

Novel and Speciality Cheeses - *Broadening the national industrial cheese base.*

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A range of novel hybrid cheeses considered to have real commercial potential were developed in this project. These have attracted interest from a number of industrial cheese manufacturers.



Evaluation of the effect of varying technological parameters of cheesemaking on the ripening and consumer acceptance of novel cheeses capable of being manufactured wholly, or in part, on existing Cheddar-type equipment.

(Novel and Speciality Cheeses - Broadening the national industrial cheese base)

Armis No. 4535

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Collaborating Partners and their main functions in this project:

DPRC - Manufacture of Speciality Cheeses and Biochemical Analysis

NFC - Market Surveys

UCC - Biochemical and Sensory Analysis

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Summary and Conclusions

The Irish dairy industry is considered vulnerable to the price pressures of the commodity market, on which it is highly dependent. Hence, a broadening of the product base, would reduce exposure to this market while offering the potential of exploiting the lucrative added value market. This involves risks and challenges.

The cheese market in particular continues to grow and investment in innovative products have in some cases been highly successful. However, a number of obstacles confront Irish cheese manufacturers. These include: seasonality of milk supply, strong tradition of Cheddar production, knowledge gaps in industrial-scale specialty cheese manufacture, and a reticence to commit significant investment, particularly in plant.

To address some of these obstacles a project was undertaken with the overall objective of developing a range of cheeses with novel flavour, texture and appearance which were complementary to existing manufacturing plant and technologies.

The project was built on the knowledge, skills base and flexible cheese manufacturing plant developed in a previous study (see DPRC Report No. 9), and had the following specific objectives:

- * assess consumer preferences,*
- * develop a range of novel cheeses capable of being manufactured wholly, or in part, on existing plant,*
- * determine the effects of manipulation of process variables on novel hybrid composition and ripening,*

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- * *assess market potential and consumer reaction to selected cheeses,*
 - * *determine the relationships between cheese composition and sensory characteristics, and*
 - * *present product options to Irish industry.*

Main Conclusions and Achievements

- *Sweet and blue-type cheeses presented the best opportunities for diversification in the Irish cheese market. This was based on a survey of consumer preferences for speciality cheeses. A strong preference was also expressed for cheeses with mature flavours.*
- *Two main groups of speciality cheese consumer were identified. The first group is aged 30 plus years from the ABC1 social class, without gender distinction. The second group, likely to consume speciality cheese once a week, is aged between 18 and 29 years, were from the same social class, but predominantly female.*
- *The targeted outlet for speciality cheese sale should be the supermarket - 98% of consumers surveyed purchased speciality cheese in a supermarket.*
- *A range of novel cheeses with sensory, textural and visual characteristics were developed through manipulation of the major compositional, processing and ripening variables of either Swiss-type or blue-type cheeses. These cheeses were designed to be manufactured wholly, or in part, on cheddar-type equipment.*

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- *Consumer focus group studies on the cheeses developed concluded that a Sweet Cheddar-type hybrid and a Square blue Cheddar were the most preferred cheeses and are thought to have real commercial potential.*
 - *Novel hybrid cheeses with sweet nutty flavour characteristics were successfully manufactured using Propionic acid bacteria in a modified Cheddar-type process.*
 - *Despite some noticeable effects on the composition and ripening of smear-ripened cheeses due to seasonal variations in the milk supply, there does not appear to be any major technological barrier to year-round manufacture provided milk is maintained above minimum cheese-making quality.*
 - *The influences of fat, pH and salt level on the ripening and sensory quality of a blue brie-type cheese were determined. This information was used to predict the sensory characteristics of a blue brie cheese from the manufacturing procedure used. Models were developed to relate cheese sensory characteristics to cheese composition.*
 - *Process technology and a knowledge base developed through this project are currently underpinning the commercialisation of a number of new products.*

Research and Results

Market Studies

Research in the Irish cheese market and the food service sector indicate the following:

- * *the Irish cheese market will continue to grow, ~ 10% of which will be accounted for by speciality cheeses.*
- * *the food service sector in Ireland and the UK will continue to grow; this market is to a large degree underdeveloped in terms of packaging and requires specifically tailored products delivering benefits to caterer and consumer.*
- * *the Kapiti Cheese company model (a flexible plant producing multiple cheese varieties) has the potential to be successfully adapted to the Irish market, but would entail the involvement of an innovative company. This model is particularly suited to an Irish cheese diversification strategy. However, further information is required on identifying the most suitable distribution channels, strategies for new product development and a greater understanding of consumer requirements.*

Hence, consumer research was undertaken to ascertain the potential market for speciality cheese and consumer acceptance of specific novel cheeses.

Consumer Profiles and User Behaviour

A detailed consumer survey of 200 consumers was undertaken. Of those surveyed 168 ate speciality cheese.

Analysis was carried out to classify consumers by cheese purchase, user behaviour, education level, employment, marital status, household size and income.

- *The survey showed that the most preferred flavour was mature. However, salty/dry or sweet flavours were liked by 83% of respondents.*
- *The most preferred milk type was cows milk liked by 95% of the respondents but over 65% also liked goats milk.*
- *The research demonstrated that there were two main groups of speciality cheese consumers. The first group was aged 30 years plus from the ABC1 social class. There was no statistical difference between gender in this group. In addition, another group aged between 18 and 29 years, again from the ABC1 social class, was predominantly female. This group was most likely to consume speciality cheese at least once a week.*
- *Consumers employment situation and their age had the most significant influence on cheese preference and these were linked. For example, students, who were also from the youngest category, preferred Tetilla, but least liked Blue Shropshire. By contrast, however, Blue Shropshire was most liked by those in the older (35 - 54 and 55+) age group.*
- *Nearly 80% of speciality cheese consumers purchased their product in the supermarket. However, 28% also purchased cheese in speciality cheese shops.*

Speciality Cheeses: Sensory Characteristics and Consumers Preferences

To determine preferences for sensory characteristics of cheeses it was required to survey a diverse range of speciality cheese types available on the Irish market. Ten cheeses were picked to provide a broad range of flavour characteristics such as sweet, acidic, blue mould and aromatic flavours as well as a range of textural qualities ranging from soft to elastic to hard (Table 1).

Table 1: Commercial cheese types subjected to quantitative descriptive analysis and preference mapping.

Cheese	Cheese Type	Origin
Mahon	Lipolysed aromatic	Spain
Esrom	Smear-ripened aromatic	Denmark
Chaumes	Soft smear-ripened	France
Cambozola	Soft blue mould	Germany
Fontina	Soft/semi-hard mild aromatic	Italy
Blue Shropshire	Strongly flavoured mould-ripened	UK
Wensleydale	Acidic semi-hard	UK
Tetilla	Mild semi-hard	Spain
Gruy re	Sharp sweet Swiss-type	Switzerland
Appenzeller	Distinctive sweet Swiss-type	Switzerland

A compositional survey of the cheeses indicated major differences in composition and provided information on the likely routes of their production.

Seven clusters of consumers with different preferences were identified using descriptive sensory analysis and consumer preference mapping. The sensory characteristics of the cheeses were then related to consumer preference scores with the following outcome:

- *Gruy re, the preferred cheese of three clusters of consumers (and the most preferred cheese overall), was distinguished by a fruity odour, a balanced and sweet flavour and firm texture.*
- *Blue Shropshire, the preferred cheese of 2 clusters of consumers (and highly rated by a third cluster) was characterised by a mouldy odour, an acidic, astringent and mouldy flavour and a crumbly texture.*

These results, confirmed by consumer focus groups, indicated that sweet and blue-type cheeses presented the best opportunities for the Irish cheese market.

Focus on Blue- and Sweet-Type Cheeses

An in-depth survey of the compositional and ripening indices of a range of both blue- and sweet-type cheeses was carried out.

Results indicated variations in compositional, proteolytic and lipolytic indices within the cheese groups and this yielded further information on the likely routes of their production.

Development of Novel Cheeses

Using information gained from this survey, a range of novel cheeses with sensory, textural and visual characteristics to satisfy the market opportunities identified were developed through manipulation of the major compositional, processing and ripening variables. These cheeses were designed to be manufactured wholly, or in part, on cheddar-type equipment. The particular variables subjected to manipulation include those outlined in *Tables 2* and *3*.

Table 2: Process variables manipulated in the manufacture of sweet-type hybrid cheeses.

Culture Type:	Thermophillic e.g. <i>Streptococcus thermophilus</i> , <i>Lactobacillus helveticus</i>
	Thermophillic and Mesophillic e.g. incorporation of <i>Lactococcus lactis</i> ssp <i>cremoris</i>
2⁰ Cultures:	Propionic acid bacteria (PAB) to develop sweet flavour and eye-type characteristics
Cook temps:	Variation in max scald
Curd Wash:	Removal of lactose to reduce curd acidity and to influence cheese texture and flavour
pH:	Variation in pH of curd pitch and in milling pH
Salt:	Use of dry salt application rather than brining, altered levels of salt application
Ripening:	Use of temperature ranges between Cheddar and Swiss, optional use of hot room step Duration of ripening

Table 3: Process variables manipulated in the manufacture of blue-type hybrid cheeses.

Cultures:	Use of standard Cheddar cultures and also those with known high flavour properties
2⁰ Cultures:	Inoculation of <i>Penicillium roqueforti</i> via cheesemilk or alternatively via downstream process steps
Salt Application:	Application of dry salt
Shape:	Use of wheel or block shapes
Press:	Standard or decreased levels of pressing to vary cheese texture
Initial Packaging:	Use of standard film barrier or plastic coat coating
Initial Ripening:	Development of base level of Cheddar flavour
Piercing:	Level of piercing, to allow Oxygen diffuse inwards and Carbon Dioxide outwards
Humidified ripening:	Use of humidified atmosphere to promote germination of mould spores
Ripening:	Ripening temperature and duration

Consumer Focus Group Studies

Six novel hybrid cheeses, four sweet hybrid and two blue mould-type, were selected for evaluation by consumer focus studies:

Sweet Hybrid

Mildly sweet hybrid

Sweeter softer mild hybrid

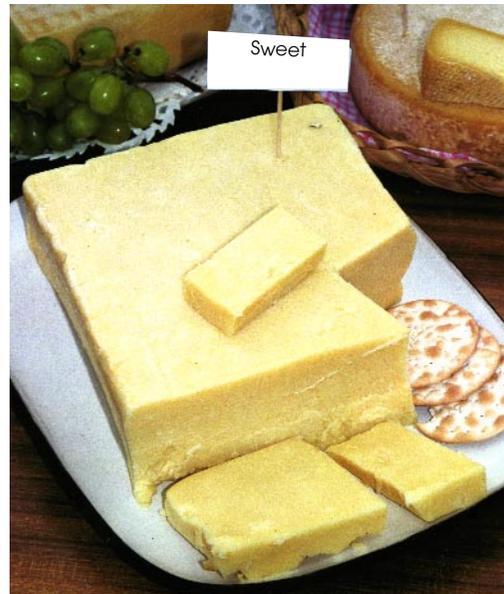
Nutty sweet hybrid

Sweet Cheddar-type hybrid

Blue Mould

Blue Cheddar (round)

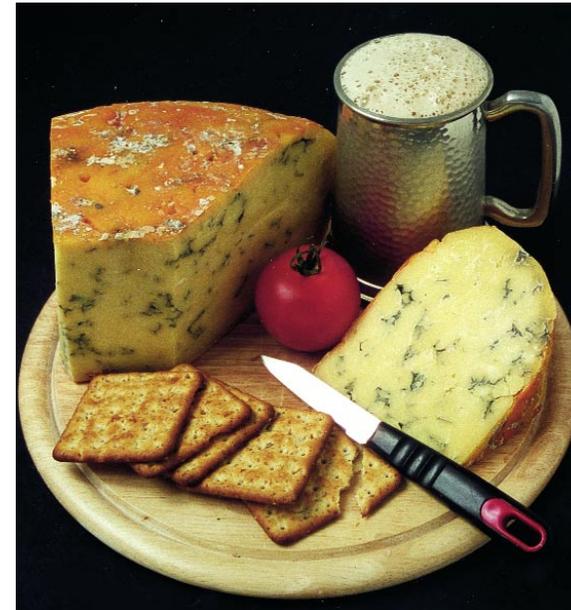
Blue Cheddar (square)



Verdict of the Focus Groups

* The Sweet Cheddar-type hybrid and the Square blue Cheddar were the most preferred of the six cheeses.

* The Sweet Cheddar-type hybrid was favoured due to its strong and well balanced flavour characteristics. It was also suggested that it could be further developed and improved as a minority of those who liked it suggested that the texture was a little too crumbly and may be difficult to slice.



* Participants liked both the flavour and the texture of the Square blue Cheddar, although the appearance may require further refinement to conceal the puncture holes which were considered unattractive.

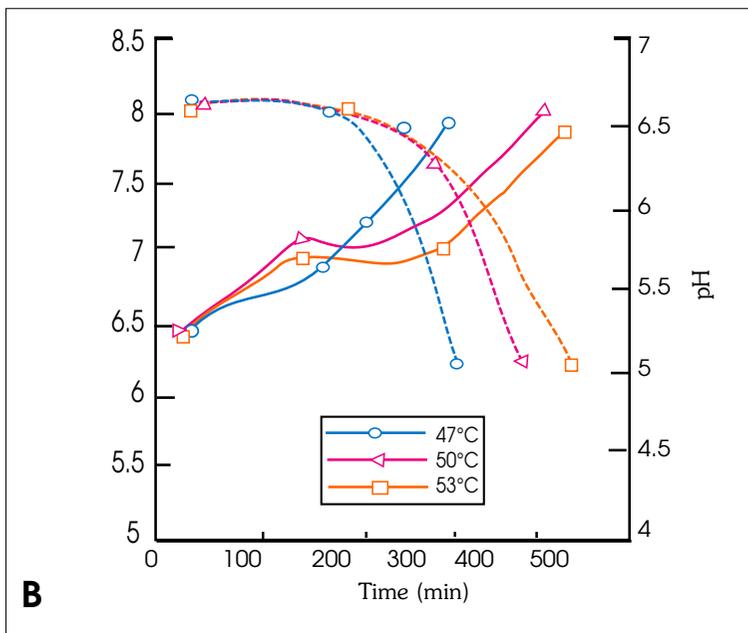
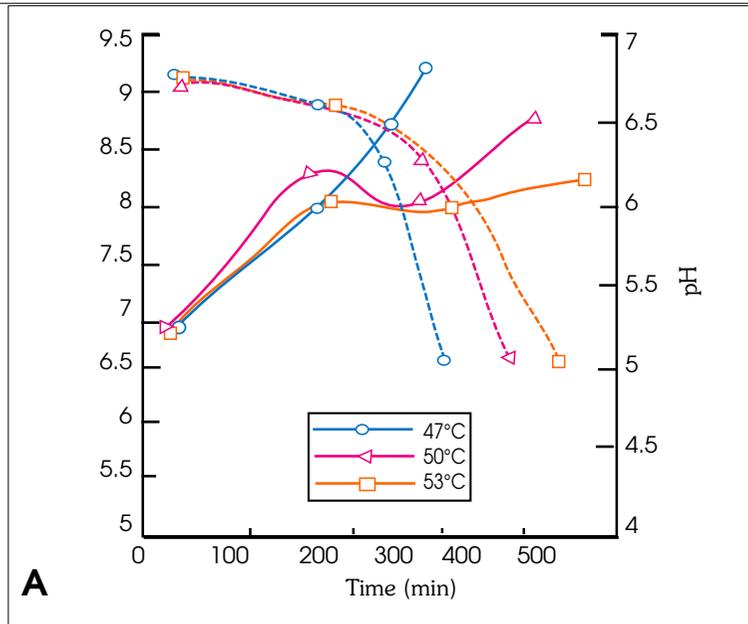
It was concluded that the cheeses developed certainly have real commercial potential and that further improvement could be made by taking the consumer feedback into account.

Effects of Manipulation of Process Variables on Ripening of Speciality Cheeses

Effect of cooking temperature on the manufacture and ripening of a sweet hybrid-type cheese.

In the manufacture of sweet hybrid-type cheeses, selected processing features of both Swiss and Cheddar manufacture were combined. However, the effects of variation in process parameters, such as cook temperature, on the manufacture process and ripening on the resultant cheeses is uncertain. A study was undertaken to evaluate the effects of increasing cook temperature in the range 47 to 53°C on the manufacture and ripening of a hybrid cheese produced using

Fig. 1: Effect of increased cooking temperature on pH development (-----) and growth (—) of *Lactobacillus helveticus* (A) and *Streptococcus thermophilus* (B) during cheese manufacture.



thermophilic cultures: *Streptococcus thermophilus* and *Lactobacillus helveticus*.

Increasing cook temperature from 47 to 53°C resulted in the following:

* a significant reduction in growth rate of both starters during cheesemaking with a concomitant increase in manufacturing time. (Fig. 1).

* a significant decrease in the salt in moisture and moisture in non-fat substance levels.

* a reduced rate of α_{s1} -casein breakdown (associated with increased cheese firmness due to denaturation of chymosin with increasing cook temperature).

Evaluation of Propionic Acid Bacteria (PAB) in a Modified Cheddar-type Hybrid

Propionic acid bacteria used in the manufacture of Swiss-type cheese are associated with its characteristic sweet nutty flavour. Many of the process steps involved in Swiss-type cheese manufacture are not possible in a Cheddar-type plant e.g. pressing of curd under whey, overnight curd fermentation, brine salting and ripening at elevated ripening temperatures including a hot room step. Furthermore, the ability of the PAB to grow in a cheese produced by dry salting, and without a hot room ripening step, are uncertain.

Therefore, a study was undertaken to determine if propionic acid bacteria could be utilised to produce a sweet flavoured hybrid-type cheese in a Cheddar-type process.

The main outcomes were as follows:

* A range of novel hybrid-type cheeses with sweet flavour characteristics were successfully produced using propionic acid bacteria in a Cheddar-type manufacture process e.g. Cheddaring of the curd, milling and dry salting, etc.

* PAB attained counts of $\sim 10^8$ cfu/g in control cheeses manufactured with predominantly a Swiss-type process (including a hot room step).

* PAB counts of 10^7 and 10^5 cfu/g were obtained in cheeses manufactured with predominantly Cheddar-type process and ripened at 12 and 9°C respectively.

* When a curd wash step was incorporated respective PAB counts of 10^8 and 10^7 cfu/g were obtained.

* Consumer focus groups described these cheeses (particularly the control and the cheese produced using a curd wash step) as having a sweet nutty flavour.

Further Biochemical Studies into the Ripening of a Range of Hybrid Cheeses

Further detailed biochemical studies were carried out on the ripening of a range of newly developed hybrid cheeses. Areas investigated included:

High cook cheeses with/without PAB adjuncts

In general, cheeses that were Cheddared and dry-salted were preferred over those that were brine-salted. Consumer preference was related to levels of PAB in the hybrid cheeses.

Blue-mould hybrid cheeses with/without lipase

*Proteolysis was accelerated and levels of free amino acids and lipolysis, were considerably higher in the mould-ripened cheeses over non-mould Cheddar controls. The addition of exogenous lipase had relatively little extra effect on the liberation of free fatty acids reflecting the potent lipases synthesised by *Penicillium roqueforti*.*

Effects of Seasonal Milk Supply on the Manufacture and Ripening of a Smear-Ripened Cheese

A detailed study was completed into the effects of seasonal milk supply on the manufacture and ripening of Saint-Paulin smear-ripened cheese.

While some effects on the composition and ripening of the cheese were noted, there did not appear to be any major technological barrier to the year-round manufacture of this cheese in Ireland, provided milk is maintained above minimum cheese-making quality.

The Effects of Fat, pH and Salt Levels on the Ripening and Sensory Quality of a Blue Brie-Type Cheese

In this study the influence of three primary compositional variables: fat content of the milk used for the cheese production, pH at brine and duration of brine treatment on cheese ripening and sensory quality was determined. A series of two different experimental designs was employed.

The range of fat content in the milk varied from 4 - 8% , the pH ranged from 4.8 - 5.3 at brining, and brine duration (which determines salt content) was varied between 3 and 6 hr during the

cheese manufacture. Sensory characteristics were determined and were related to compositional details.

The results provided information to enable prediction of the sensory characteristics of a blue brie cheese from the process by which it was manufactured.

Determination of the Relationships between Cheese Composition and Sensory Characteristics

Here the objective was to evaluate and model the effects of different cheese composition on texture perception, flavour release and thus consumer perception of flavour.

Gross composition and proteolytic and lipolytic indices were measured on a range of commercial blue (Huntsman, Blue Shropshire, Cashel Blue, a blue brie, Danish Blue, Blue D Auvergne, Blue Stilton) and sweet-type cheeses (Emmental, Appenzeller, T te de Moine, Raclette, Old Amsterdam, Dubliner, Gruy re and Gabrielle).

The cheeses were evaluated for consumers preferences for flavour and texture attributes using a trained panel. In addition, volatile composition and the potential of cheese aroma compounds for release was determined.

Relationships between individual flavour and texture attributes of the cheeses and their gross, amino acid, fatty acid and volatile compositions were determined.

** Models relating composition to sensory quality were developed. Examples include:*

- In the case of the sweet-type cheeses, twelve flavour attributes were found to be correlated with subsets of compositional/chemical data e.g. the nutty flavour of Emmental was found to be positively associated with propionic acid and a number of esters and ketones. It was negatively associated with variables such as salt in moisture (S/M), pH 4.6 soluble nitrogen (SN), aspartic acid and ammonia. Seven texture attributes were associated with subsets of gross compositional variables.

- In the case of the blue mould cheeses five flavour attributes were associated with subsets of chemical/compositional data. For example mouldy flavour was positively associated with variables including pH 4.6 SN and certain specific ketones.

** Examples of sensory characteristics of a blue brie with altered fat, pH and salt levels include:*

- Fat content had an important influence on the sensory characteristics and the lower fat cheeses were undesirable.

- The buttery/creamy odour significantly increased when fat content increased.

- Salty flavour was strongly correlated with a high pH. A high mouldy flavour was found in cheeses made with the lower salt content.

- A combination of low fat content and low pH had a negative effect on pungent and mouldy odour and mouldy flavour.

Overall it was found that individual cheese flavour and texture attributes are the result of interactions between specific volatile compounds and compositional variables, and models were developed which can be used to determine sensory characteristics in each of the selected cheese types.

Presentation of Product Options to Irish Industry

A range of the novel hybrid cheeses developed through this project together with the biochemical, sensory and marketing data were presented to the Irish industry (see *Proceedings of Workshops Nos. 15 and 37*).

Process technology and a knowledge base developed through this project are currently underpinning the commercialisation process of a number of new product developments.

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