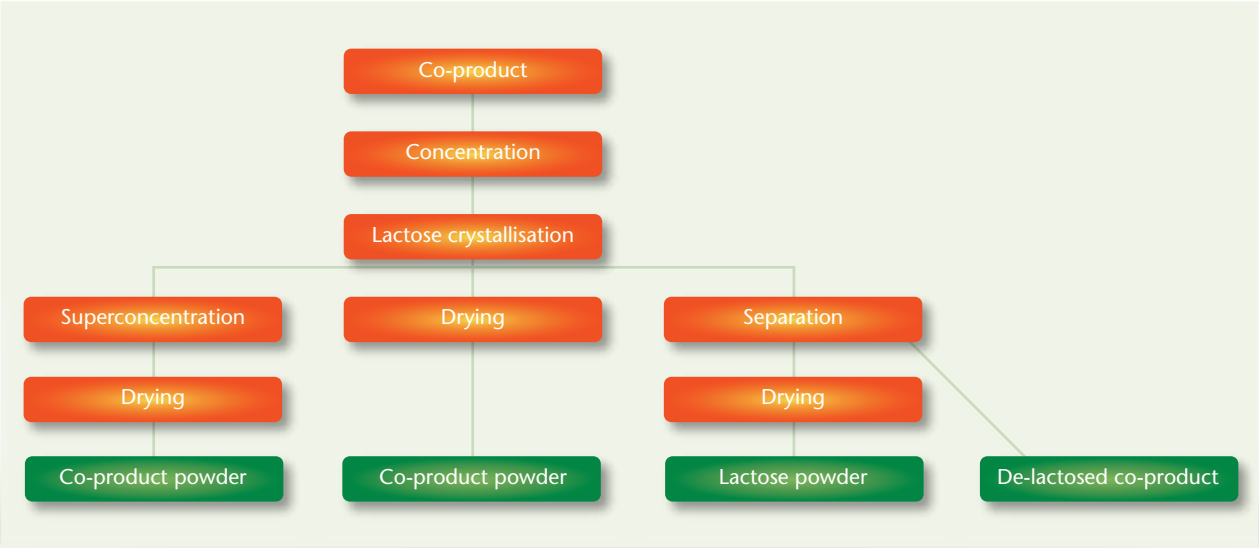

FIGURE 1: Dairy co-products can be processed using a few different methods.

the capacity available for the drying of higher-value ingredients. As a consequence, processors may be faced with a choice between disposing of permeate in liquid form or investing in increased drying capacity. Applied research is required to tackle the challenge of growing permeate pools by increasing the efficiency of current drying processes and investigating lower-cost alternatives.

Crystal clear – increasing process efficiency

There are a number of routes for processing high-lactose co-products (**Figure 1**). In Ireland, the most common processing routes are direct drying of the co-product, or separation and subsequent drying of lactose from the intact stream. A common element in both routes is lactose crystallisation, and the process control during this operation is central to process efficiency.

Direct drying of high-lactose co-product streams (at lactose levels equivalent to >80% of dry solids) presents a technological challenge due to the sticky nature of lactose in its amorphous form. It is necessary to transform amorphous lactose in these streams to non-sticky crystalline lactose prior to spray drying. Inefficient crystallisation not only leads to problems with drying but can also cause storage instability in the finished product. Likewise, in the case of lactose manufacture, lactose crystal separation from the mother liquor is governed by the extent and size of crystals produced. Work is currently underway at Teagasc to characterise the conditions at which crystallisation can be optimised in order to add value to co-product and lactose streams through better process efficiency and product quality. However, while optimisation of current processes is important, it is essential to recognise that alternative processing and valorisation routes will be required in future to obtain the most value from growing co-product volumes.

Future proofing

Standard practice for manufacturing co-product powders is to evaporate the dilute stream to approximately 60% total solids, crystallise and dry. Many processors use existing energy-intense, spray drying plants designed for the drying of conventional, proteinaceous dairy powders (skim milk, protein concentrates). Novel processes are being developed in which the initial concentration is maximised to produce super-concentrates, which can then be dried using more cost-effective compact driers. In one case, a super-concentration process has been designed which removes the need for a spray-drying tower altogether. In addition to energy reduction, such processes could provide processors with a lower-cost supplementary drying technology, which liberates existing spray-drying capacity for the manufacture of high-value dairy ingredients. However, work is still required to test process robustness on the commercial scale.

Teagasc project 0185, 'Valorisation of Dairy Co-Product Powders through Optimisation of Concentration and Drying Technologies', will commence in October 2017. The project will focus on improving efficiency of current processes and investigate new technologies for the manufacture of high-lactose dairy co-products. The project will be carried out in conjunction with INRA-Agrocampus Ouest, France.

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