Project number: 5115
Funding source: DAFM
Date: May, 2011
Project dates: July 2003 - June 2006

Development of a highly functional cheese sauce

Key external stakeholders:
Dairy Industry, Food Manufacturers

Practical implications for stakeholders:
- Ultra High Temperature (UHT) and *sous vide* cheese sauces were developed.
- A new process to create concentrated cheese flavours was developed. This new process allows a diverse range of concentrated cheese flavours to be developed from base dairy substrates.
- In addition a spray dried concentrated cheese flavour was also in production and information as to minimize losses of volatile key flavour compounds was highlighted.

Main results:
- A method for producing retort cheese sauces
- Novel method for the production of concentrated cheese flavours
- A greater understanding of the flavour potential and use of dairy cheese lactic acid starter bacteria in the production of concentrated cheese flavours
- How manipulation of pH can impact on losses of key volatile cheese flavour compounds during spray drying
- How manipulation of pH can impact on sensory perception.

Opportunity / Benefit:
Consultancy and contract research opportunities are available to both national and international clients in the area of enzyme-modified cheese and concentrated cheese flavours.
A HPLC method to quantify short chain volatile free fatty acids was developed and is now available as a technical service to industry.
A detailed one-two day course on all aspects of enzyme-modified cheese has been developed and is available to industry on request.

Collaborating Institutions:
None

Contact Kieran Kilcawley Email: kieran.kilcawley@teagasc.ie.

Teagasc project team: Dr Kieran Kilcawley (PI)
Ms Martina O'Brien
Mr David Stewart
Dr Diarmuid Sheehan
Mr Jim Kelly
Dr Brendan O'Kennedy

External collaborators: None

1. Project background:

Cheese sauce is widely used in the convenience food sector in pre-prepared and prepared meals. In addition to providing flavour, cheese sauces are often required to provide functional and visual roles, i.e. mouth-feel, texture and colour. Cheese sauce is mainly comprised of cheese powder (dehydrated cheese), emulsifying salts and fillers such as starch, whey, flour, buttermilk, maltodextrins or skim milk. Cheese powder is the most expensive ingredient in the cheese sauce formulation and it is envisaged that this cost could be reduced by replacing a proportion of the cheese powder with natural concentrated cheese flavours, such as enzyme-modified cheese. Concentrated natural cheese flavours are typically produced by enzymatic hydrolysis of cheese curd under controlled conditions. The main advantages of natural concentrated cheese flavours over natural cheese, nature identical flavours and synthesized chemical cheese flavours are as follows: 100% natural, produced cost-effectively, have long shelf lives, consistent flavour and texture; much more intense flavours than natural cheese. The aim of this project was to produce high quality natural concentrated cheese flavours or enzyme-modified cheeses, minimize losses of volatile cheese flavour compounds during drying and to incorporate these natural flavours into cheese sauce formulations.

2. Questions addressed by the project:

- Develop concentrated cheese flavours from base dairy ingredients and utilize lactic acid bacteria and exogenous enzymes.
- Development of process for spray drying enzyme-modified cheese with minimum loss of important volatile flavour compounds.
- Formulation of cheese sauce containing enzyme-modified cheese as a replacement for a part of the cheese powder.
- Evaluation of novel cheese sauce functionality & sensory characteristics

3. The experimental studies:

Sodium caseinate and skim milk powder were used to create a 10 % protein base substrate. This was pre-hydrolysed with commercial enzymes (proteinase and peptidase) to a specific level of proteolysis. Five commercial starter cultures used as adjunct cultures in Natural Cheddar cheese production were selected on the basis of their low acidification rates at the reaction temperatures of the process chosen to enhance the background "cheesy" notes from this hydrolysed protein base. Dose rates were optimized to give a specific level of secondary proteolysis after incubation under controlled conditions. These products were subsequently evaporated to higher solids and spray dried with sodium caseinate using an anhydrous pilot scale drier to create dried natural cheese concentrates. Another fat based product was created by blending sterile water and anhydrous butterfat and hydrolysing with a commercial lipase under controlled conditions to a specific level of free butyric acid. The hydrolysed fat formed two separate phases on cooling, a clear liquid phase with high concentrations of water soluble free fatty acids and a solid phase with high concentrations of water and fat soluble fatty acids, mono-, di- and tri-acylglycerides. This solid phase was homogenized with skim milk powder and spray dried using an anhydrous pilot scale dryer resulting in a final product with a fat in dry matter of > 50%. The liquid phase was pre-blended with maltodextrin and skim milk powder and spray dried. Losses of key volatile free fatty acids during drying were minimized by increasing the pH prior to drying to convert them into insoluble sodium salts. This simple pH adjustment significantly minimized losses of butyric acid. By blending different ratio's of these dried protein and fat products, a range of different concentrated cheeses flavours were produced. Selected cheese flavours were then incorporated into a specific formula to create different types of cheese sauces, also consisting of sodium caseinate, anhydrous butterfat, water, sodium chloride and emulsifying salts. The impact of varying pH on the sensory perception of this formula was evaluated. Ranked preference analysis identified a preference for products at lower pH and that statistically differences existed between the products at different pH's. A sous vide cheese sauce which can be stored at refrigeration temperatures for 10 days and a ultra high temperature (UHT) product with a shelf life of 3 months at room temperature were created using a Barriquand Steriflow Cooker. The sensory rheological characteristics were evaluated after production over storage.

Contact Kieran Kilcawley Email: kieran.kilcawley@teagasc.ie.

4. Main results:

- A method for producing retort cheese sauces
- Novel method for the production of concentrated cheese flavours
- A greater understanding of the flavour potential and use of dairy cheese lactic acid starter bacteria in the production of concentrated cheese flavours
- How manipulation of pH can impact on losses of key volatile cheese flavour compounds during spray drying
- How manipulation of pH can impact on sensory perception.

5. Opportunity/Benefit:

Technical Service:
A HPLC method to quantify short chain volatile free fatty acids was developed and is now available as a service to industry.
Training Course:
A detailed one-two day course on all aspects of enzyme-modified cheese has been developed and is available to industry on request.
Consultancy/contract research:
Consultancy and contract research opportunities are available to both national and international clients in the area of enzyme-modified cheese and concentrated cheese flavours.

6. Dissemination:

Open Day/WorkShops:
Relay Workshop 29 Moorepark: Cheese Ingredients in Consumer Foods
New Generation EMCs K. Kilcawley
Minimising Flavour Loss D. Sheehan
NIZO Food Research Ede, Netherlands:
New Developments in cheese science and technology – K. Kilcawley

Main publications:

- Kilcawley, K.N., Wilkinson, M.G & Fox, P.F. (2006) 'A novel two-stage process for the production of enzyme-modified cheese' *Food Research International*, **39**, 619-627.
- Lee, B.H., Kilcawley, K.N., Hannon, J.A., Park, S.Y., Wilkinson, M.G & Beresford, T.P (2007) 'The use of viable and heat-shocked Lactobacillus helveticus DPC 4571 in Enzyme-Modified Cheese Production' *Food Biotechnology*, **21**, 149-143.

7. Compiled by: Kieran N Kilcawley

Contact Kieran Kilcawley Email: kieran.kilcawley@teagasc.ie.