The Sirocurd process for cheese manufacture*

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The dairy industry is increasingly concerned with the economic processing and marketing of individual milk components as a means of adding value to the standard processing of whole or skimmed milks. Introduced some fifteen years ago, ultrafiltration as a unit process offered for the first time the effective separation of milk proteins and fat from lactose and salts, without degradation or change of pH, and was quickly applied to conventional cheese wheys. For years, the valuable whey proteins had been routed indirectly and wastefully back into the human food chain by feeding whey to pigs or in the preparation of calf starters or still more inefficiently, by spraying whey back on to the land. It was evident that the true market value of these proteins could only be realized by effective and economic separation, and ultrafiltration enabled us, for the first time, to produce high protein powders whose functional and nutritional properties yielded a higher market return. Products of this type are now increasingly accepted in many food formulations but their broad adoption by the food industry has been relatively slow, due at least in part to competition from other low cost protein sources, such as soy bean.

Another major application for ultrafiltration has been in the preparation of skim and whole milk concentrates equivalent to the final solids content of a range of soft cheese. The cheese milk may be ripened before or after concentration with minimal subsequent loss of whey and whey proteins. A number of flavour and texture problems have arisen, however, and in some types of cheese the process has had to be modified to avoid bitterness and to improve texture. These modifications have sometimes led to operating losses; the savings are, therefore, less than the theoretical maxima and the full potential of ultrafiltration is not always achieved. The greatest practical difficulties obviously arise where attempts are made to reproduce traditional cheese manufactured under conventional conditions where flavour and texture are defined by tradition, which in turn has shaped consumer choice.

Camembert has been particularly difficult to produce through ultrafiltration, and it appears that the higher bulk density of milk concentrates with retained whey proteins will always present obstacles in terms of texture and packaging sizes. A good cheese can be made and is accepted in many markets but it differs in minor ways from the traditional form. These first applications of ultrafiltration for the retention of whey protein in soft cheese are now widely accepted and have produced significant economic benefits to the industry in addition to widening the variety of both intermediate and final products available to food processors and consumers. Annual production tonnages of these products, however, are relatively small. Feta, which is the most successful of the ultrafiltration applications to date, for example, is produced at a rate of about 100,000 tons/year, with a total world production of about 400,000 tons.

The annual world production of Cheddar cheese, by contrast, is over 3.0m tons/year. It was, therefore, important to consider how the retention of whey proteins could be achieved reliably and economically within the group of hard cheese which represents by far the majority of the market.

Cheddar is an established commodity in world trade with both national and international grading standards. As an export commodity it is vulnerable to world pricing and has, for many years, offered relatively small margins per tonne both because of the influence of world prices and because of the large volumes produced.

A number of attempts have been made in the past to apply ultrafiltration to the Cheddar process but they have failed to meet the required flavour and texture standards and lacked the reliability essential to large-scale production.

In the mid-1970s, a group of scientists in the Commonwealth Scientific and Industrial Research Organization

This magnitude as commercial risks on the scale of industrial composition. Today, as a result, great operating confidence procedures necessary to meet seasonal variations in milk has been built up based on some ten years of laboratory, pilot development was made available by CSIRO, the Australian Dairy Research Committee and the Australian Dairy Research Committee and the Australian Department of Dairy Research and marketing the process on a commercial scale. A continuous pilot plant was designed and constructed at the CSIRO laboratories at Highett, Melbourne, Australia, in 1983 and studies were carried out to assess yield benefits and operating parameters while retaining the essential characteristics of the final cheese. At the same time, a simpler batch pilot plant was constructed at the MMB R & D facility at Crudgington to ensure that the Australian results could be reproduced on United Kingdom milks and to demonstrate the process in its basic form to interested parties in the UK. Funding during this period and subsequent commercial development was made available by CSIRO, the Australian Dairy Research Committee and the Australian Department of Productivity in addition to funds supplied by the MMB and the APV Group.

The importance of these trial plants cannot be overemphasized. First of all, they provided operating data and experience over all seasons of the year and enabled many aspects of the process to be studied in order to arrive at the correct operating procedures necessary to meet seasonal variations in milk composition. Today, as a result, great operating confidence has been built up based on some ten years of laboratory, pilot and commercial operation providing a detailed history of production data and grading results. Indeed, without this solid history of research and pilot work, it would be unrealistic to expect the manufacturer to accept a fundamental change of this magnitude as commercial risks on the scale of industrial Cheddar cheese production are simply too great to contemplate.

In 1985 the Murray Goulburn Dairy Co-operative of Cobram, Victoria, agreed to install the first commercial Cheddar plant. This was planned to operate at 3.5 tons/hour and represented a 32 times scale-up of the pilot continuous plant; the new process was marketed under the name 'APV Sirocurd'.

The Cobram plant was successfully commissioned in March 1986 and began an extended programme of proving runs. It is now producing Cheddar cheese which grades consistently well in routine State and export gradings and it is especially significant that graders cannot separately identify cheese made by the conventional or Sirocurd methods from mixed batches of cheese.

The APV Sirocurd process and key items of equipment are covered by patents granted or pending in the main cheese producing countries and are now available for licence throughout the world for application to Cheddar cheese and UK territorial cheeses; work is continuing also on the production of a range of European semi-hard cheese.

The operating parameters must, of course, remain confidential to the licensee, but the main details of the process are as follows.

Whole milk is standardized and pasteurized, followed by fivefold concentration at 50°C in a seven stage 1100 m² Abcor spiral ultrafiltration plant including two stages of diafiltration at 5% giving a 38-40% retentate with the required solids, lactose and salt balance; 80% of the milk volume is removed as permeate. The importance of minimizing shear damage during these stages should be noted.

The retentate is divided into two parts; 10% is set aside, heat treated and inoculated to provide a continuous source of fermented retentate or starter for operations on the following day; 90% of the retentate is adjusted in temperature before blending with fermented retentate and rennet in a recirculating loop which feeds forward sequentially to a set of static coagulating cylinders. The retentate is held in one of the cylinders until a coagulum is formed; the curd during this period is entirely at rest. The curd is then expelled from the cylinder by the next charge of incoming retentate. On leaving the cylinder, the curd passes through a cutting grid and the extruded curd is cut continuously by a rotating blade into 1 cm cubes. The diced curd so formed is washed in bulk in a large, rectangular, rotating drum to enable scalding and syneresis to take place in line with standard Cheddar procedure. The curd then passes to the second drum, progressing throughout the two syneresis stages by the action of inclined flights which lift and drop the curd over short vertical distances; the walls of the drums are heated by hot water to maintain correct temperature conditions. Eight per cent of the original milk volume is released in the form of high protein whey during the syneresis stages. It should be noted that the period of syneresis in the two drums is only about one hour and the starter growth is limited to one generation. The concentration of starter used is, therefore, higher (9 × 10⁹/g) than in the case of conventional processing, typically 7 × 10⁶/g. Growth of lactic organisms to these higher concentrations presents no difficulties in the strongly buffered conditions in the retentate growth medium. There is very little mechanical damage within the syneresis drums, and the treated curd leaving the second drum retains its extremely regular shape. The curd then passes forward to a standard cheddaring system. In summary, there are a number of benefits and advantages for the cheesemaker:

1. A yield increase of 6-8% over conventional processing.
2. The make time is reduced by one hour.
3. The process uses substantially less salt.
4. Rennet usage is about one third.
5. The process and the starter systems are totally enclosed and greatly reduce the risk of bacteriophage infection.
6. Consistent cheese composition, through accurate, automatic control of moisture, salt and pH.
7. The process is flexible and is being adapted to other cheese types, eg, territorials.
8. The process can effectively handle seasonal variations in milk composition.

The introduction of any important new process is never simple and in the UK the problem is complicated by the very substantial investment in conventional whey processing over many years. In the Sirocurd process, the retention of whey proteins in the cheese fundamentally alters the composition and the processing of the two sidestreams.

Typical figures are:

<table>
<thead>
<tr>
<th>Permeate:</th>
<th>Syneresis:</th>
<th>Whey:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactose</td>
<td>Lactose</td>
<td>4.76%</td>
</tr>
<tr>
<td>Protein</td>
<td>Protein</td>
<td>5.05%</td>
</tr>
<tr>
<td>Salts</td>
<td>Salts</td>
<td>0.58%</td>
</tr>
<tr>
<td>Fat</td>
<td>Fat</td>
<td>2.56%</td>
</tr>
<tr>
<td>Water</td>
<td>Water</td>
<td>87.05%</td>
</tr>
</tbody>
</table>

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While there is little difficulty in disposing of the relatively small quantities of high protein syneresis whey — in yogurt or ice cream recipes or as a high protein powder — the disposal of the larger volumes of permeate must be considered in the particular circumstances of the customer's facilities and product range. For example, many dairy companies today are part of major groups producing a wide range of food and dietary products which can readily utilize substantial quantities of concentrated demineralized permeate, eg, pharmaceuticals, baby foods, salad creams, sauces, ice cream, etc.

Recent improvements in hydrolysis technology will also certainly lead to the wider use of glucose/galactose mixtures derived directly from the hydrolysis of permeate. A longer term solution must be to consider modern methane production technology to provide gas as fuel for plant boilers and electricity generation from gas engines.

A complete and careful cost-benefit analysis is called for in each case and it requires the present returns and costs of whey and whey cream disposal, yields from conventional equipment and market opportunities for the processor to be considered in relation to the investment.

This summary indicates that the introduction of the APV Sirocurd process requires careful study on a site-specific basis. The benefits to the manufacturer, however, are substantial and represent major advances in productivity and control when compared with batch methods. In the APV Sirocurd process the continuous and automated production of Cheddar has now become a technical reality; I believe it will also be seen as an economic necessity for all manufacturers looking for an increased market share and profitability in the international Cheddar markets.

SYMPOSIUM PAPER

Malicious tampering with foodstuffs — the forensic scientist’s role in the police investigation*

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When food is maliciously tampered with, it is essential to determine the nature of the noxious material, establish its hazard to anyone consuming it and gather evidence to arrest the perpetrator of the crime. This paper describes some of the sophisticated methodology available to the modern forensic scientist.

When a case is received by the laboratory involving the malicious tampering of food products it is the aim of the Forensic Science Laboratory to provide the investigating police officer with as much information as possible within a short period of time. This type of forensic examination can involve a wide range of scientific disciplines including:

1 Toxicology. The foodstuff itself can be examined for poisons, and if one is found an opinion could be given as to the effect of this poison if consumed by either an adult or a young child. An opinion may also be given as to whether or not the product could have possibly been consumed without it being totally obvious that it had been contaminated, for example through taste.

2 Document examination. Any note, addressed envelope and packing of the foodstuff would be examined for possible clues to the sender.

3 Biology. Examination of any saliva detected on the stamp or the sealing flap of the envelope for possible matching to that of the blood group of any suspect.

4 Chemistry. The packaging of the foodstuff would be examined to determine whether or not it had been opened and resealed.

5 Fingerprint examination. All the items mentioned above would be examined and any fingerprints found compared with those obtained from any suspect.

So by using these areas of forensic science it may be determined (a) whether or not the product has been previously opened and resealed; (b) whether or not it contains any noxious substance — that is, a compound that may harm, aggrieve or annoy a person if consumed; (c) with the use of the document, biology and fingerprint sections it may be possible to confirm the suspicions of the police that a certain suspect is involved, or, alternatively, exclude persons who are thought to be possible suspects.

These areas of forensic science are discussed in slightly greater detail below.

DOCUMENT DIVISION

The document examiner would take possession of any envelopes in which the foodstuff and the note alleging poisoning were sent together with the allegation note itself. The postmark on the envelope(s) may not be entirely clear, possibly the foodstuff inside the package has leaked, so these may need to be clarified. This may be carried out not only by examining the mark closely under normal lighting conditions but also by examining the mark under various other conditions, for example under ultraviolet light or viewing through a red filter.

In an attempt to provide further information about the sender, any envelopes and notes will be examined for 'Indented impressions'. These are impressions on the paper that have been left by previous writings. Indented impressions are left if