



 **Technology** **Updates**

Advanced Systems for the Rapid Detection of Anti-Parasitic Drugs in Food

Key External Stakeholders

Dairy, beef and sheep farmers, primary meat and milk processors, regulatory agencies (DAFF, FSAI, IMB)

Practical Implications for Stakeholders

Excellent progress has been made in the development of screening assays for drug residues in food. Immunochemical screening assays were developed in this project as a rapid low cost means of detecting benzimidazole residues in food, as an alternative to chemical assays. A number of assays were successfully validated. A biochip array assay was successfully developed to detect four different drug classes and shows good potential for application in specialist laboratories or at an industry level.

The milk industry is the only industry likely to apply this technology because they are the only industry that carries out monitoring at factory level. However, the scope of the assays needs to be extended to key flukicide residues (nitroxylnil, closantel, rafoxanide, clorsulon and triclabendazole) to meet industry demands if they are to be used.



With benzimidazole drugs widely used in the treatment of worm and fluke infections in food producing animals, these novel immunochemical assays are proposed as an alternative low cost means of detecting benzimidazole residues in food. These assays are applicable in specialised laboratories or at a factory level to prevent contaminated produce entering the food chain.

Main Results

- Three working immunobiosensor assays were developed and validated to detect 17 benzimidazole residues in milk and meat.
- A novel multiplex immunoassay was developed for detecting benzimidazole and macrocyclic lactone residues in fruit juice.
- The new technologies developed were validated to meet EC 2002/657 criteria.
- These represent a rapid, low-cost, effective means of screening drug residues, and a viable alternative to chemical assays, applicable in specialised laboratories or at factory level.

Opportunity/Benefit

Teagasc can be at the forefront of engaging with food producers relating to such low-cost screening techniques, through our extensive expertise in the field.

Collaborating Institutions

Dublin City University

Project Number: 5556

Funding Source: DAFF (05/R&D/TN/355)

Date: January, 2011

Project Dates: Sep 2006 – Aug 2010

How to Proceed

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Anti-oxidant and Anti-Microbial Compounds from Dandelion Root, Fenugreek and Bitter Melon

Key External Stakeholders

Vegetable processors, functional food manufacturers, government authorities/legislators, consumers, food research scientists

Practical Implications for Stakeholders

- The bioactive constituents in dandelion root, fenugreek and bitter melon, offer promising leads as sources of natural alternatives to synthetic food additives/preservatives.
- In particular, the ethyl acetate extract of *T. officinale* (dandelion) root has demonstrated strong antioxidant and antimicrobial properties which may warrant further investigation in food matrices as a potential functional food ingredient.



Main Results

- The ethyl acetate extracts (1mg/ml) of *Trigonella foenum-graecum* (fenugreek) seeds had the highest antioxidant activity (DPPH IC₅₀ = 212 µg/ml) but showed no anti-microbial activity.
- The ethyl acetate extract of *Momordica charantia* (bitter melon) exhibited antimicrobial activity against *S. aureus*, MRSA and *B. cereus* strains (MIC = 62.5 – 93.8 µg/ml) while the *n*-hexane extract and a methanol-hydrophilic dialysed extract of *M. charantia* fruit demonstrated the best antioxidant activity in comparison to all other extracts from this species (DPPH IC₅₀ = 575–648 µg/ml).
- Dandelion roots (*T. officinale*) contain 1,5-dicaffeoylquinic acid as a major antioxidant compound while its ethyl acetate extract demonstrated the strongest antimicrobial activity against *S. aureus*, MRSA and *B. cereus* strains (MIC = 250–500 µg/ml).
- A number of previously unreported compounds (4-Hydroxyphenylacetic acid derivatives of inositol) were isolated from dandelion root that could have useful biological properties not under investigation here.

Opportunity/Benefit

Dandelion roots were shown to have substantial anti-oxidant and anti-microbial properties. The outcomes of the project demonstrated that these under-utilised plants, generally considered weeds, can be potentially exploited as natural food preservatives and for nutraceutical applications.

Collaborating Institutions

University College Dublin

Project number: 6038

Funding source: Teagasc

Date: November, 2015

Project dates: Oct 2009 – Jan 2014

How to Proceed

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Antioxidant Status of Fully Processed Fruits, Vegetables and Their Products: Technology Optimisation to Minimise Losses

Key External Stakeholders

Vegetable processors, government authorities/legislators, consumers, food research scientists

Practical Implications for Stakeholders

Thermal and non-thermal processing effects on fruits and vegetables influence their antioxidant capacity.

The outcomes of the investigation are:

- Thermal processing such as *sous-vide* and post-processing storage decrease the antioxidant activity and concentration of antioxidant compound groups in fruits and vegetables.
- However the effect is not clear cut with some thermal and non thermal strategies resulting in an increase in antioxidant activity.



- In general post-processing storage at temperatures above 0°C resulted in a decrease in antioxidant levels.

Main Results

- *Sous-vide* processing is a promising strategy for retaining the antioxidant capacity and colour of thermally processed carrot disks.
- High hydrostatic pressure processing at ambient temperature and pressures of 400–600 MPa is an excellent food processing technology which has the potential to retain antioxidant compounds in strawberry, blackberry, tomato and carrot puree while also ensuring the foods are effectively pasteurised.
- Blast freezing and storage at -18°C is a good technique for preserving ascorbic and antioxidant activity in broccoli and greens but not carrots, provided the samples had been blanched prior to freezing.

Opportunity/Benefit

This project developed relatively novel processing techniques, *sous-vide* and high hydrostatic pressure processing, which are attractive options for end-users as they allow retention of antioxidants in fruits and vegetables and also aid in increasing the shelf-life of the products. Expressions of interest in this research are welcome.

Collaborating Institutions

University of Limerick

Project number: 5414

Funding source: DAFF (04/R&D/UL/327)

Date: March, 2012

Project Dates: Jan 2005 – Sep 2010

How to Proceed

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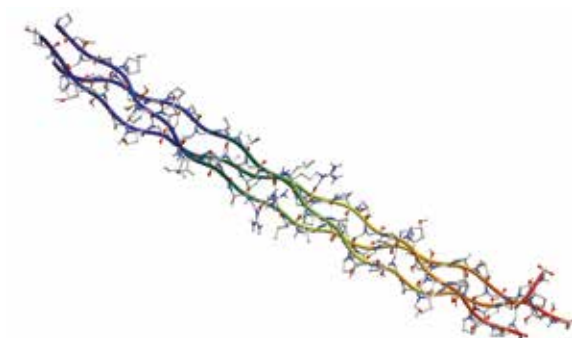
Assessing Pig and Sheep Industry By-Products as Sources of Constituents of High Value Biomaterials

Key Stakeholders

Meat sector, biomedical, cosmetics

Practical Implications for Stakeholders

A dressed carcass is approximately 55% of a live animal weight resulting in 45% offal/viscera, blood, etc. While there are existing markets for some products e.g. offal many of these are low in value. Much of this material can be considered as a rich source of proteins, which have great potential for cosmetic, pharmaceutical and tissue engineering and regenerative medicine applications. This project will evaluate these meat processing streams and identify those with potential for extracting valuable proteins with regenerative medicine and pharmaceutical potential (e.g. collagens, glycosaminoglycans, proteoglycans). Sample handling and processing systems to extract out the valuable components will be



developed. The quality, purity and allergenic status of the proteins will be assessed. Industry players have expressed strong interest in this research strategy and hence this project will be carried in close communication/collaboration with industry.

Main Results

This project will:

- Establish sample handling and processing protocols for the extraction of collagen, proteoglycans and glycosaminoglycans;
- Assessing protein quality/purity by SDS-PAGE, HPLC, amino acid analysis, western blots;
- Assess cytocompatibility by in vitro cultures with dermal and lung fibroblasts;
- Assess immune response by in vitro cultures with macrophages.

Opportunity/Benefit

This proposal aims to address challenges facing exploitation of the opportunities presented to the meat sector, namely extracting functional components and assessing functional activity. A successful outcome to this project will provide the meat sector with clear knowledge about the best source materials for biomedical and cosmetic applications, in addition the expertise and ability to carry out this processing will be held in Ireland, which will also greatly enhance the Irish biomedical industry.

Collaborating Institutions

Network of Excellence for Functional Biomaterials (NFB), NUI Galway.

Project Number: 6577

Funding Source: Teagasc WF

Date: April 2014

Project Dates: Oct 2014 – Sept 2018

How to Proceed

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Assessment of DNA Markers for Meat Quality Traits in Irish Beef and Pork

Key External Stakeholders

Breeders, meat processors, diagnostics companies

Practical Implications for Stakeholders

The outcomes of this project highlight the importance of investigating and understanding the molecular basis of quality traits for meat, with a view to optimisation of management systems for quality. These hold potential quality prediction tools for meat management systems and/or to provide a basis for the inclusion of meat quality in selection goals. This research validated some of the DNA markers tested in Irish crossbred cattle populations, and novel SNP markers associated with tenderness in Irish crossbred cattle identified.

- A number of candidate genes have been identified as potentially relevant to beef sensory and technological traits.
- DNA markers have been tested and were shown to be associated with quality parameters.

There is a need for tools to discriminate meat on the basis of quality and select sires for improved quality.

Variability in meat quality presents many problems for the industry and for consumer satisfaction. The underlying causes are multi-factorial in nature and are considered to include difference in the genetic profile (genotype) of the animal. Attributes of relevance to the consumer sensory experience include tenderness, colour, juiciness, flavour and texture; while those directly impacting on industry management systems include water holding capacity and colour.

Management systems to predict and optimise these attributes require clear understanding of the factors underpinning variability. Currently eating quality is a major deficiency in breeding programmes and this is reflected along the beef chain from processors to retailers, who have highlighted the necessity for tools to accurately predict quality, in particular tenderness. Water-holding capacity has additional importance due to its ability to influence processed product quality and the financial losses incurred when it is sub-optimal.

Main Results

- Novel single nucleotide polymorphisms (SNPs) developed which are associated with tenderness (shear force on day 14 and sensory tenderness) and intra-muscular fat (flavour, juiciness) content.
- SNP in CAST, PRKAG3, GHR and SCD genes were associated with muscle colour and PRKAG3 was also shown to be associated with cook loss in beef.
- SNP in CAPN1 and ANK1 were confirmed to be associated with shear force (tenderness).
- A GHR polymorphism was associated with composition of muscle including moisture, intra-muscular fat and protein content in loin and rump muscles.
- Commercially available markers were tested (and subset validated) for association with Irish beef quality.

Opportunity/Benefit

This research validates the genomic approach to meat quality and expansion of this research area is recommended. The further development of these and other markers for independent traits to create tools for prediction of quality would have a wide range of potential applications spanning animal production and meat management systems.

Collaborating Institutions

University College Dublin

Project Number: 5421

Funding Source: DAFF (04/R&D/TN/258)

Date: October, 2011

Project Dates: Feb 2006 – Jul 2008

How to Proceed

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BASELINE: Risk Targets in Milk and Dairy Products

Key External Stakeholders

Dairy industry, European Food Safety Authority (EFSA)

Practical Implications for Stakeholders

The study focused on the risk posed by *Listeria monocytogenes* in raw and pasteurised milk cheese. The study showed that *L. monocytogenes* grew at a faster rate on pasteurised milk cheese compared to raw milk cheese during the storage period following ripening. A quantitative risk assessment model predicting the growth and survival of *Listeria monocytogenes* in raw and pasteurised milk cheese, from farm to fork showed that the mean level of exposure to *L. monocytogenes* in contaminated cheese was higher for raw milk cheese ($2.22 \log_{10} \text{ cfu g}^{-1}$) compared to pasteurised milk cheese ($<1 \log_{10} \text{ cfu g}^{-1}$). This model can support food processors to optimise conditions to reduce *L. monocytogenes* growth in cheese and to comply with EC2073/2005.

This research was carried out as part of a multi-national EU Framework project, *BASELINE* which focused on research to provide harmonised and validated sampling strategies, supporting European policies in food safety and suitable for food producers to collect comparable data, to improve quantitative risk analysis of selected biological and chemical agents.

Research by Teagasc in this project focused on the growth kinetics of *L. monocytogenes* in semisoft rind washed cheese prepared from raw and pasteurised milk, in the storage period following ripening. Additionally work focused on predicting the risk posed by the *Listeria monocytogenes* contamination arising from the farm environment as well as cross-contamination at processing and retail level, and subsequent human exposure, using a quantitative risk assessment modeling approach.

Main Results

- *L. monocytogenes* grew at a slower rate on the raw milk cheese compared to the pasteurised milk cheese at all the storage temperatures investigated.
- The simulated quantitative risk assessment model showed that the mean level of exposure to *L. monocytogenes* in contaminated cheese was higher for raw milk cheese ($2.22 \log_{10} \text{ cfu g}^{-1}$) compared to pasteurised milk cheese ($<1 \log_{10} \text{ cfu g}^{-1}$).
- A model sensitivity analysis highlighted the critical factors for exposure to *L. monocytogenes* from both cheeses were the serving size of the cheese, storage days and temperature at distribution stage.
- The model showed that when the Performance Objective (PO) for *L. monocytogenes* in raw milk cheese was set at $\leq 2 \log \text{ cfu g}^{-1}$ at retail level, nearly 10.34 % of product was predicted to exceed this PO limit, whereas the model predicted 100% of pasteurised milk cheese met the PO target.

Opportunity/Benefit

The study showed that growth kinetic models can facilitate prediction of *L. monocytogenes* growth during shelf-life and will help to demonstrate compliance with food safety criteria (EC 2073/2005). Further, the quantitative risk assessment conducted based on a farm-to-fork approach also showed possible cross-contamination of raw milk at farm level and retail level.

Such model predictions, will allow food processors and policy makers to identify the possible routes of contamination in cheese processing and to reduce the risk posed to human health.

Collaborating Institutions

18 international collaborators, for details contact Geraldine Duffy.

Project number: 5994

Date: Jan 2014

Funding source: EU Seventh Framework Programme

Project dates: June 2008 – November 2013

How to Proceed

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Beef and Dairy Farm Hazard Analysis and Critical Control Point (HACCP) with Particular Emphasis on *Salmonella* Control

Key Stakeholders

Beef farmers, beef processors, scientists, regulatory personnel, EFSA

Practical Implications for Stakeholders

The data generated in this research should be used to develop HACCP type systems to control the incidence and spread of pathogens on farms. This should include a control point (CP) to ensure water used for animals is clean and pathogen free. Routine monitoring of livestock including non-food animals for *Salmonella* and Verocytotoxigenic *Escherichia coli* is also recommended and the importance of ensuring those in contact with animals, especially children, wash their hands properly afterwards is highlighted.



Main Results

- Water was identified as a source of *Salmonella* and cattle, deer and the farm dog were identified as vectors that may carry and/or spread VTEC around the farm and from farm to farm.
- *Salmonella enterica* Typhimurium DT193 was the predominant *Salmonella* serotype/phagetype detected. Although these isolates displayed a penta-resistant phenotype, this was not arranged in SG11.
- Both *Salmonella* and VTEC survived for extended periods (up to 102 days) in the farm environment.

Opportunity/Benefit

This project provides data for risk analysis and the development of hazard analysis and critical control point (HACCP) type systems for farms, to minimize pathogen carriage in livestock. The results are available for any interested parties.

Collaborating Institutions

University College Dublin

Project Number: 5406

Funding Source: US-Ireland Fund

Date: June, 2012

Project Dates: Nov 2004 – Oct 2007

How to Proceed

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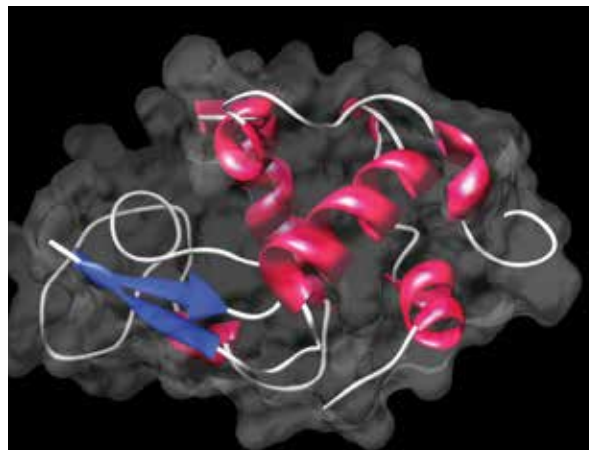
Bioactive Dairy Protein Complexes – *In Vitro* and *In Vivo* Digestion

Key External Stakeholders

Food, feed and pharmaceutical industry

Practical Implications for Stakeholders

- Whey proteins can act as delivery vehicles of small molecules such as fatty acids, thereby changing their biological activity.
- *In vitro* and *in vivo* tools are available within Teagasc to assess digestibility, bioaccessibility and bioavailability of food compounds.



Main Results

The key results were:

- α -lactalbumin (α -la) and β -lactoglobulin (β -lg), both whey proteins, can bind small hydrophobic molecules and act as delivery vehicles to cells.
- α -la and β -lg can alter the solubility of fatty acids, thereby affecting their biological activity e.g. increasing or decreasing their anti-tumour activity or delay the uptake of fatty acids.
- *In vivo* gastric digestion of α -lactalbumin in adults (n=10) provided valuable and novel insight into the mechanism and kinetics of protein breakdown.

Opportunity/Benefit

The research team in Teagasc Moorepark has developed *in vitro* and *in vivo* tools to assess the digestive mechanism of food components. Assays such as bioaccessibility and bioavailability are now available to interested end users.

Collaborating Institutions

Trinity College Dublin
University College Cork

Project number: 5947

Date: May , 2013

Funding source: FIRM 08/RD/TMFRC/650

Project dates: Nov 2008 – Feb 2013

How to Proceed

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Bio-Actives from By-Products of Food Processing

Key External Stakeholders

Vegetable processors, government authorities/legislators, consumers, national food research institutes

Practical Implications for Stakeholders

Large volumes of waste are produced as a result of processing of foods. This project highlighted the potential of this waste as a source of bio-active compounds for inclusion in functional foods.



Main Results

- Fruit and vegetable by-product and waste sources in Ireland were tested for their antioxidant activity and polyphenol content. The highest levels of antioxidants measured by both ferric reducing antioxidant power (FRAP) and diphenyl-picrylhydrazyl (DPPH) assays were detected in whole kiwifruit. Of the vegetable by-products, broccoli stems showed the best antioxidant potential.
- A pressurised liquid method for the extraction of antioxidants from apple pomace utilising 60% ethanol at a temperature of 102°C was developed.
- A solid-liquid extraction method for recovering antioxidant from apple pomace was also developed utilising 56% ethanol, 80°C and 31 min.
- Chitin extraction optimisation, using different organic acids, times and temperatures, was evaluated. The optimal conditions for chitin extraction were 2M concentration, 2h steeping time 24°C temperature which resulted in 98.86% and 90.28% purity for citric acid and lactic acid, respectively, at the ratio of 1:10.
- Optimal conditions of 75% ethanol, 80°C and 22 min for the extraction of antioxidants from potato peel were determined using solid-liquid extraction. The use of pressurised liquid extraction did not enhance the extraction of antioxidants from potato peel.

Opportunity/Benefit

The potential of high volume fruit, vegetable and fish processing waste as a source of bio-active compounds has been highlighted. A number of methods for the recovery of bio-active compounds using food friendly solvents have been developed. The methodologies developed could be used as a basis for up-scaled methods to recover bio-active compounds from food waste for inclusion in functional foods.

Collaborating Institutions

Dublin Institute of Technology, National University of Ireland, Galway, Trinity College Dublin, Natures Best Ltd, Keeling Fruit Importers.

Project number: 5713

Funding source: DAFM (06RDТАFRC519)

Date: November, 2011

Project Dates: Dec 2006 – Nov 2010

How to Proceed

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Biocide Tolerance in Foodborne Pathogens

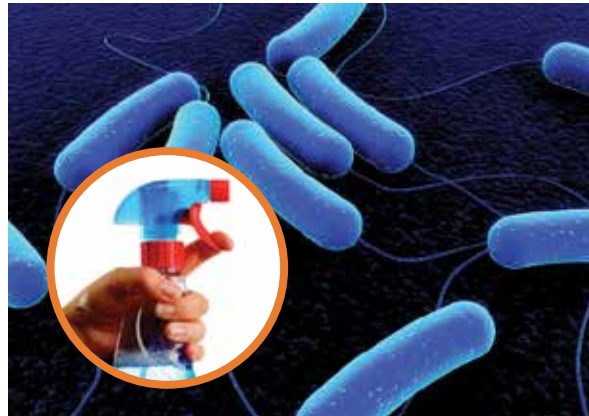
Key External Stakeholders

Food industry, biocide producers, regulatory authorities

Practical Implications for Stakeholders

The outcome of this project is a greater understanding of how foodborne pathogens including *E. coli* O157 and *Salmonella* spp. respond to the presence of biocidal agents, with a particular emphasis on triclosan.

- A panel of verocytotoxigenic *E. coli* (VTEC) and *Salmonella* isolates were found to have minimum inhibitory concentrations (MIC) less than the recommended working concentrations of a number of commercial biocide formulations, although some possessed an MIC of greater than 50% of the working concentration of some agents. This highlights the importance of strict adherence to manufacturer guidelines and appropriate training of personnel.
- Mutants with an enhanced tolerance to triclosan were readily obtained for both *Salmonella* and VTEC. In the case of *Salmonella* corresponding alterations to the strains' antibiotic profiles were



observed, illustrating an additional public health risk.

- A spectroscopic method was developed for the detection of quaternary ammonium compounds on stainless steel surfaces, allowing for the detection of residue build up which may constitute a risk for pathogen exposure to sub lethal concentrations of such agents. This would increase the likelihood of resistance developing.

Main Results

A bank of foodborne pathogen isolates were tested against commercial biocide formulations. Although all isolates had an MIC below the recommended working concentration for all the biocide formulations tested a concern is that for some isolate-biocide combinations the MIC was 50% of the working concentration. Such a concentration may easily occur in real world situations, either due to over dilution, handler error or high organic load. Through this study the transcriptomic and proteomic response of triclosan tolerant *E. coli* O157 and *Salmonella* mutants in comparison with their reference strains were characterised in detail, identifying key responses for each pathogen. Subsequent phenotypic studies showed key changes which may contribute to enhanced pathogen persistence. A spectroscopic method was developed for measuring the potential buildup of biocidal agents on industrial surfaces.

Opportunity/Benefit

The findings of this project provide a detailed analysis of the response of two key foodborne pathogens to sub lethal exposure to biocides commonly used in the farm to fork chain and how these responses may contribute to pathogen persistence in the food chain. The project findings underline the key importance of utilising biocidal

agents as directed. Furthermore, the spectroscopic method developed and validated as part of this project is readily transferable to industry for the measurement of the buildup of biocide residues on industrial surfaces.

Collaborating Institutions

University College Dublin

Project Number: 5954

Funding Source: DAFM 08/RD/TAFRC616

Date: November 2012

Project Dates: Dec 2008-May 2012

How to Proceed

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BioCop – Detecting Chemical Contaminants in Food

Key External Stakeholders

Dairy, beef and sheep farmers, regulatory agencies
e.g. DAFF, FSAI, IMB

Practical Implications for Stakeholders

- It is now possible to screen a large series of samples for the biological effects caused by the use of a growth promoting hormone using BioCop, a cost-efficient, protein based biomarker biosensor assay that has been developed.
- Rapid, improved diagnostic methods that are able to detect low concentrations of fluoroquinolone antibiotics have been developed and can be used in a range of animal products, including chicken muscle, eggs and fish.

BioCop addressed the issue of hormone growth promoters because they are banned for use in cattle fattening in the EU. Hormone abuse is a concern from food safety, animal welfare and law enforcement perspectives as residues in meat are a potential health threat, especially for vulnerable populations such as preadolescents. Current analytical methods are restricted, (i) to a limited number of known substances and, (ii) by the relative high cost. Therefore unexpected compounds will be overlooked and the number of samples analysed is limited by the cost.



BioCop addressed the issue of veterinary drug residues in food (fluoroquinolone antibiotics and hormone growth promoters) because overuse and/or illegal use of fluoroquinolone antibiotics in animal production is of particular concern to humans. Repeated exposure to fluoroquinolones, via the food chain, will limit the future effectiveness of these drugs by increasing the risk of antimicrobial resistance developing.

Main Results

- New biosensor assay developed to detect fluoroquinolone antibiotics in different foods.
- A new high throughput biosensor assay was developed to detect hormone abuse in cattle.

Opportunity/Benefit

This range of novel screening assays for chemical contaminants in food will provide the industry with a more cost effective and efficient food testing service allowing for an increase in safety and reduction in expenses. Expressions of interest in this research and the novel assays developed are welcome.

Collaborating Institutions

Queens University Belfast

Project Number: 5442

Funding Source: EU (FOOD-CT-2005-006988)

Date: July, 2011

Project Dates: Apr 2005 – Sep 2009

How to Proceed

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Biomarkers to Authenticate Irish Grass-Fed Beef

Key External Stakeholders

Regulatory agencies, Bord Bia, beef producers/processors

Practical Implications for Stakeholders

- Biomarkers to authenticate Irish grass-fed beef have not been identified and, therefore, the marketing advantage that should accrue by being able to prove unequivocally that beef is Irish and grass-fed has not been exploited.
- This project produced a unique and extensive dataset consisting of marker elemental isotopes, molecules, and differentially expressed genes characterising (i) Irish beef produced solely off grass or off concentrates or off silage/grass/concentrate combinations and (ii) non-Irish beef.
- The approach taken will be useful for individual producers seeking to market beef produced to a unique and defined regional production system.



Main Results

- Stable isotope analysis and fatty acid analysis permitted 100% correct classification of grass-fed beef from concentrate-fed beef and from beef from animals fed a 50:50 combination of grass and concentrates.
- Discriminant analysis of stable isotope data from 146 international samples showed that 84.9% were correctly assigned to their country of origin.
- Stable isotope analysis of bovine tail hair provided an archival record of the pre-slaughter diet of beef cattle and, importantly, of changes (e.g. grass to concentrates) to the pre-slaughter diet.

Opportunity/Benefit

Commercialisation of this research could involve the setting up of a food authentication testing facility involving the establishment and maintenance of databases against which routine or suspect samples would be tested.

Collaborating Institutions

University College Dublin

Project Number: 5644

Funding Source: DAFF (06/R&D/D/481)

Date: November, 2011

Project Dates: Sep 2006 – Nov 2010

How to Proceed

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Bio-sensitives Advanced Stabilisation

Key External Stakeholders

- Dairy Ingredients and Nutritional Beverage Manufacturers
- Academic and Research Institutions

Practical Implications for Stakeholders

- The research investigates processes, such as dehydration, as a way of stabilising sensitive and bioactive food components in structure-forming food matrices.
- Stabilisation of high-value ingredients requires a thorough understanding of ingredient interactions during formulation, processing, storage and distribution. The research demonstrates the effects of altering the composition of the continuous phase of emulsions on microstructure and physical properties of resultant powders such as glass transition temperature, sugar crystallisation, and lipid oxidation.



- The production of nanoemulsions, using microfluidisation for spray drying, with carbohydrate glass-formers has potential as a technique for increased retention of active components and uniformity of powder particle structure.

Main Results

The project utilised microfluidisation equipment for the production of nanoemulsions (fat globule size ~ 150 nm), which may be used for encapsulation of lipid soluble bioactives by spray drying to produce powdered ingredients. Spray drying produced a solid, glassy matrix with sensitive components as part of the glassy material or entrapped in the structure-forming matrix (solid-oil dispersion). The research showed the impact of reducing the fat globule size on the physical properties of emulsions and powders. Spray dried nanoemulsions had altered microstructure compared to the control powders, with reduced levels of lipid oxidation but increased rates of lactose crystallisation. Partial replacement of lactose with sucrose, reduced glass transition temperature (T_g), delayed lactose crystallization and reduced the extent of lipid oxidation in powders – a possible beneficial effect for long term storage of powders.

Opportunity/Benefit

This research provides a comprehensive account of the fundamental properties of nanoemulsions in liquid and dried forms. The techniques described can be translated into improved product quality and stability with demonstrable benefits to the Irish industry as producers of high quality ingredients and foods for the international markets.

Collaborating Institutions

University College Cork, UCC

Project number: 5953

Date: November, 2014

Funding source: DAFM (08/RD/C/695)

Project dates: Oct 2008 – Mar 2013

How to Proceed

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Campylobacter Control on Broiler Farms

Key Stakeholders

Poultry farmers, poultry processors, scientists, regulatory personnel, EFSA

Practical Implications for Stakeholders

- The data generated in this research should be used to revise current biosecurity measures on broiler farms.
- New information on antibiotic resistance can be used to assess the likely success of different control strategies.

This research also supports the hypothesis that quinolone and macrolide antibiotic resistance in *Campylobacter* is mutation based. While this trait may not be transferred horizontally from one organism to another, it is relatively stable in the *Campylobacter* population and can be passed vertically between parents and offspring cells. The use of antibiotics during food production will confer a selective pressure



promoting the survival and proliferation of resistant strains while susceptible organisms are eliminated from the microflora with inevitable adverse consequences for therapeutic intervention (in severe cases) and public health.

Main Results

- Adjacent cattle and transport crates used during thinning are important sources of *Campylobacter* in broiler houses.
- Quinolone and macrolide antibiotic resistance in Irish *Campylobacter* isolates is mutation based.

Opportunity/Benefit

This project provides data for risk analysis that may be used to provide the scientific basis for improved biosecurity of broiler farms and in the formulation of strategies to control the emergence and dissemination of antibiotic resistance determinants in *Campylobacter*. The results are available for any interested parties.

Collaborating Institutions

University College Dublin, Cork County Council.

Project Number: 5427

Funding Source: Safefood 04-RESR-04

Date: June, 2012

Project Dates: April 2006 – Sept 2009

How to Proceed

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Characterisation and Enrichment of “Buttermilk” Fat Globule Membrane Composition Using Novel Technologies

Key External Stakeholders

Dairy processors, butter manufacturers, ingredient innovators

Practical Implications for Stakeholders

This project has demonstrated that the milk fat globule membrane (MFGM) residue contained within buttermilk possesses biological activity and offers potential for greater commercial exploitation and adding value.

A key implication for dairy producers and processors is a realisation that buttermilk as a by-product of buttermaking is presently under-utilised through processing into a relatively low-value commodity buttermilk powder.

- Expertise and analytical capability were developed, in relation to bioscience aspects and technological features of MFGM, which is key to understanding the fate of MFGM proteins and phospholipids during processing.



- Specific analytical capabilities developed during the project were made available to interested dairy processors thereafter to enable them to characterise the composition of buttermilk and MFGM fractions generated by their processes. This, in turn, led to international food and nutritional company reaction e.g. expressions of interest on the part of infant milk formula manufacturers.

Main Results

- Analytical techniques were established which enabled, for the first time, the fate of MFGM proteins and phospholipids to be tracked during processing simulations performed on freshly-produced milk.
- MFGM proteins are partitioned mainly into buttermilk during cream churning, some of these proteins were also detected in the resulting butter. All major MFGM phospholipids, i.e. PE (phosphatidylethanolamine), PI (phosphatidylinositol), PC (phosphatidylcholine), PS (phosphatidylserine), SM (sphingomyelin), as well as high quantities of LC (lactosylceramide) were detected in the various sample streams irrespective of mechanical action and/or heat treatment of cream prior to processing.
- Significant anti-cancer effects were detected in the various buttermilk fractions produced experimentally.

Opportunity/Benefit

Follow-on research is necessary to elaborate our scientific understanding of MFGM and document further biological evidence to support health benefit claims but the expertise developed from this project would be key to such commercially focused research and possible links with industry.

Collaborating Institutions

Dublin City University

Project Number: 5552

Funding Source: DAFF (05/R&D/TD/370)

Date: March, 2012

Project Dates: Oct 2008 – Mar 2009

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Chitosan Generation and Characterisation from Shell

Key External Stakeholders

Marine processors, ingredient producers

Practical Implications for Stakeholders

Use of by-products from marine processing and reduction in disposal at landfill costs.

Novel ingredient for use in a myriad of applications as a functional food (anti-obesity/anti-cholesterol), horticulture, plant protection.



Main Results

- Chitosan generation and characterisation from shell material (prawn and crab).
- NMR analysis and molecular weight determination.

Opportunity/Benefit

By-product disposal is expensive and no longer permitted under the revised CFP. We have developed methodologies to generate a high-value grade chitosan from prawn and crab shell material and methods to characterise the resultant product which has a myriad of applications in functional foods, foods, packaging and horticulture.

Collaborating Institutions

National University of Ireland, Galway

University College Dublin

Project number: NutraMara – The Marine Functional Foods Research Initiative

Date: May 2015

Funding source: DAFM and Marine Institute and Teagasc

Project Dates: October 2009 – December 2012

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

or contact:

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Culture Collections in Teagasc Food Research Centre Moorepark

Key External Stakeholders

Dairy Industry, food manufacturers, pharm industry, research community

Practical Implications for Stakeholders

The culture collections in the Teagasc Food Research Centre Moorepark provide banks of bacterial cultures with potential for exploitation as dairy starters, adjunct cultures and probiotics for the Food and Pharma industries and the research community.

Main points

The main functions of the DPC and APC culture collections are:

- To provide a central repository for safe housing and cataloguing of DPC and APC Biobanks.
- To provide researchers within Teagasc and APC and interested stakeholders with accurate data regarding the potential applications, safety and quality of strains within the collections.
- To provide unambiguous traceability for IP protection and accountability.



Main Results

DPC and APC culture collections contain 7000 and 62,000 strains respectively. The DPC culture collection predominately consists of strains of lactic acid bacteria of the genera *Lactococcus*, *Lactobacillus* and *Streptococcus*. These bacteria have been isolated over many years from a variety of dairy-associated sources. In addition, this collection also houses bacteria and yeasts isolated from surface ripened cheese, many food, animal and human Class 2 pathogens and also bacteriophages isolated from both dairy and environmental sources. More recently the biobank associated with the APC contains strains isolated from human intestinal samples which have potential for exploitation as probiotics for the treatment of anti-inflammatory diseases such as IBD and IBS, anti-*Clostridium difficile* probiotics and antimicrobials in addition to strains producing bioactive metabolites such as conjugated linoleic acid and exopolysaccharides.

Opportunity/Benefit

The DPC and APC culture collections are available to researchers in Teagasc Food Research Centre, researchers in the APC and companies for exploitation in the Food or Pharma or Veterinary arena.

Collaborating Institutions

University College Cork

Project number: 6042 and 6312

Date: May 2014

Funding source: SFI and DAFM

Project dates: 2008–2013 and 2013

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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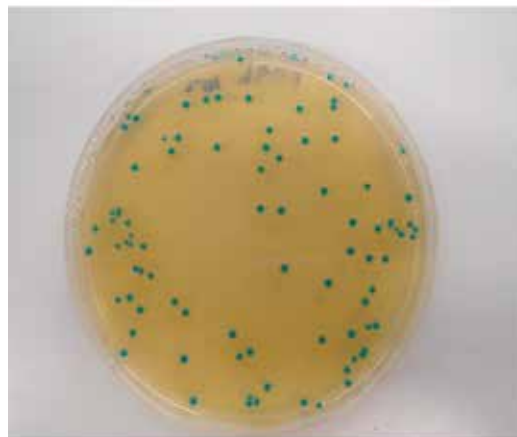
Detection and Surveillance of *Enterobacter sakazakii* (*Cronobacter* spp.) Along the Infant Formula Food Chain

Key External Stakeholders

Infant milk formula industry, Food Safety Authority of Ireland

Practical Implications for Stakeholders

Cronobacter spp. is a key food safety issue for the infant formula sector. Apart from an obligation to meet the regulatory microbiological criteria for this pathogen, the sector would be severely damaged by any food safety scare affecting infants consuming these products. This study has focused on transmission sources and survival characteristics of *Cronobacter* spp. The study highlighted that *Cronobacter* can occur widely in the environment and are particularly associated and adapted to survive in dry environs.



Main Results

- *Cronobacter* spp. are not 'ubiquitous' in the environment and would be best described as 'widespread but infrequent' as it appears they have found a particular niche in dry environments.
- Dry ingredients added to milk powder may have a role in transmission of *Cronobacter* spp.
- *Cronobacter* spp. are resilient, surviving the time/temperature profile experienced during spray-drying, in soil, in rumen fluid, in inulin and lecithin (ingredients in infant formula manufacture).
- An adaptive tolerance response to sub-lethal heat that confers increased heat resistance can be induced. However, the increased heat tolerance was not transferred to increased survival potential in a dry environment. Changes in the ratio of saturated to unsaturated fatty acids in the cell membrane appear to be responsible for this adaptation.

Opportunity/Benefit

This project has generated knowledge about the transmission and survival of *Cronobacter* in the farm to fork chain which will underpin risk management of this pathogen.

Collaborating Institutions

University College Dublin, Food Safety Authority of Ireland

Project number: RMIS 5561

Date: October 2013

Funding source: FIRM

Project dates: June 2006 – Dec 2009

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Detection of Endocrine Disrupting Agents in Milk

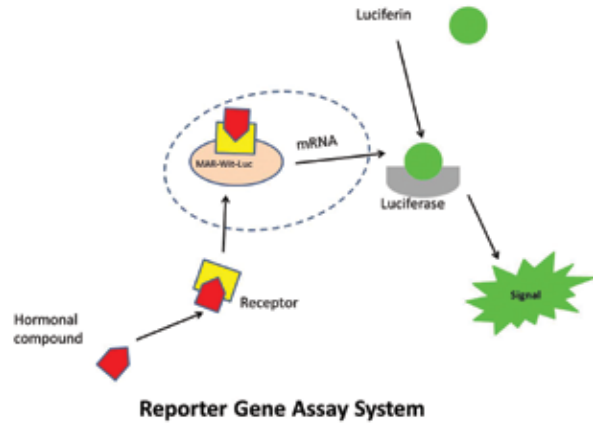
Key External Stakeholders

Dairy industry, Dairy farmers, Agri-businesses, Policy makers

Practical Implications for Stakeholders

Endocrine disruptor agents (EDAs) comprise of both naturally occurring and synthetic chemicals. Some of these chemicals can transfer into milk due to environmental contamination, feed contamination, leaching from milking machine components, cleaning agents or processing. This research has shown that endocrine disruptors can be successfully detected in milk using receptor assays. However, chemical analysis using liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS) is required to accurately measure and identify each compound. Unfortunately, a wider range of EDAs could not be detected because there are more amenable to GC-MS analysis, which was not available at the time.

Using the technology developed on this project low



levels of EDAs were found in milk samples but further investigations should be carried out to identify the source of residues. More extensive methodology is required to properly investigate a wider range of phthalates, which have been detected in dairy products in other EU countries.

Main points

- The technology developed on the above project provides two validated solutions for detecting EDAs in milk.
- End-users can use the technology to screen for endocrine disrupting chemicals in milk and be confident that dairy is safe for consumption.

Main Results

- Two new methods were developed to analyse endocrine disrupting agents in milk using an estrogenic reporter gene assay and liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS).
- The technologies were applied to a range of different types of milk and infant formula.
- A range of endocrine disruptors were detected in samples including the natural hormone progesterone and low levels antimicrobials, phytoestrogens and benzyl butyl phthalate.

Opportunity/Benefit

This technology is now available as a tool to monitor the safety of milk.

Collaborating Institutions

Queen's University Belfast

Project number: 6141

Date: November, 2014

Funding source: Teagasc

Project dates: Oct 2010–Sep 2014

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Detection of Flukicide Residues in Milk and Meat

Key External Stakeholders

Meat and milk processors, Irish baby food industry, regulatory agencies e.g. DAFF, FSAI, IMB

Practical Implications for Stakeholders

- The first analytical test to detect all of the major anti-parasitic drug residues has been developed through a collaboration with the US Department of Agriculture.
- A new group of residues in milk and meat samples were detected for the first time; nitroxylnil, closantel, triclabendazole and rafoxanide were detected in milk at low levels. However, with setting of provisional Maximum Residue Limits (MRLs) for some flukicides in milk, this will become less of a problem from 2011 on.
- The technology developed under this funding has been comprehensively validated according to international guidelines and was accredited to the ISO 17025 standard. The technology has been applied to some 3000 test samples.



- The main recommendation for primary processors is that flukicide residues should be monitored in milk, particularly during the spring period post-calving.

Main Results

- A sensitive test was developed and validated to detect 38 anti-parasitic drug residues in milk and animals tissue.
- The technology was satisfactorily evaluated through application in inter-laboratory studies.
- The technology was accredited to ISO17025 standard in 2009.
- The technology has been applied to approximately 3000 test samples.

Opportunity/Benefit

This analytical test is now available as a tool to monitor the safety of milk and meat products through accurate determination of flukicide residue levels, and offers an opportunity for food processors to prevent contaminated product entering the food chain and potential product recalls, with all of the economic fallout this entails.

Collaborating Institutions

US Department of Agriculture – EARC

Project Number: 5579

Funding Source: DAFF (06/RD/TAFCR/479)

Date: January, 2011

Project Dates: Nov 2006 – Nov 2009

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Development of High Protein Bars as Vehicles for Functional Ingredient Delivery (PROBar)

Key External Shareholders

Dairy ingredient manufacturers, nutritional food formulators

Practical Implications for Stakeholders

- The shelf stable nature of high protein bars is largely attributable to their controlled water activity (a_w) which creates an environment that limits the activity of spoilage microorganisms.
- Probiotic microorganisms are equally affected by such controlled a_w levels, hence this study aimed to understand how probiotic cultures such as *L. casei* may be adapted to survive when carried in a protein bar matrix. Strain adaptability was established by exposing the culture to variation in relative humidity (%RH) especially if incorporated with a prebiotic FOS/GOS mixture. Additional protection is afforded if skim milk is included in the preparation.
- Incorporation of hydrolysed protein (WPH) in bar formulations favours higher initial counts of *L. casei* (<24h) but does not sustain the initial momentum during subsequent storage at 20°C.



- Dispersal of *L. casei* in combination with a mixture of FOS-GOS and skim milk in molten chocolate prior to bar formulation provides an effective protective medium.
- Significantly better probiotics protection was afforded when co-blended with the prebiotic mixture, FOS/GOS, and dispersed in larger chocolate pieces as well as chocolate coating.

Main Results

- A high protein bar system incorporating ingredients in an experimentally-designed formulation study was used to monitor the survival added probiotic cultures.
- Advanced analysis by means of flow cell cytometry indicated that a significant proportion of the apparently 'dead' probiotics cells following storage may be capable of revival.

Opportunity/Benefit

A novel protocol by which probiotics may be added to high protein bars and their viability maintained during bar storage is outlined. Further extended storage tests are recommended in follow-up studies to validate the findings of this time-constrained project.

Project number: 6611

Funding source: FIRMplus / DAFM (13/F/513)

Date: May, 2015

Project Dates: Dec 2013 – April 2015

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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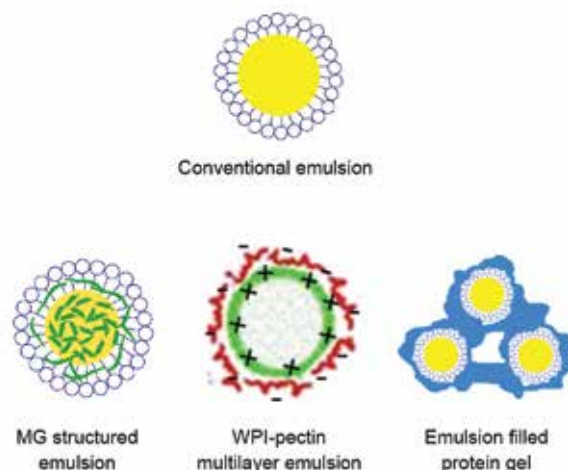
Development of Novel Food Structures Which Deliver Engineered Flavour and Health Benefits

Key External Stakeholders

Dairy and beverage industry, manufacturer of fat-reduced foods, academic and research institutes

Practical Implications for Stakeholders

The study provided important information about different structured emulsions as delivery systems for flavour compounds, and on how food structure can be designed to modulate flavour release. The findings suggested that it is possible to modulate flavor release (response to different triggers) by changing emulsion structure, which could be helpful in the development of functional foods with improved flavour profile. The emulsions studied in this research may also find applications to deliver non-volatile functional ingredients.



Main Results

- Monoglyceride formed liquid crystalline structures in the oil phase of oil-in-water emulsions, and crystalline structure worked to reduce the amount of flavour released to the headspaces.
- Headspace concentration of flavours was significantly lower in WPI-pectin multilayer emulsions than that in conventional emulsions and flavour release can be modulated by adjusting pH, salt concentration of the emulsion.
- Flavours had lower release rates and headspace concentrations in emulsion filled protein gels, and the release was more inhibited when more protein was included. Reduced flavour release in oil-reduced gels can be achieved by increasing WPI content.
- The involvement of matodextrins in the emulsions improved emulsion stability against freeze-thawing, and flavours had similar release profiles before and after freeze-thaw treatment.

Opportunity/Benefit

This research provides profound knowledge about emulsion structures and flavor release, and the designing of flavor delivery systems. Different structured emulsions with structuring of the oil phase, water phase, and interface allow better delivery of food flavors and other functional ingredients. The findings obtained in this study provided important information on designing novel food products with specific health/function claims and improved flavor profile, e.g., fat reduced food, long shelf-life foods.

Collaborating Institutions

University College Cork

Project number: 5991

Funding source: Teagasc

Date: March, 2015

Project dates: Oct 2010 – Dec 2014

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Developing Novel Convenient Meat Based Products by Application of High Pressure Processing (HPP)

Key External Stakeholders

Meat processors, chilled ready meal producers, state agencies

Practical Implications for Stakeholders

The output of this research provides a broad range of data which can assist many players in the chilled meat product chain to understand the relevance of a minimal processing technology such as high pressure processing (HPP). Results also provide valuable information to assist in understanding, at a proteome level how, HPP exerts its effects on quality.

- Influence of different HPP treatment levels were observed with lower pressure (200MPa) being more appropriate than higher for meat.
- Higher pressure (600MPa) appeared to be more relevant for processing vegetables.



- Industry was positively disposed towards the availability of a HPP central treatment facility.

Main Results

- Mild pressure treatments minimally influence meat quality while improving meat hygiene.
- While high pressure levels would promote lipid oxidation, mid-range levels had no impact on fatty acid profile.
- Results suggest that increases in pressure result in increased precipitation of sarcoplasmic proteins onto myofibrils.
- Processing at 600MPa and blanching were the treatments that best preserved the antioxidant capacity of vegetables.
- The enhanced nutritional profile of the chilled ready meal concept garnered higher levels of consumer acceptance especially amongst respondents in the family life stage.
- The overall result from the 300 consumer acceptance tests, indicated that a pressure treatment of 200 MPa was most acceptable to the majority of consumers.
- Further education and technical training is warranted to increase industry awareness of HPP.

Opportunity/Benefit

This project provides valuable information for scientific and consumer audiences and provides a good starting point for further research or development by others, including industry. As a non-thermal treatment which can influence

microbial safety, HPP holds potential as a minimal process technology of relevance to the production of ready to eat meat products which are microbiologically safe and possess superior sensory and nutritional attributes. Expressions of interest in further developing this research are welcome.

Collaborating Institutions

University College Cork

Project Number: 5580

Funding Source: DAFF (R&D/TAFRC/521)

Date: March, 2012

Project Dates: Nov 2006 – Jun 2010

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Early Detection of Mushroom Bruising Using Imaging Technology

Key External Stakeholders

Mushroom producers, mushroom packers, supermarket chains

Practical Implications for Stakeholders

- The capability to identify damaged mushrooms before browning becomes visible has been developed.
- The technology has the potential to reduce acceptance problems for mushroom lots at both wholesale and retail level.

Browning of mushrooms because of damage during harvesting and transportation results in a monetary loss for the mushroom industry. This project investigated the use of a rapid, non-destructive system, near infrared (NIR) spectroscopy and hyperspectral imaging (NIR-HSI), which has the



potential to identify the damaged mushrooms before browning is visible. The technique is capable of on-line installation and operation and could eventually be deployed for screening of sample or whole lots.

Main Results

- Conventional NIR spectroscopy can discriminate between damaged and undamaged mushrooms with almost 100% accuracy.
- Conventional NIR spectroscopy is capable of predicting post-harvest age in damaged and undamaged mushrooms with a high level of accuracy.
- NIR-HSI can discriminate between damaged and undamaged mushrooms within 1 day of harvest at rates of 72 and 86% respectively.

Opportunity/Benefit

Expressions of interest from mushroom producers or distributors relating to exploitation of this emerging technology through engagement with Teagasc are welcome. Teagasc can develop turnkey applications for interested companies on request.

Collaborating Institutions

Dublin Institute of Technology, University College Dublin

Project Number: 5708

Funding Source: DAFF (06/R&D/DIT487)

Date: February, 2011

Project Dates: Nov 2006 – Jul 2010

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Emerging Verocytotoxigenic *Escherichia coli* (VTEC) on Irish Beef Farms

Key External Stakeholders

Irish beef farmers, beef processors, FSAI, DAFF, public health personnel, epidemiologists and scientists interested in VTEC research

Practical Implications for Stakeholders

This study discovered that VTEC were widespread on Irish beef farms and some serotypes were capable of causing serious illness in humans. A range of different VTEC serotypes were also detected on cattle hides and carcasses in the abattoir. New, more virulent serotypes are emerging and will join *E. coli* O157 in causing serious disease outbreaks in the future.



Main Results

- VTEC are widespread on Irish beef farms.
- VTEC are present on hides and carcasses in the abattoir.
- VTEC survive well in Irish clay and sandy soils.
- Several serotypes of potential clinical significance are emerging.

Opportunity/Benefit

The data generated, especially on non-O157 VTEC will be used to formulate new risk-based meat inspection procedures and in the development of public health protection policy. It strongly supports the case for expanding current microbiological criteria in meat monitoring and identifies novel VTEC that should be tested for in seriously ill patients not infected with O157.

Collaborating Institutions

University College Dublin; University of Ulster, Jordanstown; US Department of Agriculture-ARS

Project Number: 5554

Funding Source: FIRM (06/R&D/TN/357)

Date: October, 2011

Project Dates: Oct 2006 – Sep 2009

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Functional Beverages Containing Health-Promoting Prebiotic Milk Oligosaccharides

Key External Stakeholders

IMF manufacturers, dairy/cheese industry, dairy farmers

Practical Implications for Stakeholders

- In addition to known bovine milk oligosaccharides, detection of 18 new high-molecular weight oligosaccharides was observed in the enriched powders.
- Kg quantities of powders enriched in milk oligosaccharides can be produced using the developed membrane filtration process.
- The oligosaccharide powders produced have been shown *in vitro* to possess prebiotic activity and can prevent invasion of human cells by *Campylobacter jejuni*.



- The oligosaccharides powders also decreased number of potential pathogens *in vivo* in a mouse model.

Main Results

- In this study, pilot-scale enrichment of oligosaccharides from whey streams using 1 kDa membranes was successful yielding as high as 17.52% enrichment of oligosaccharides as a % of lactose.
- This study revealed, for the first time, the presence of several new free oligosaccharides containing up to 10 monomers that correspond in size to the most abundant oligosaccharides present in human milk including some fucosylated structures.
- A variety of bioactivities were shown to be associated with the bovine oligosaccharides *in vitro* such as increased colonization of human intestinal cells by Bifidobacteria, prebiotic effects and anti-invasive activity against *Campylobacter*.
- Bovine milk oligosaccharides were found to reduce non-beneficial or pathogenic bacterial populations *in vivo* in the mouse GIT and have no adverse effects on the other health parameters measured.

Opportunity/Benefit

The technologies to enrich oligosaccharides in this work are based on membrane filtration techniques. The membranes are already well established in the dairy industry and depending on the extent of use of an existing plant, it is anticipated that little additional costs would be required in terms of plant, personnel and

training investment. Furthermore, bearing in mind the potential applications of oligosaccharides if produced by such industries, the initial capital and production costs would be spread between different high value-added ingredients for diverse applications.

Collaborating Institutions

UC Davis

Project number: MD-BY-5551/Dairy Levy 5450

Funding source: DAFM, Dairy Levy

Date: November 2015

Project dates: March 2006 – May 2012

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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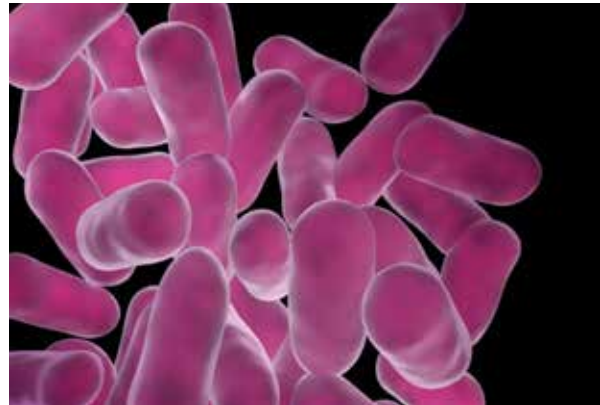
Genomic Analysis of *Lactobacillus helveticus* DPC4571

Key Stakeholders

Dairy industry, starter supply companies, research community

Practical Implications for Stakeholders

Bacteria used in the manufacture of cheese play a major role in determining the flavour of the final product. The capacity to direct cheese flavour development to address specific consumer desires, through the use of such bacteria, offers the cheese manufacturer a significant advantage in the market place. Previous research at Teagasc has demonstrated that the use of *Lactobacillus helveticus* in cheese manufacture results in cheese with a very desirable sweet, nutty flavour. This project sought to use molecular biological approaches to gain a greater understanding of *Lactobacillus helveticus* and its role in cheese flavour development.



The main focus of the research was:

- Generation of the first complete genomic sequence of *Lactobacillus helveticus*.
- Exploitation of the genomic data to gain a greater understanding of the manner in which this bacterium impacts on cheese flavour development.

Main Results

- The complete genomic sequence of *Lactobacillus helveticus* DPC4571 was assembled and analysed.
- Four genes with the potential to impact on cheese flavour were examined using molecular approaches.
- Molecular tools for the further genetic manipulation of *Lactobacillus helveticus* were developed.

Opportunity/Benefit

This project resulted in the first published genome sequence of a *Lactobacillus helveticus* strain, thus providing a complete overview of the metabolic capabilities of what is a very successful cheese-making bacterium. The successful completion of the project has provided an insight into how this bacterium impacts on cheese flavor development during ripening and this has enabled selection of additional strains that can impact successfully on cheese flavor development. By doing so, the project supports the efforts of the Irish cheese makers to exploit markets for cheese, in particular cheeses with sweet, nutty flavours that are highly prized by the modern cheese consumer. Expressions of interest from companies involved in this area are welcome.

Collaborating Institutions

University College Cork

Project Number: 5434

Funding Source: DAFM 04/R&D/TD/311

Date: June, 2012

Project Dates: Sept 2005 – Oct 2009

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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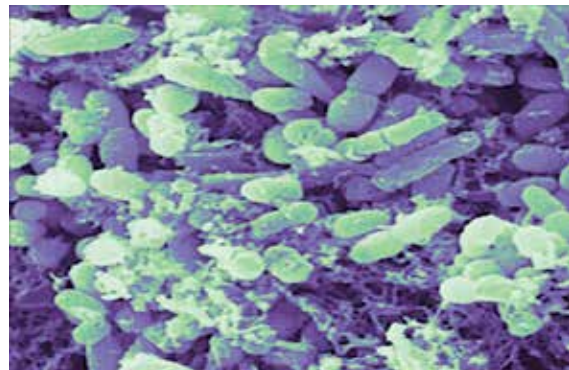
Genomics of Gram Negative Food Poisoning Bacteria of Animal Origin

Key External Stakeholders

Food sector (pork sector in particular), Regulators, Food Safety Authority of Ireland

Practical Implications for Stakeholders

Approximately 40% of *Salmonella Typhimurium* isolates examined, readily attached to food contact surfaces and formed biofilms (bacterial populations on surfaces). In biofilms, *Salmonella* can persist for long periods of time, and pose a risk of contamination in food production. Research showed that particular genes and proteins needed to be expressed to allow formation of biofilms by *Salmonella*, and these could be targeted in the development of new biocides.



Main Results

- Of the *Salmonella Typhimurium* isolates (n=172) examined, which were recovered from the pork chain in Ireland or of human clinical origin, about 40% had the ability to form biofilms on stainless steel and plastic surfaces. Among clinical isolates, 73% attached to PVC plastic compared to 53.3% of pork isolates. This indicates that the ability to persist on surfaces may be enhancing the transmission of *Salmonella* through the food chain to the consumer.
- *Salmonella* in biofilms formed at pH 5 showed increased expression of virulence genes *hilA* and *invA* compared to those from biofilms formed at neutral pH 7. This indicates that acidic environments in food production plants may enhance the ability of *Salmonella* to cause food borne illness.
- In acidic environments, genes related to *Salmonella* motility i.e. flagella structures (*Flagellin*) were down-regulated in cells from biofilms as compared to non surface attached (planktonic) cells. Genes related to cell-to-cell signaling and transport of exopolysaccharides across the outer membrane, were up-regulated and needed for successful biofilm formation. Proteomic analysis also revealed that the switch from planktonic to biofilm status required up-regulation of proteins associated with glycolysis, cell-to-cell signaling and protein transport.
- The design of biocidal agents that specifically interfere with glycolysis and cell-to-cell signaling and that enhance flagella formation could help inhibit biofilm formation by *S. Typhimurium* in food processing facilities.

Opportunity/Benefit

The data generated in this project gives a fundamental understanding on the persistence and biofilm formation by *Salmonella* on contact surfaces used in food production. This information may support industry in the control of this pathogen and the development of novel targeted biocidal agents.

Collaborating Institutions

University College Dublin

Project Number: 5854

Funding Source: DAFF (06/TNI/UCD/10)

Date: September 2013

Project Dates: Nov 2007 – Dec 2012

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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GLYCO-PROSPECTING: For Health Promoting Activity

Key External Stakeholders

Food manufacturers, dairy industry, pharmaceutical companies, research communities, public health agencies and health professionals and policymakers

Practical Implications for Stakeholders

- A major research focus has moved to identify components of bovine milk which, when isolated or concentrated, can bring added value to applications such as infant formula.
- Irish dairy research in particular is expanding in this area due to the large increase in milk volumes following the abolition of milk quotas.
- In particular, research on the complex carbohydrate structures which are inherent in bovine milk is gaining momentum.
- In the case of bovine milk glycoproteins, the larger molecular weight of these components and the



more diverse chemistries facilitates ease of purification.

- Here, the importance of the glycans on such proteins, structural changes that may occur and their relevance to the functionality of the intact glycoprotein is explored.

Main Results

- More diverse complex-type oligosaccharides structures are present on lactoferrin during early lactation with an abundance of oligomannose type glycans in later lactation.
- Novel interactions were identified for *C. sakazakii*, *S. pneumoniae* and *P. aeruginosa* with the highest binding observed for mature milk lactoferrin in all cases, with the exception of *S. typhimurium*. The interaction between lactoferrin and these pathogens may imply a role as decoy receptors to which pathogens bind to instead of to host cells.
- Glycomacropeptide (GMP), a 64 amino acid peptide, derived from k-casein, was also selected given the current interest in this glycopeptide as a prebiotic. GMP promoted the growth of *Bifidobacterium longum* subsp. *infantis*. Transcriptional analysis of *B. infantis* following exposure to GMP revealed a substantial response to GMP relative to the controls (no GMP and GMP with disrupted glycans). These results suggest that the O-linked glycosylation of GMP is intrinsic to the growth stimulation of *B. infantis*.

Opportunity/Benefit

Overall, this research adds to our understanding of the structural and functional importance of milk protein glycosylation. It also highlights the potential of these compositionally complex molecules as ingredients which can be exploited by the food and pharmaceutical industry.

Collaborating Institutions

Glycoscience Group, National Centre for Biomedical Engineering Science, National University of Ireland Galway, Galway, Ireland.

Project number: 5975

Funding source: Core

Date: November, 2015

Project dates: Nov 2009 – Oct 2013

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Identification and Molecular Characterisation of Genes Influencing Irish Pork Meat Quality

Key External Stakeholders

Pig producers, pigmeat processors, diagnostics companies

Practical Implications for Stakeholders

Tools to provide early prediction of the ultimate quality of meat, i.e. shortly after slaughter, would help facilitate logistical decisions of pork processors in relation to meat management. However measurements that are currently applied by industry, e.g. carcass pH measured at 45 minutes postmortem, are not considered satisfactory as accurate predictors of ultimate quality.

- Molecular approaches applied in this project have led to the identification of biological markers which are associated with quality parameters. These have considerable potential as tools to predict quality in meat management systems and/or to provide a basis for the inclusion of meat quality in selection goals.
- Gene expression profiles and novel DNA markers in these gene regions were shown to be linked



with meat quality in large pig populations representing Large White, Duroc and Pietrain breeds. Interestingly, several of the associations were breed-specific. Results have applications in meat management systems and breeding.

- Exudate from muscle was shown to be a readily accessible biological resource and a rich source of potential protein biomarkers of quality. More than two-hundred proteins/fragments were altered through postmortem ageing and are thus linked to quality. Twenty proteins were linked to drip loss. The findings provide a means for the future development of high-throughput protein diagnostics for diverse aspects of meat quality in an industrial setting.

Main Results

- A detailed meat quality database (tenderness, fat content, water-holding capacity etc.) for three breeds (Large White, Pietrain, Duroc) was established.
- More than 600 candidate genes were identified whose expression levels were associated with tenderness, intramuscular fat content, drip loss or PSE-like/DFD-like meat.
- Many novel associations have been identified between 190 novel markers (SNPs) discovered in the most promising candidate genes and meat quality measurements in four cohorts (total 724 animals).
- 2D proteomics resulted in the identification of protein spots significantly associated with drip loss at the one day postmortem point. These have potential to serve as early biomarkers of water-holding capacity.

Opportunity/Benefit

A panel of proteomic markers associated with a highly relevant pork quality trait for pigmeat processors, i.e. drip loss, was identified in the course of this project. The results could be further developed into rapid tests for drip loss in a commercial context. This approach could also be highly relevant for palatability traits, such as

tenderness, juiciness and flavour. Expressions of interest in further developing this research are welcome.

Collaborating Institutions

National University of Ireland, Galway; University College Dublin.

Project Number: 5643

Funding Source: DAFF (06/R&D/NUIG/470)

Date: October, 2011

Project Dates: Jan 2007 – Jun 2010

How to Proceed

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www.teagasc.ie/publications

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Improved Biotraceability of Unintended Microorganisms and Their Substances in Food and Feed Chains

Key External Stakeholders

Irish Farmhouse Cheesemakers (FSAI)

Practical Implications for Stakeholders

- The data obtained contributes to a better understanding of the potential risk that *L. monocytogenes* presents to cheese producers (growth on the product, if it is contaminated) and constitutes a very useful set of data for further modelling studies in food.
- Persistent strains of *L. monocytogenes*, that are more difficult to control, were identified in some processing environments.



Main Results

- Sixteen cheesemaking facilities were sampled during the production season at monthly intervals over a one-year period. Thirteen facilities were found to have samples positive for *L. monocytogenes* on at least one occasion.
- 19% of samples at farm level were positive for *L. monocytogenes*.
- This study demonstrates the prevalence of *L. monocytogenes* in the dairy farm and processing environments and the need for good hygiene practices to prevent its entry into the food chain.
- Predictive modeling is not always applicable to food.

Opportunity/Benefit

- Contamination of food processing facilities (not food) was shown. There is an opportunity to use this pre-emptive knowledge to improve hygiene at processing facilities and prevent future issues with food contamination.
- Predictive modeling is not always applicable to food – challenge studies are necessary.
- A database of pulsed field gel electrophoresis (PFGE) profiles of *L. monocytogenes* isolates from Ireland was generated.

Collaborating Institutions

Principally the Danish Technical University, Copenhagen and the University of Veterinary Medicine, Vienna. There were 45 other participants in the project.

Project Number: 5691

Funding Source: EU FP7 Project no. 036272

Date: July 2013

Project Dates: Jan 2007-Dec 2011

How to Proceed

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www.teagasc.ie/publications

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Improved Whey Permeate Drying Using High Pressure Gas/Liquid Dosing During Spray Atomisation

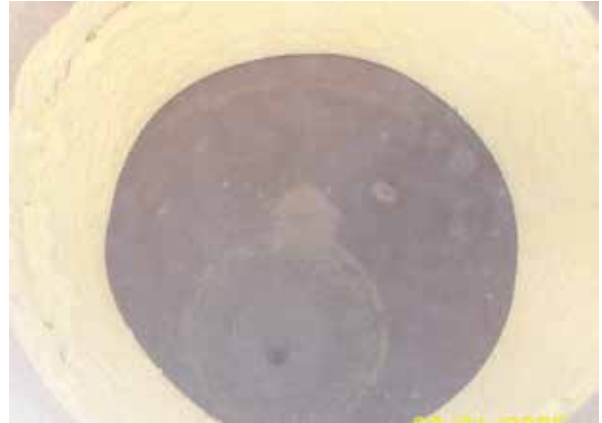
Key External Stakeholders

Irish dairy processors and whey ingredient manufacturers on behalf of their dairy farmer members

Practical Implications for Stakeholders

The outcome/technology or information/ recommendation is:

- Modification of the feed dosage systems using high pressure gas dosing into the concentrate line to nozzle atomisers of spray driers looks promising as a means of improving permeate drying without undue deposit formation.
- Such a high pressure gas/liquid dosing is uniquely installed on Moorepark's MTL Tall-form drier and may be availed of by stakeholders and clients to pursue more detailed R&D investigations.



Deposits of whey permeate powder in the spray drier chamber.

- Complementary on-site specialised analytical services such as microscopy (National Food Imaging Centre), rheology and particle size monitoring serve enable a comprehensive development programme to be pursued.

Main Results

High pressure CO₂ dosing in the concentrate feed line to the spray atomiser would appear to potentially benefit whey permeate drying. It would appear that the beneficial effects may be attributable more to changes in powder physical properties rather than alteration of the glass transition states. It is recommended that careful control of the gas dosing is exercised in order not to impact negatively on the wettability behavior of the powders.

Opportunity/Benefit

Processing conditions established during the course of the study may be used by dairy company R&D personnel in order to accomplish improved spray drying of whey permeates using novel technologies installed on the pilot plant drying facilities at Moorepark Technology Ltd. The results of such investigations would be readily scalable to industrial manufacturing scenarios.

Collaborating Institutions

None

Project number: 5986

Date: Nov, 2014

Funding source: Dairy Levy

Project dates: Sept 2009 – Dec 2012

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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INFANTMET: Infant Nutrition for Programming the Gut Microbiota in Neonates

Key External Stakeholders

Food manufacturers, dairy industry, pharmaceutical companies, research communities; public health agencies and health professionals; policymakers

Practical Implications for Stakeholders

- Establishment of the intestinal microbiota commences at birth and the microbiota has a major role in protection against pathogens, maturation of the immune system and metabolic welfare of the host.
- In terms of infant health, it is imperative to understand how early infant nutrition influences the development of a healthy gut microbiota.
- Delivery mode and gestation age have significant effects on early neonatal microbiota composition.



- A bank of infant intestinal strains (mainly *Bifidobacterium* and *Lactobacillus*) has been generated as future potential probiotics for the infant nutrition and health markets.

Main Results

- Standard Vaginally delivered Full-Term infants' microbiota remained stable at both phylum and genus levels during the first 24 week period.
- Caesarean section delivered Full-Term infants' displayed a different microbiota composition compared to Standard Vaginally delivered infants, with an increased faecal abundance of Firmicutes and decreased Actinobacteria abundance one week after birth.
- The microbiota of Caesarean section delivered infants displayed a greater flux than that seen in Standard Vaginally delivered infants over the first 24 weeks of life, and gradually progressed to a microbiota closely resembling Standard Vaginally delivered Full-Term infants over that period.
- The gut microbiota of preterm infants displayed a significantly greater abundance of Proteobacteria compared to full-term infants ($p < 0.001$) at week 1.
- The data uniquely shows the longitudinal effect of preterm birth after the infant leaves the hospital environment.

Opportunity/Benefit

The INFANTMET data provides new opportunities for optimisation of infant milk formula composition, with appropriate new bioactive ingredients such as milk

fractions, probiotics and prebiotics to effectively programme the early infant gut microbiota in a manner closer to mothers milk.

Collaborating Institutions

APC Microbiome Institute
University College Cork
Cork University Maternity Hospital

Project number: 6276

Funding source: DAFM

Date: November, 2015

Project dates: Nov 2011 – Oct 2015

How to Proceed

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In-situ Starch Modification in Food Formulations Using Protein

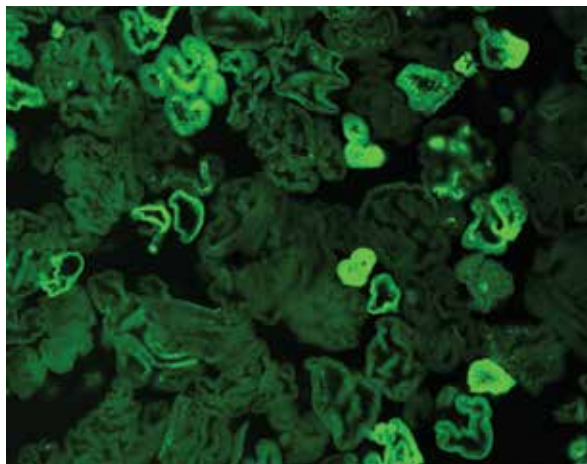
Key External Stakeholders

- Dairy ingredients and Starch Industry
- Prepared foods and Nutritional beverage manufacturers
- Academic and Research Institutions

Practical Implications for Stakeholders

The objective was to study the behaviour of mixed protein-starch systems with a view to understanding protein starch interactions as a possible mechanism for in-situ alternation to starch functionality.

- Structure of the starch pastes can be altered by the presence of the proteins (intact or hydrolysed).
- Gelatinisation temperature of starch and denaturation temperature of proteins can be synergistically used to create new food structures.



- A novel rheological reactor cell can be used for simultaneous measurement of viscosity and in-vitro digestion of protein-starch mixtures.

Main Results

- The gelatinisation temperature of potato starch is lower than the temperature for whey protein denaturation/aggregation; thus in mixtures of potato starch and whey proteins, starch granules swell before denaturation/aggregation of the protein occurs, resulting in a reduction in viscosity and change in functionality.
- Hydrolysed whey protein resulted in a reduction in potato starch granule swelling during heating.
- Different blends of dairy proteins were evaluated in the presence of pre-gelatinised starch for changes in viscosity during in-vitro digestion using a newly designed rheological reactor cell. The study found that a blend of casein and α -lactalbumin may provide viscosity increase and release of peptides/amino acids for use in commercial applications, e.g., anti-reflux infant formula.

Opportunity/Benefit

New knowledge on the effect of intact and hydrolysed dairy proteins on the pasting properties of waxy maize and potato starch can be utilised for development of structure in beverage and prepared food applications. The methodologies developed in this study can be used

to evaluate ingredients under simulated (in-vitro) gastrointestinal digestion for use in development of functional, medical or therapeutic beverages.

Collaborating Institutions

University College Cork, UCC

Project number: 5950

Date: Nov, 2014

Funding source: DAFM (08/RDT/MFRC/636)

Project dates: Nov 2008 – Feb 2014

How to Proceed

For further information access the full Technology Update at:

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Interaction of Gene Expression Pathways, Breed and Diet on the Nutritive and Flavour Aspects of Pigmeat

Key External Stakeholders

Pig producers and pigmeat processors

Practical Implications for Stakeholders

The outcome of this research provides more in-depth understanding of factors such as breed, muscle, sex and diet which can have a significant effect on meat quality, in particular intramuscular fat (IMF) levels.

- A number of genetic pathways which respond to these factors through alterations in their expression levels have been identified.
- Blood parameters provide potential as novel routine markers for quality characteristics with circulating triglyceride and albumin levels associated with dietary treatments.
- Many of the genes identified as differentially expressed between Duroc and Pietrain breeds are



likely to harbour genetic variability in their regulatory regions that may ultimately have applications in meat management and/or genome-assisted animal selection programmes. This project shows the potential of nutrigenomics to optimise the efficacy of pork production regimes.

Main Results

- Generation of a knowledge baseline of quality and gene expression differences between two breeds (Duroc and Pietrain) with regard to IMF deposition.
- Demonstration, at a molecular level, that the degree of IMF deposition is as a result of a suite of diverse genomic responses with the importance of signaling pathways, lipid, fatty acid and steroid metabolism and the immune response highlighted.
- A muscle effect was highlighted, in relation to IMF content, in the influence of restricted lysine treatment on meat quality, with the *semimembranosus* (leg) muscle responding more strongly than the striploin muscle. Breed also influenced the response with Duroc muscle (both muscles) exhibiting a greater response to the restricted diet.

Opportunity/Benefit

Information generated in the course of this project will aid the improvement of meat quality traits in Irish pork. The results highlight the importance of breeding and selection programmes and the need to emphasise improvement in meat quality without compromising the production gains from traditional selection for lean carcass and high growth rate. The new knowledge generated about the Duroc breed is highly relevant as there is a gradual increase in the proportion of genetics of breeds such as Duroc in Irish

and European commercial operations. This project may potentially open up the application of nutrigenomics to improve the efficacy of pork production regimes. The control and manipulation of these genes is a promising pathway of research for the future and Teagasc welcomes expressions of interest in this research.

Collaborating Institutions

University College Dublin

Project Number: 5420

Funding Source: DAFF (04/R&D/TN/262)

Date: October, 2011

Project Dates: Mar 2005 – Mar 2010

How to Proceed

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Investigation of Bioactive Peptides in Food Through the Application of Mass Spectrometry Techniques

Key External Stakeholders

Food producers and processors, Functional/ Nutraceutical Food Manufacturers, Consumers, Pharmaceuticals, Research Communities

Practical Implications for Stakeholders

- Bioactive peptides are segments of dietary proteins, which can have salutary health-effects.
- Analysis of bioactive peptides is however difficult due to the complex nature of food samples and requires specialised analytical instrumentation and software.
- Various sources of bioactive peptides including meat, cereals and food-by-products have been investigated using mass spectrometry techniques.
- A facility and expertise is now available to support the food industry and collaborative research in the analysis of food bioactive peptides.



Main Results

- Anti-oxidant peptides from bovine liver proteins were characterised.
- An ACE-I and renin inhibitory peptides from bovine blood proteins consisting of 2–4 amino acids in length were identified.
- Anti-inflammatory, ACE-I and renin inhibitory peptides from potato peel proteins were sequenced.

Opportunity/Benefit

Mass spectrometry based analytical methods have been developed to sequence bioactive peptides in a variety of food matrix. This facility can be utilised by the food industry to identify bioactives and support functional food product development.

Collaborating Institutions

Cork Institute of Technology
University College Cork

Project number: 5984

Funding source: Teagasc

Date: November, 2015

Project dates: Sept 2008 – Aug 2011

How to Proceed

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Investigation of Stickiness of Milk Powder for the Purpose of Improved Process Control in Milk Powder Manufacture

Key External Stakeholders

Dairy ingredient manufacturers, infant milk formula manufacturers

Practical Implications for Stakeholders

- Partial substitution of lactose with proteins or maltodextrin can reduce stickiness problems during drying, crystallisation and storage.
- New measurement techniques have been developed and are applicable to industry.

Understanding the effects of specific formulation components (type of sugar, type of protein) on stickiness is of immense practical benefit with regard to new product development. To this end the project has demonstrated the role of different powder constituents (proteins, maltodextrins and lactose) on stickiness and has developed measurement techniques that are in use in our laboratories.



Modelling was used to show how to deal with the constraints of drying sticky products (including infant formula and other high lactose formulations) and how to optimise process control to maximise production while avoiding plant blockage (and downtime) while air humidity varies.

Main Results

- Partial substitution of lactose with proteins (i.e. higher molecular weight components) is a means of reducing stickiness problems.
- Maltodextrin inclusion in skim milk powder decreases susceptibility to sticking during drying and crystallisation during subsequent storage.
- Modelling was used to show how to deal with the constraints of drying sticky products (including infant formula and other high lactose formulations).

Opportunity/Benefit

Teagasc can assist interested parties in improving process efficiencies in the manufacture of dried products. The opportunity exists for further research in this area and expressions of interest from relevant companies are invited.

Collaborating Institutions

University College Cork

Project Number: 5632

Funding Source: DAFF (06/RD/TMFRC/443)

Date: July, 2011

Project Dates: Nov 2006 – Nov 2010

How to Proceed

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Investigation of the Presence of Anti-Nutritional and Toxic Compounds in “Health Foods”

Key External Stakeholders

Manufacturers, wholesalers and retailers of health food products, general public, regulatory agencies: DAFF, FSAI, IMB

Practical Implications for Stakeholders

The objective of this project was to investigate the occurrence of microcystin (MC) and aristolochic acid (AA) toxins in algal and herbal products, respectively.

- Methods were developed and validated to detect AA and MC toxins, which can be employed to monitor the safety of health foods.
- Contaminated products were detected and removed from the Irish market.
- A number of health alerts were published worldwide including, Ireland, the UK and Canada.



Main Results

- MC toxins were detected in Klamath Lake blue green algae (BGA) products, which are sold in health foods shops throughout the island at concentrations between <0.5 and 3 mg/kg.
- MC toxins were not detected in spirulina BGA products, which may be used as a substitute for Klamath Lake products.
- AA toxins were detected in some herbal preparations sold on the island but these products have been removed from the market.

Opportunity/Benefit

- Stakeholders can now access analytical methods for detecting AA and MC toxins.
- A novel biosensor assay was developed for detecting MC toxins, which has the potential to be exploited as a rapid test.

Collaborating Institutions

Xenosense Ltd., Belfast.

Project Number: 5429

Funding Source: DAFF (SafeFood 04CR-06)

Date: January, 2010

Project Dates: Oct 2005 – Oct 2008

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Kinetic Trapping: A Novel, Energy-Efficient Approach to Designing Protein-Based Fat Replacers

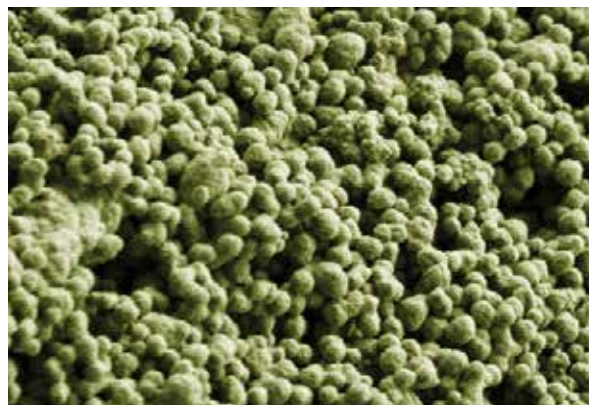
Key External Stakeholders

Dairy & food industry, ingredient manufacturers

Practical Implications for Stakeholders

Kinetic trapping is a novel low-energy process for producing nano- and micro-sized protein particles. The technology relies on precise process control of standard food ingredient mixtures using readily available food manufacturing equipment. The kinetic trapping process represents a **new platform technology** for producing size-controlled protein particles in the nano- and micro-size range which was developed and used in this project to produce novel fat replacer ingredients. The benefits of such ingredients when compared to other fat replacers include reduction in capital costs, lower energy demand, enhanced nutrition & functionality and improved sensory quality. Also the use of non-chemically modified i.e. natural ingredients is significant.

Because of health concerns relating to Olestra, a chemically modified oil-based fat replacer, the demand



for protein and polysaccharide based fat replacers is increasing. With the market for fat-replacers globally expected to be **280,100 metric tons** with a compound annual growth rate of 6.03% between 2011 and 2015 (Global Industry Analysts), the availability of such a novel fat replacer ingredient has significant implications for the dairy and food industry and specifically ingredient manufacturers.

Main Results

- A new whey protein-based fat replacer ingredient was produced using kinetic trapping.
- The novel fat replacer ingredient was produced in dried form with and without konjac gum (soluble dietary fibre) and had creamy texture when added to ice cream. It was whey protein particles size-optimised (100 nm – 10 μm) and calcium enriched (~100mM Ca⁺).
- Conditions for production were optimised and ingredients produced in spray dried form.

Opportunity/Benefit

This novel platform technology represents a significant advancement in production of fat replacer ingredients and a patent application is currently being filed to protect the novel process and resulting unique products. Teagasc is keen to engage with dairy and food industry and ingredient manufacturers to consider collaborative opportunities as a means of optimising, validating and ultimately commercialising this technology.

Project number: 6041

Funding source: EI (POC-2009-260)

Date: January, 2012

Project Dates: Jan 2009 – Dec 2010

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Mining for Milk-Based Bio-Actives Using Microbial Fermentations

Key External Stakeholders

Irish dairy industry, dairy farmers, consumers

Practical Implications for Stakeholders

- Added functionality of casein, whey and milk based powders with health benefits beyond those associated with nutrition, increased profitability to the Irish milk sector.
- Improved health benefits to the consumer.



Main Results

The key results were:

- Dairy associated microbes with extracellular proteolytic activity were identified.
- Fermented casein, whey and skim milk based substrates and water soluble extracts from commercial cheeses, were made into freeze-dried powders, a number of which had bioactivity across a range of health indicator assays.
- Optimized fermentation and post-fermentation heat treatments were established that retained bioactivity.

Opportunity/Benefit

The range of bioactivities associated with the microbial fermented milk products will increase the functionality of milk-based ingredients, adding market value and extending the applications for the dairy industry. The development of products containing the bioactive ingredients will directly benefit public health. This project was a component of FHI, the primary objective of which was to attempt to release peptides from milk proteins that demonstrate bioactivity in the areas of interest to FHI.

Collaborating Institutions

DCU, UCD, UCC, UL and the companies Carbery, Dairygold, Glanbia and Kerry

Project number: 5939

Date: November, 2014

Funding source: EI & Industry; CC20080001

Project dates: Jan 2009 – Jun 2013

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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National Food Residue Database (NFRD)

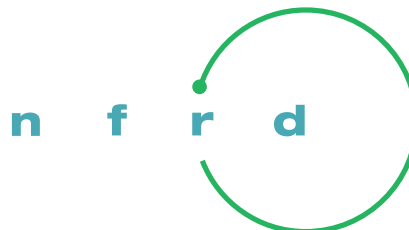
Key External Stakeholders

Food industry, state agencies (DAFF, Pesticide Control Service, FSAI, RPII, EPA, Marine Institute, State Laboratory), scientific community, general public

Practical Implications for Stakeholders

This funding has ensured the continued development and enhancement of the National Food Residue Database (NFRD), leading it to becoming the 'one stop shop' for chemical residue information in food in Ireland.

The project resulted in 49 new datasets being published on the NFRD website, along with two NFRD annual reports. An exposure assessment to pesticide contamination in food showed that the exposure to pesticides was well below the allowable daily intake (ADI) and the risk to the consumer from pesticides was low.



Consumer and industry confidence in food production and processing is key to the sustainability of the food industry in this country. The information contained on the NFRD can be used to promote the safety and quality of Irish food, through its use by the food industry and policy/regulatory agencies. In addition, 'country of origin' for pesticide results can aid importers of fruit and vegetable products to identify countries with safer produce. The NFRD needs to be continuously developed and maintained to help ensure that food safety is at the heart of the development of the food industry in Ireland.

Main Results

- 49 new datasets were uploaded and published on the NFRD website over the duration of the project.
- Two issues of the NFRD Report (2007/2008 and 2009) were published.
- Exposure analyses were conducted for 10 of the most commonly found pesticides (captan, carbendazim, chlorpyrifos, diphenylamine, fenahexamid, imazalil, iprodione, malathion, prochloraz and thiabendazole).
- Results from this study showed that exposure to pesticides was well below the ADI and the risk to the consumer (both adult and child) from pesticides was low.
- Extensive dissemination was been carried out during the project through publication on the NFRD website, NFRD annual reports and through a workshop.

Opportunity/Benefit

The National Food Residue Database can be used as a reference tool by exporters, when queried about the safety of Irish food. It can also be used by importers and processors when buying products from outside of Ireland.

Collaborating Institutions

University College Dublin

Project Number: 5640

Funding Source: DAFF (06RDТАFRC535)

Date: January, 2012

Project Dates: Nov 2006 – Nov 2009

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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New and Rapid Methods for Evaluating the Baking Characteristics of Irish Grown Wheat Varieties

Key External Stakeholders

Millers, bakeries, food ingredients companies, food manufacturers

Practical Implications for Stakeholders

Based on the results of this project, it is now possible for Teagasc to recommend rapid, scientific, accurate tests on grains, flours, doughs and baked products to the industry. Furthermore, researchers at Ashtown have the expertise to work with industry and increase capabilities in these areas, or to engage in confidential industry-led research, using these newly developed methodologies.

As some traditional methods are not deeply scientific, it is possible that some vital information relating to dough and baked properties had not previously been uncovered. Therefore, the methods which have been developed should be of significant advantage to the milling, baking and food industry for a complete analysis and better characterisation of their raw materials and end products, while complementing the more traditional cereal methods.



The new suite of modern and novel methods developed for use along the complete chain from the grain to the finished products includes spectroscopy, rapid flour protein fractionation, laser imaging and digital image analysis.

Main Results

Novel methods have been developed in the following areas:

- Near infra-red spectroscopy of grain, flour, dough and bread.
- Flour protein fractionation.
- Native starch and protein properties of flours.
- Imaging of confectionary batter and cookie dough during baking.
- Laser imaging of bread dough fermentation and density properties.
- Digital image analysis of bread crumbs.

Opportunity/Benefit

Advice, consultancy work and/or technical services, relating to the novel and/or traditional methods, in the areas of wheat chemistry, dough rheology and baking processes, can be provided through the Teagasc Food Research Centre, Ashtown.

Collaborating Institutions

University College Dublin

Project Number: 5412

Funding Source: DAFF (04/R&D/TN/249)

Date: June, 2011

Project Dates: Jul 2005 – Jan 2009

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Novel Fruit Products from Apples and Other Tree Fruit (IsaFruit)

Key External Stakeholders

Vegetable processors, government authorities/legislators, consumers, food research scientists

Practical Implications for Stakeholders

The project developed a number of fresh cut fruit salads and ready-to-eat dessert products enriched with functional ingredients to capitalise on the growing functional food market. These products incorporated a range of functional ingredients including pre- and pro-biotics. An Irish based SME was involved in the development of these products and is interested in launching them when economic conditions improve.



Main Results

- Fruit cultivars with optimal properties for the development of fruit based desserts and fresh cut salads were selected based on their sensory, physicochemical and quality attributes.
- Novel protocols were developed for incorporation of functional ingredients using technologies such as edible films and vacuum impregnation.
- Functional ingredients were added at levels required to deliver the health benefit based on manufacturers' recommendations.
- At all points the sensory and quality attributes of the products were assessed to ensure that a real marketable product was being produced.

Opportunity/Benefit

Fruits and fruit products are seen as healthy by consumers. However, if their market share is to grow they need to take advantage of the growing functional food market which fulfils consumer demands for products which deliver a health benefit beyond basic nutrition. This project demonstrated that fruit based functional foods with optimal functional, quality and sensory properties could be developed.

Collaborating Institutions

University College Dublin, Nature's Best Ltd, IRTA

Project number: 5548

Funding source: EU FP6 (016279)

Date: July, 2011

Project Dates: Jan 2006 – Sep 2010

How to Proceed

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Novel Proteins and Peptides from Seaweeds

Key External Stakeholders

Protein ingredient manufacturers, marine processors

Practical Implications for Stakeholders

- Novel protein sources for use in the sports nutrition markets, Halal and Kosher as well as vegetarian markets.
- Increases essential amino acid profile of products.
- Imparts a health benefit.



Main Results

- Bioactive peptides isolated from red seaweed were found to reduce blood pressure when tested in the lab and in spontaneously hypertensive rats (animal models).
- A novel hydrolysis and purification methodology was employed and applied to red seaweed.
- Optimal conditions for developing bread products with this hydrolysate were determined and blood pressure regulation activity was maintained.

Opportunity/Benefit

Protein extracts developed as part of this project were examined for their essential amino acid content, ability to inhibit enzymes important in blood pressure control and suitability for use in cereal products such as bread. Extracts could have benefits in the manufacture of food products for the prevention of heart health associated problems such as blood pressure.

Collaborating Institutions

National University of Ireland, Galway

University College London, UK

Project number: NutraMara – The Marine Functional Foods Research Initiative, Teagasc Walsh Fellowship Programme and INFOGEST (EU COST Action FA1005)

Date: May 2015

Funding source: DAFM and Marine Institute and Teagasc

Project Dates: October 2009 – October 2014

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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NOVTECH: The Use of Novel Technologies for Improving Quality and Process Efficiency in High Protein Beverage Production

Key External Stakeholders

Food manufacturers, dairy industry, research communities

Practical Implications for Stakeholders

- The novel technology of supersonic steam injection provides an alternative method for thermal processing of dairy products.
- An investigation into the benefits with regards to the physical and chemical properties of dairy based products processed using this technology.



Main Results

- Steam injection is a direct method of thermal processing in which food grade steam, under pressure, is directly mixed with the food product creating a more rapid rate of heat transfer than traditional methods.
- Maklad injectors use a specialized form of de Laval nozzle to achieve supersonic flow within the injection chamber. This is to aid in the rapid mixing of product and steam streams and provides a small level of homogenization.
- The rapid heat transfer and subsequent flash cooling result in a reduced thermal load experienced by the product. This has been shown to impart reduced protein denaturation in skim milk compared to products processed using conventional indirect tubular heat exchangers.
- The use of flash cooling within the system provides an opportunity for a small level of total solids concentration. This can be controlled by altering the temperature differential between the product inlet and flash cooling outlet.
- The steam injection unit can be used to 160°C and is Teflon coated to reduce burn on from product when mixed with the steam.

Opportunity/Benefit

this technology in conjunction with dairy based products, particularly dairy based protein beverages. This heat treatment technology has the potential to yield dairy products with improved physical and chemical characteristics compared to that of conventional indirect heat treatments.

Collaborating Institutions

University College Cork

Project Number: 6284

Funding Source: DAFM

Date: November, 2015

Project Dates: Oct 2012 – Oct 2016

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Nutraceutical and Functional Food Bio-active Peptides in Beef, Bovine Offals and Fermented Meat Products

Key External Stakeholders

Beef processing sector

Practical Implications for Stakeholders

The main outcome of this research provides support for a strategic approach to recovering value from the meat processing chain. Clear evidence has been presented that bio-active peptides can be generated from low value meat and offal. The capabilities for generating, isolating and characterising bio-active peptides from meat sources have been established at Teagasc. The assays have been optimised and are now part of a full peptide isolation, purification and characterisation infrastructure available to the Irish food industry. The potential of generating bio-active peptides from bovine offal and low value muscle has been demonstrated in this project. Research in the extraction of commercially valuable peptides from



meat and meat industry by-products is in its infancy and this project provides a solid foundation on which future development and discovery will inevitably yield scientific advancement and commercial return.

Main Results

- Capabilities established for the generation, isolation and characterisation of bio-active peptides from meat sources.
- Antioxidant peptides successfully generated from bovine liver.
- Peptides with antioxidant and antihypertensive activity isolated from brisket fractions.
- Peptides generated from bovine lung which exhibited antioxidant, antihypertensive and antithrombotic activity.
- Heart peptide fractions displayed antioxidant and antimicrobial activity.
- Bio-active peptides generated from proteins isolated from bovine muscle.

Opportunity/Benefit

Knowledge generated in this research will be beneficial in developing strategies to recover value from meat processing streams. Such scientific expertise and infrastructure should act as a springboard to encourage the exploitation of the protein component of offal and waste streams produced by the meat industry, as a source of high value biologically active ingredients with food and pharmaceutical applications.

Collaborating Institutions

University College Cork

Project number: 5636

Funding source: DAFF (06RDТАFRC472)

Date: March, 2012

Project Dates: Dec 2006 – Nov 2010

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Optimum Milk Quality Focusing Particularly on Chemical Residues

Key External Stakeholders

Dairy farmers, Milk processors, Export markets, members of veterinary profession

Practical Implications for Stakeholders

- The Dairy industry (milk producers and processors) and Teagasc, Moorepark have worked in collaboration since 2007 to identify and develop strategies for trichloromethane (TCM) residue reduction in milk and butter. A reduction in average milk values from 0.007 to 0.003 means that Irish butter exports will continue to compete favourably on the German market;
- Both dietary iodine supplementation and teat disinfection iodine individually result in milk iodine levels exceeding common target values of 250–300µg/kg. Both iodine treatments can frequently occur simultaneously on farm, thus supplementations should be monitored, particularly in light of infant feed formula manufacture;
- Traces of active ingredients of some flukicide



products will migrate from whole milk to skim milk powder. Therefore it is important that research be conducted to establish MRLs (maximum residue limits) in milk and dairy products, for the active ingredients in animal treatment products (e.g. flukicides) to ensure (a) avoidance of risk to public health and (b) prevention of animal health issues by allowing use of effective products (some have been banned due to the absence of an MRL).

Main Results

- Milk TCM levels have been reduced to 0.002 mg/kg in milk in 2011, i.e. the target level in milk that ensures TCM never exceeds 0.03 mg/kg in the butter product. These low levels have to be maintained in the long term;
- Supplementation of dietary iodine at 30 and 70 mg/day significantly increased mean milk iodine concentrations from 208µg/kg to 672 and 733µg/kg, respectively. Teat disinfection post-milking and pre- + post-milking significantly increased the mean iodine concentration from 219µg/kg to 475 and 670µg/kg, respectively;
- Between 95% and 98% of Nitroxylin (active ingredient in flukicide product) migrated from whole to skim milk. The remainder was within the cream. When skim milk was converted to skim milk powder, almost 100% of Nitroxylin was transferred into the powder.

Opportunity/Benefit

These results may be used by (i) dairy farmers to improve their milk quality on-farm, (ii) milk quality advisory personnel to solve milk residue issues on-farm and (iii) bodies such as DAFM and IDB in promoting dairy products for the export market.

Collaborating Institutions

Cork Institute of Technology, Bishopstown, Cork.

Project number: 5895

Funding source: Dairy Levy Funding

Date: February, 2012

Project dates: Jan 2009– Dec 2011

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Pathogenic *Escherichia coli* Network

Key External Stakeholders

Farmers, food processors, scientists, regulatory personnel, medical doctors, veterinarians, epidemiologists, microbiologists, consumers, European Food Safety Authority (EFSA)

Practical Implications for Stakeholders

Up-to-date information and advice on the different *Escherichia coli* pathogens, detection, epidemiology, pathogenicity, virulence, ecology and control in the farming and beef processing stages of the food chain.



Main Results

Six reports were published on current knowledge, identifying data gaps and making a range of key recommendations designed to improve food/medical testing, epidemiological investigations, control and our overall understanding of these serious pathogens.

Opportunity/Benefit

This project furthered the existing knowledge base by bringing together international experts on pathogenic *E. coli*, especially verocytotoxigenic *E. coli* (VTEC), to discuss and resolve issues relating to culture and molecular detection, virulence, pathogenicity, epidemiology, ecology and control.

Collaborating Institutions

See full Technology Update

Project Number: 5704

Funding Source: FP6 (FOOD-CT-2006-036256)

Date: June, 2011

Project Dates: Jan 2007 – Jan 2010

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Pork Food Safety

Key External Stakeholders

Irish pork producers, Irish pork processors, regulatory agencies (FSAI & DAFM), retailers

Practical Implications for Stakeholders

- Pig farm: Urea or ammonia may be used to disinfect *Salmonella* and/or *Yersinia enterocolitica* contaminated pig slurry.
- Pig abattoir: A time-temperature combination of 2.67 min at 60°C is required to achieve a 1 log reduction in *Y. enterocolitica* in scald tank water. The predicted equivalent at 65°C is 0.59 min.
- Pig abattoir: Cross contamination occurred in the lairage and during carcass processing. More effective sanitation is recommended.



Main Results

The incidence and spread of *Salmonella* and *Y. enterocolitica* on Irish pig farms could be reduced through the application of urea or ammonia to disinfect animal waste. *Y. enterocolitica* contamination on pork carcasses would be reduced if the time-temperature combination in the scald tank was set at a minimum of 2.67 min at 60°C or equivalent and cross contamination of carcasses could be prevented if the lairage area was disinfected more efficiently. All of this would result in reduced pathogen contamination on pork carcasses and in pig products thus protecting public health and pork consumers.

Opportunity/Benefit

This project provided information on the control of key pathogens in Irish pork at the farm and processor stages. Interested industry and regulatory personnel should contact Dr. Declan Bolton directly to discuss implementation. The main benefit of implementing the results of the project would be a reduced risk of pork associated illness thus protecting public health and the reputation of the Irish food industry. Furthermore, the current status of the Irish pig industry in European Food Safety Authority (EFSA) league tables would improve.

Collaborating Institutions

University College Dublin

Project Number: 5706

Funding Source: FP6 (FOOD-CT-2007-036245)

Date: March, 2012

Project Dates: Jan 2007 – Dec 2011

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Potato Peels: a Rich Source of Pharmaceuticals and Bioactives

Key External Stakeholders

Potato growers, potato processors, pharmaceuticals, functional food manufacturers, government authorities/legislators, consumers, food research scientists

Practical Implications for Stakeholders

Large volumes of potato peels as by-products are generated as a result of processing of foods. This project highlighted the potential use of this waste as a source of bio-active compounds for bio-pharmaceutical and natural bio-control agents.



Main Results

- A set of optimised methods for the extraction, isolation, purification and characterisation of glycoalkaloids was developed.
- The purified aglycone glycoalkaloid, solanidine, had a high potential to synthesize novel anticancer and apoptotic drugs.
- None of the 9 different cultivars exceeded the threshold of toxicity of glycoalkaloids content of 1 mg/g. As expected, room temperature storage influenced the greater production of glycoalkaloids in peels when compared to potatoes stored at chilled temperature.
- Glycoalkaloids and potato peel extracts enriched in glycoalkaloids did not possess anticancer potential nor did they induce apoptosis nor showed cardioprotective effects. However, they demonstrated anti-inflammatory and immuno-modulatory potentials. Whilst the potato peel peptides showed anti-inflammatory, anti-hypertensive and modest anti-oxidant activities.
- Pelleted potato peels rich in glycoalkaloids controlled the level of nematode *Globodera pallida* in conjunction with crop rotation or nematicide and more importantly the light treated pelleted peels had significantly higher 'suicide hatch' rate of potato nematodes.

Opportunity/Benefit

The methods developed for the recovery of compounds from their waste streams will allow potato processors to exploit a potentially valuable resource. Information on the

levels of toxic glycoalkaloids in Irish fresh potato cultivars and the effect of commercial storage conditions used by the processing industries will be available. The outcomes of the project will also indirectly address the call for sustainable agriculture development as it seeks to find an environmentally safe solution for the control of potato nematodes, a major pest of potato crops, which cause significant damage and losses.

Collaborating Institutions

University College Cork; Largo Foods, Ashbourne, Co. Meath; Wilson's Country, Craigavon, Co. Armagh.

Project number: 5961

Date: December, 2008

Funding source: DAFF 08/RD/TAFRC/673

Project dates: Dec. 2008 – July 2014

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Pre-commercial Scale-up of Biologically Active Milk Protein Hydrolysates (FHI Project WP3)

Key External Stakeholders

This Industry-led, EI-funded Food for Health Ireland (FHI) project was co-funded by 4 major Irish dairy manufacturers Glanbia, Kerry, Carbery and Dairygold. The FHI project was governed by a consortium agreement drawn-up in conjunction with all participants which set out protocols for the uptake of results.

Practical Implications for Stakeholders

Successful precommercial scale-up work at Moorepark retained bioactivity of FHI lead functional compounds (LFCs) i.e. enzymatically-produced milk protein hydrolysates and their sub-fractions in line with their original laboratory-based protocols, and also satisfied the microbiological specification necessary for formulation of the active ingredients in human clinical trial diets (undertaken by UCD).

- Pre-commercial scale-up contributed substantively towards the compilation of technological data

which will be incorporated in scientific dossiers setting out health claims for individual LFCs to be submitted to the European Food Safety Authority (EFSA).



- In addition to the protocols and LFC's assigned by FHI, the pre-commercial scale-up team generated a novel casein-based hydrolysate and sub-fractions which was biologically active against multiple physiological functions (anti-inflammatory; endothelial and satiety-ghrelin).
- Technological developments employed to enrich biological activity during scale-up included advances in membrane separation technology e.g. charged- and electro-membrane based processes.

Main Results

The following is a list of outputs accomplished by the FHI pre-commercial scale-up team:

- No. protocols validated (laboratory): 150.
- No. plant scale-up trials: 50 (small) and 35 (large).
- **LFC's** (Lead Functional Compounds): 6 based on the MF025 hydrolysate series
- **ACR** (Available Centre Result): 1 (Hypoallergenic Infant Dessert).
- **NPD** (Novel Product Development): 3 (Family Milk & HA Infant Dessert).
- Complementary research highlighted the benefits of protein aggregation-enhanced enzymatic hydrolysis.

Opportunity/Benefit

Ground rules laid down in the FHI consortium agreement set out conditions for priority right of access by its Industry Partners to project outputs with commercial potential. Otherwise, expressions of interest in the scale-up and characterisation of FHI milk protein hydrolysates and their fractions will be entertained by the technology transfer officer. An FHI 'available centre result' (ACR) based on the novel formulation of a hypoallergenic infant food (desert-format) is currently licensed out for evaluation.

Collaborating Institutions

UL, UCD, UCC, DCU

Project number: 5940

Date: October, 2014

Funding source: Enterprise Ireland

Project dates: June 2008 – May 2013

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Predicting Beef Eating Quality

Key External Stakeholders

Beef processors, retailers

Practical Implications for Stakeholders

Beef processors could use the Meat Standards Australia (MSA) grading system to sort individual cuts into eating quality classes priced accordingly. Such a guarantee of expected eating quality could increase the share of the market particularly at the premium end. For optimum eating quality boning should not be carried out on the day after slaughter. Processors and retailers need to consider the negative effects of MAP on eating quality.



Main Results

- The MSA palatability grading scheme uses a predictive model to assess the eating quality of individual cuts from each carcass and assigns them to a quality class.
- Although the model was developed in Australia using Australian consumers our research showed that it worked equally well for Irish beef and Irish consumers.
- The model was tested over a wide range of carcass types and for three cooking methods (grill, roast and thin slice) with over 1600 consumers tasting over 1100 samples.
- Factors of particular importance to the Irish beef industry (breed, sex, electrical stimulation, aitch-bone hanging, prolonged ageing) were accounted for by the model.
- Boning at 24 versus 48 hours post mortem had a small negative effect on eating quality and this was not accounted for by the model.
- PiVac, a novel method of avoiding cold shortening of hot boned beef (Tenderbound) produced meat of equal quality to cold boning.
- High resolution imaging using hyperspectral imaging can predict eating quality attributes with a high degree of accuracy.
- High oxygen MAP promotes lipid oxidation leading to off-flavours and protein oxidation leading to less tender meat.
- Irish consumers preferred meat from MAP packs with 50% oxygen despite a high level of lipid oxidation.

Opportunity/Benefit

Irish beef processors could use the MSA system to sort beef into quality classes and supply the market with beef of guaranteed quality.

Collaborating Institutions

UCC and UCD

Project Number: 5418

Funding Source: DAFM 04/R&D/TN/256

Date: October, 2013

Project Dates: April 2005 – June 2008

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Prevalence and Epidemiology of Emergent Strains of Verocytotoxigenic *E. coli* (O157, O26 And O111) in Irish Food Animals at the Pre-Harvest and Harvest Levels of the Food

Key External Stakeholders

Meat and dairy industry, Food Safety Authority of Ireland

Practical Implications for Stakeholders

Verocytotoxigenic (VTEC) *E. coli*, and in particular serogroup O157, are highly significant food borne pathogens. More recently, other non-O157 VTEC serogroups, in particular O26 O111, O103, and O145 have emerged and been associated with human illness. This project focused on establishing the risk posed by *E. coli* O26, O111, O145, and O103 as well as O157 in ruminant food animals (cattle and sheep) and on their transmission from hide/fleece to meat carcasses during the slaughter and dressing



operations. The project also generated data on these pathogens in dairy cattle and raw milk from selected dairy herds. The key message from the study is that *E. coli* O157 remains the most common serogroup. In the meat chain, the hide and fleece are the most important sources of contamination.

Main Results

- **Beef:** *E. coli* O157 was detected in 15.96% of hide, 2.33% of faeces, 0.59% carcass (pre-wash), 0.63% (post-wash) and 3.03% environmental samples. The majority of isolates were highly virulent. *E. coli* O26 was isolated from 0.25% of hide, 1.48% of faeces and 0.56% of environmental samples but no other sample types. *E. coli* O145 was isolated from 0.74% of faeces samples and 0.56% of environmental samples but not on carcass surfaces. *E. coli* O111 was not detected in any of these samples. Of the non O157 serogroups, only a small proportion were virulent.
- **Sheep:** *E. coli* O157 was found in 1.0% of fleece and 0.8 % of carcass samples. *E. coli* O26 was recovered from 2.4 % of fleece, 1.8% of carcass and 4.1% of environmental samples. O103 was found in 16.0% of fleece and 12.6% of carcass swabs and *E. coli* O145 was recovered from 0.2% of fleece samples. *E. coli* O111 was not detected in any of the samples processed.
- **Dairy:** 1% of dairy faecal samples contained O157, O26 or O103 strains but none of the milk or milk filter samples yielded any virulent isolates.

Opportunity/Benefit

Advice, consultancy work and/or research can be provided by Teagasc on Verocytotoxigenic *E. coli*.

Collaborating Institutions

University College Dublin, Cork County Council Veterinary Unit

Project Number: 5555

Funding Source: DAFF (05/R&D/D/364)

Date: January, 2011

Project Dates: Jun 2006 – May 2009

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Probiotic Lactobacilli Survival and Impact in the Animal Gut

Key External Stakeholders

Animal feed manufacturers; thoroughbred racehorse industry, veterinary health professionals

Practical Implications for Stakeholders

- This project provides first time information on the microbial ecology of the equine, and other mammalian species gut.
- This project also provides information on commensal lactobacilli found in the gut microbiota of humans and animals.



Main Results

- The project provided definitive genome-based evidence to support the fermentation patterns of sixteen strains of *Lactobacillus ruminis*, and has identified prebiotic carbohydrates with the potential to promote *L. ruminis* growth *in vivo*.
- This project identified the core faecal microbiota of ruminants, hindgut fermenters and mono-gastric animals co-localised to a single farm in Ireland.
- The project provided details for the first time, on the faecal microbiota of thoroughbred racehorses, both active and at rest.
- Analysis of the thoroughbred horse microbiota has revealed *Lactobacillus equi* to be a predominant *Lactobacillus* species in the hindgut. Genome analysis identified genes and enzymes highlighting *L. equi* adaptations to the herbivorous gastrointestinal tract of the horse, including fructan hydrolases.
- Having sequenced the genome of *Lactobacillus equi*, will help to further understand the microbial ecology of the equine hindgut and the influence lactobacilli have on it.

Opportunity/Benefit

The outcomes of this project is of relevance for the basic understanding of commensals/probiotics, potential mammalian applications, and potential alternatives to in-feed antibiotics for the animal production industry and generation of information of direct relevance for human probiotic consumption.

Collaborating Institutions

Teagasc and University College Cork

Project number: 5972

Date: Summer 2014

Funding source: Science Foundation Ireland

Project dates: Sept 2008 – Aug 2013

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Product Reformulation and *In Vitro* Testing of Low Glycaemic Breads

Key External Stakeholders

Food ingredients companies, bakeries, millers, food manufacturers, consumers

Practical Implications for Stakeholders

Significant findings of the research conducted in this project include detailed information on a range of low glycaemic index (GI) grains and fibres/flours, and their application in novel low glycaemic index (GI) bread formulations. How these fibres behave under mixing, proofing and baking conditions has been assessed, and their shelf life (texture) and sensory properties have been established. This project has led to the development of new, high quality, low GI bread formulations.

A large number of new bread recipes containing a range of different low GI ingredients have now been formulated, and information is now available relating to the optimal water addition and mixing characteristics,



and expected bread, shelf life and sensory properties of the products. Both quantitative and qualitative sensory trials have shown that low GI flours may be introduced into a wheat bread formulation without significantly negating the sensory properties of the resulting breads.

Main Results

- Compositional characterisation of low GI grains.
- Flour blending and baking methods for new low GI bread formulations.
- Sensory properties of new low GI formulations.
- Fundamental rheology, baking and molecular aspects of the new formulations.
- An *in vitro* method for calculating the glycaemic index of the formulations.
- Scientific and technical publications describing the research methods and how the results and formulations may be utilised by an end-user.

Opportunity/Benefit

Advice, consultancy work and/or technical services, relating to the methods and/or formulations developed during this project can be provided at Teagasc Food Research Centre, Ashtown, particularly in the areas of cereal chemistry, dough rheology and baking processes.

Collaborating Institutions

University College Cork

Project number: 5714

Funding source: DAFF (06/R&D/TAFRC/522)

Date: March, 2012

Project Dates: Oct 2006 – Mar 2010

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Properties of Nano-fibrillar Whey Proteins

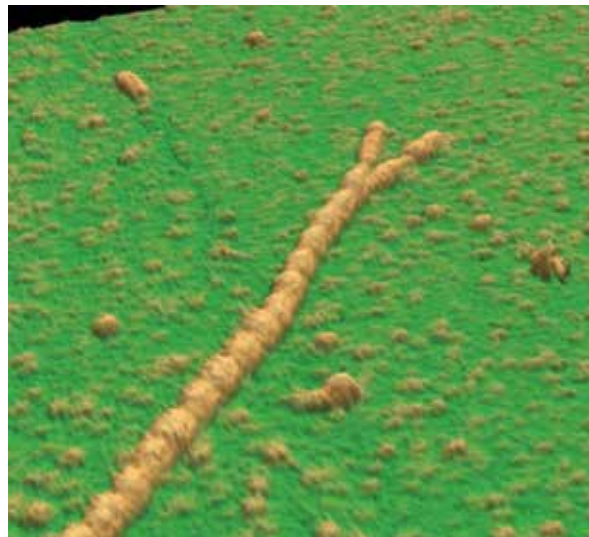
Key External Stakeholders

- Dairy Industry
- Food and Ingredient Manufacturers
- Biotechnology companies
- Academic Institutions

Practical Implications for Stakeholders

The main objective was to produce fibrillar whey proteins at the nano-scale and assess their potential as functional ingredients. Main outcomes included:

- Optimised conditions for producing stable nanofibrillar whey proteins.
- Nanotechnology expertise in characterising the structure and formation mechanism of fibrillar proteins.
- Shown that nanofibrils can be used to create low salt gels, foams and biofilms.
- Development of nano-fibrils into a spray dried ingredient.



- Established a research platform of expertise in food nanotechnology.

Main Results

- Mechanism for forming nanofibrillar whey proteins has been established.
- Functionality of the nanofibrils has been assessed.
- Spray dried nanofibrils have been produced.
- New atomic force microscopy expertise has been gained.

Opportunity/Benefit

This has established Ireland's first food nanotechnology platform based on nano-engineering food structures. Whey-based nanofibrils have unique functionality, in particular they are excellent foaming agents that can be used to replace more expensive ingredients such as egg-white. In addition, nanofibrils can be used as texturing agents in food products, for example to produce low-salt gels.

Collaborating Institutions

Materials and Surface Science Institute, University of Limerick

Institute of Food Research, Norwich

Wageningen University

Project number: 5607

Date: September, 2013

Funding source: DAFM (06/RDT/MFRC/432)

Project dates: Oct 2006 – Mar 2010

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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ProSafeBeef: Assessment of Microbiological and Chemical Safety of Beef

Key External Stakeholders

Beef sector, Regulators, FSAI

Practical Implications for Stakeholders

This research study indicated that the risk posed by the microbial pathogens and chemical residues examined in beef was generally low. Nonetheless the study showed that the hide was an important vehicle of microbial pathogen contamination into the abattoir and would thus be a key target for risk reduction measures. A new technology for anthelmintic drug residues was developed and is now in use by the Irish national reference laboratory.



This research was carried out as part of a multi-national EU Framework project, *ProSafeBeef* which focused on research and innovation to improve beef safety and quality. Research on beef safety at Teagasc focused on the risk posed by microbial pathogens and chemical residues in beef.

Main Results

- The occurrence of verocytotoxigenic *E.coli*, *Listeria monocytogenes*, *Campylobacter* and *Salmonella* in the beef chain was low. However many of the isolates that were recovered had traits similar to those seen in human illness-causing strains, highlighting the need for continued vigilance in the risk management of such pathogens along the beef chain (farm to fork).
- In this study *E.coli* O157, the most common type of VTEC in human illness, was also the most commonly recovered VTEC from beef. Emergent serogroups were recovered at a lower prevalence, and the majority of these isolates did not have the combination of virulence genes typically seen in human disease-causing strains.
- During slaughter, it was shown by genetic fingerprinting that, the source of pathogens on a carcass could be from an animals own hide or from the hide of other animals being slaughtered on the same day, highlighting that the hide is a key target in the chain for interventions.
- A new state-of-the art Mass Spectroscopy (UHPLC-MS/MS) method was developed for the detection of 38 anthelmintic drug residues. This accredited method was then applied to assess occurrence of anthelmintic residues in 1061 retail beef samples from across Europe over a two year period. Results showed that the risk of exposure to EU consumers from anti-parasitic drug residues in beef was negligible.

Opportunity/Benefit

The study showed that the hide was an important vehicle of microbial pathogen contamination into the abattoir and would thus be a key target for risk reduction measures. A new technology for anthelmintic drug residues was developed and has been transferred to a number of EU laboratories, thus harmonizing the approach of residue control for beef consumed by EU consumers. This research underpins the safe image of EU beef, ensuring consumer confidence and safeguarding international investment in the sector.

Collaborating Institutions

See full Technology Update at www.teagasc.ie/publications

Project Number: 5705

Funding Source: FOOD-CT-2006-36241

Date: September, 2013

Project Dates: March 2007 to Dec 2012

How to Proceed

For further information access the full Technology Update at:
www.teagasc.ie/publications

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Protecting Consumer Choice: Ensuring the Provenance of Artisan Foods Produced on the island of Ireland

Key External Stakeholders

Artisan cheese producers; food processors; retailers; regulatory agencies; public analysts

Practical Implications for Stakeholders

Protection of Brand Ireland is of critical importance for the ingredients and processed foods industries. Artisan cheese production in Ireland has grown considerably over the last decade and has established a reputation for high quality. Linkage of production to local raw materials is a key characteristic of this developing enterprise sector. Development of appropriate analytical means to confirm the provenance of such finished cheeses would represent a key support for companies and lay some of the foundations to support a geographic designation label should any such be desired in the future. Meat products are ideal vehicles for fortification with extra



protein, vitamins and minerals and reformed products will provide enhanced and targeted nutrition to promote healthy ageing and vitality in the older population.

Main Results

- A representative sample set of Irish artisanal cheeses has been collected on two occasions over a 12 month period.
- Baseline data describing the content and variability of 11 elements (Na, Mg, P, K, Ca, Mn, Fe, Cu, Zn, Se and Mo) have been established.
- Corresponding data for ratios of naturally-occurring isotopes (H, C, O and N) are being collected.
- Preliminary results indicate that it may be possible to discriminate artisan cheeses produced on the island of Ireland from those produced on mainland Europe. Separation of cheeses produced in Ireland from those originating in Great Britain may not be possible.
- Currently, data collection and full mathematical analysis are being completed.

Opportunity/Benefit

Any successful application for geographic origin status within the EU will require, among other things, the demonstration of a verified analytical capability to confirm the claim being made. This project aims to demonstrate one potential approach to achieve such a capability. This approach mirrors that used successfully for the monitoring of Grana Padano cheeses in Italy for geographic provenance infringements by an industrial

consortium. This general analytical approach is capable of being applied to many food products to confirm geographic origin and other authenticity characteristics.

Collaborating Institutions

Queen's University Belfast

Project Number: NFD T-0101-6557

Funding Source: safefood

Date: 11/05/2015

Project Dates: 01/09/2013-31/07/2015

How to Proceed

For further information access the full Technology Update at:

www.teagasc.ie/publications

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Proteome Analysis to Improve Meat Tenderness

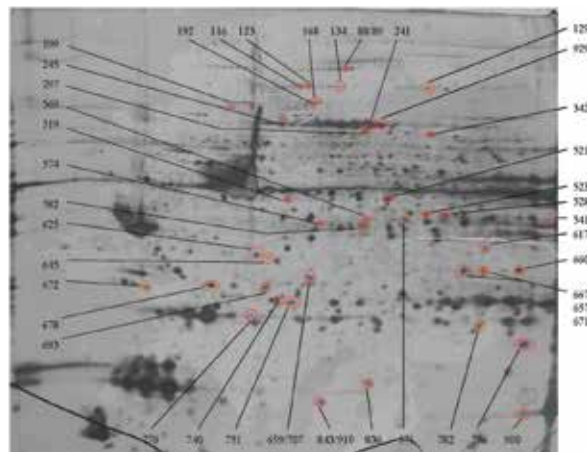
Key External Stakeholders

Meat processors, scientific community, government agencies

Practical Implications for Stakeholders

The main outcomes from this research relate to the increased understanding of factors underpinning variability in meat tenderness, with novel proteins identified, and information which will support optimisation of postmortem carcass management.

- Identification of a novel biochemical pathway which is of relevance to the development of tenderness in beef and pork.
- Increased understanding of known biochemical pathways influencing tenderness.
- Optimising postmortem interventions: importance of factors such as muscle composition, genetic makeup and animal age.



Main Results

- Structural protein degradation, metabolic enzyme systems and cell defense capability in early postmortem muscle contribute to final tenderness differences in beef and pork with a novel protein identified in cell defense pathways.
- Differential protein profiling was observed in response to postmortem interventions, in particular indicating the importance of intramuscular fat levels and the genetic makeup of the animal when using electrical stimulation.
- Tenderstretch influenced collagen solubility in both muscles while the total collagen content was not change. Microstructure analysis suggests that a greater separation of the myofibres did observed following tenderstretch treatment.

Opportunity/Benefit

Knowledge gained from this project could be beneficial in enhancing current grading systems to incorporate a tiered pricing system in terms of tenderness, and defining optimal postmortem intervention practices to provide assurance of tenderness to meet market demand.

Collaborating Institutions

University College Dublin

Project Number: 5422

Funding Source: DAFF (R&D/TN/254)

Date: March, 2012

Project Dates: Apr 2006 – Mar 2009

How to Proceed

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Public Health Significance of Emergent *Campylobacter* Species in the Irish Food Chain

Key External Stakeholders

Pork industry, poultry industry, public health laboratories, Food Safety Authority of Ireland

Practical Implications for Stakeholders

Campylobacter spp. is the most common cause of bacterial food borne illness in Ireland. It was considered up to the mid 2000's that infection was almost exclusively linked to just two species, *C. jejuni* and *C. coli*, but new methods capable of detecting 15 other species of the pathogen indicated that these emergent species were also causing human illness. This study investigated the occurrence and human virulence potential of emergent *Campylobacter* species in Irish pork, poultry and human clinical stool samples. The key finding was that these emergent



species are indeed widely prevalent in the food chain and have virulence factors which indicate their public health importance.

Main Results

- *Campylobacter* was detected in pig gut (caecal) contents (34.7%), pre chill pork carcasses (17%), pork cuts (9.5%) and chicken pieces (68%) with a wide range of species present across all sample types including *C. coli*, *C. jejuni*, and emergent species *C. lari*, *C. upsaliensis*, *C. mucosalis*, *C. curvus*, *C. sputorum*, *C. concisus*, *Arcobacter butzleri*, *Arcobacter Skirrowii*.
- *Campylobacter* was found in 4.8% of previously undiagnosed human clinical samples with emergent species *C. concisus* the second most common species recovered after known species *C. jejuni*.
- The majority of emergent species isolated had virulence genes typically found in known *C. jejuni* and *coli* giving further evidence of a link to human illness.
- *Campylobacter* isolates recovered from poultry and beef were genetically identical to isolates recovered from human stools. Isolates recovered from pork were less similar, indicating that the pork has less of a role in the transmission of human disease causing strains than other commodities.

Opportunity/Benefit

Advice, consultancy work and/or research can be provided by Teagasc on *Campylobacter*.

Collaborating Institutions

Public Health Laboratory at Cherry Orchard Hospital

Project Number: 5553

Funding Source: DAFF (05/R&D/TN/356)

Date: September, 2010

Project Dates: Jul 2006 – Jun 2009

How to Proceed

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Rapid Methods for Detection of Anti-Protozoan Drugs

Key External Stakeholders

Meat, egg and poultry sectors, feed mills, regulatory agencies, e.g. DAFF, FSAI, IMB

Practical Implications for Stakeholders

The objective of this research was to develop and validate a range of rapid methods for detection of three key anti-protozoan drug residues – diclazuril, halofuginone and toltrazuril. The technologies currently available for residue detection are often highly specialised (and costly) and generally not suitable for application within industry. Therefore low-cost, effective means of screening such components will benefit food producers. A comprehensive liquid chromatography method was developed to detect 21 anti-protozoan and anticoccidial residues in eggs and meat and validated to meet EC 2002/657 criteria.

Anti-protozoan drugs are used in the treatment of *Eimeria* and *Cryptosporidium parvum* infections in poultry, pigs, lambs and calves. Residues of these drugs can occur in food because of feed contamination or failure to observe withdrawal periods



following administration. To date, there has been little knowledge on the incidence of antiprotozoan drug residues in food of animal origin due to the lack of suitable analytical methods and the difficulty in analysing these substances. This new development therefore has significant implications for meat, egg and poultry sectors and can be applied to the detection of anti-protozoan drug residues within food at factories, feed mills, or on-line processing monitoring in large-scale food production plants.

Main Results

- Novel antibodies were developed to halofuginone and diclazuril.
- A range of biosensor assays were developed for these residues including a novel multiplex immunoassay, capable of simultaneous detection of diclazuril, halofuginone and toltrazuril.
- A comprehensive liquid chromatography method was developed and validated to detect 21 anti-protozoan and anticoccidial residues in eggs and meat.

Opportunity

A new analytical test was developed and validated to detect 21 anti-protozoan and anticoccidial residues in eggs and meat. This comprehensive test is currently the best available for these residues and is now available as a commercial service to the Irish food industry to ensure that they are in compliance with HACCP and their produce is safe.

Collaborating Institutions

Dublin City University

Project Number: 5578

Funding Source: DAFF (06/RDCU478)

Date: July, 2011

Project Dates: Sep 2006 – Aug 2010

How to Proceed

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Rapid Methods for Food Authentication and Quality Confirmation

Key External Stakeholders

Food manufacturers, consumers, regulatory agencies

Practical Implications for Stakeholders

The outcome is a clear indication of the power and utility of rapid, non-destructive spectroscopic methods for demonstrating conformance to specification of foods and food ingredients.

- Variations in raw material quality may be detected and defective material rejected.
- In-process changes may be mapped and controlled.



- Final product consistency may be measured and assured.
- This technology facilitates the application of PAT (Process Analytical Technology) in the food industry.

Main Results

- Spectroscopic models have been developed which are capable of discriminating between closely-related food products e.g. extra virgin olive oils from Liguria and other regions in Italy, Corsican honey and honey from neighbouring territories.
- A spectroscopic method for confirming the identity of a branded product was demonstrated. Spectroscopy combined with mathematical modelling has been demonstrated to be suitable for demonstrating conformance to specification in a range of food products.

Opportunity/Benefit

By interaction with this expertise at Teagasc Food Research Centre Ashtown, food processors can reduce variability in the functional and other characteristics of their products, and move towards a PAT approach in food processing.

Collaborating Institutions

See full Technology Update

Project Number: 5430

Funding Source: FP6 (2003-Food-2A-0060942)

Date: January, 2011

Project Dates: Jan 2005 – Dec 2011

How to Proceed

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Re-engineering Process Technology for the Manufacture of Infant Formula

Key External Stakeholders

- Dairy Ingredients and Infant Formula Sector
- Dairy Processing Equipment Manufactures
- Academic and Research Institutions

Practical Implications for Stakeholders

The study aimed to re-engineer process technology for the manufacture of infant milk formula (IMF) by modification of formulation dynamics and use of steam shockwave Injector (Maklad-Fluid GmbH) technology:

- A greater understanding of the impact of macronutrient interaction (upon heating) on viscosity during IMF manufacture has been achieved and can be utilised for new formulation development.
- High solids infant formulations can be processed using a shockwave steam injector.
- IMF concentrate manufactured with a selectivity



hydrolysed whey protein ingredient has application in high dry matter processes for reduced energy costs and more sustainable processing.

Main Results

The study demonstrated that heat-induced changes in infant formula associated with whey protein (denaturation, viscosity) are not only a function of concentration but are also dependent on interactions between macronutrients. Selectively hydrolysed proteins were shown to be an effective way of reducing viscosity, while maintaining good emulsification capacity, in heat-treated high solids concentrates of 1st age (0–6 months) infant formula. A new energy efficient high solids process for manufacture of infant formula with lower viscosity was developed using a shockwave steam injector.

Opportunity/Benefit

The research provides a platform for understanding the heat-induced changes associated with macro-nutrient interactions in IMF for development of new formulations. In addition, technology has been developed for processing formulations at high solids using novel energy efficient approaches based on new ingredients and processing techniques. The new knowledge/process can be exploited by end users i.e., ingredient manufactures and infant, adult and medical nutritional beverage sectors.

Collaborating Institutions

University College Cork, UCC

Project number: 5949

Date: November, 2014

Funding source: DAFM (08/RDT/MFRC/666)

Project dates: Oct 2008 – Feb 2014

How to Proceed

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Risk Assessment Network of Ireland

Industry Impact

The study assessed the impact of two food pathogens on the safety of raw milk cheese for the benefit of raw milk cheesemakers and the public in general. The study showed that risks associated with *Staphylococcus aureus* are low, while those associated with *Listeria monocytogenes* are more significant.

Key External Stakeholders

Raw milk cheese industry; Policymakers, Food researchers

Practical Implications for Stakeholders

The study assessed the risk posed by two food pathogens (*Staphylococcus aureus* and *Listeria monocytogenes*) in raw milk cheesemaking. A range of samples (n=117), including milk, curds, whey and cheese, from 5 raw milk suppliers, and 4 raw milk cheesemakers were analysed for coagulase positive *S. aureus*. Of the isolates obtained, 17% had toxin producing ability and produced only Staphylococcal Enterotoxin C (SEC) which is generally animal rather than food associated. The other classical enterotoxins SEA, SEB or SED (food poisoning associated) were not produced. No toxin was produced in raw or pasteurised milk or in sterile reconstituted skim



milk stored below 14°C for 24 h and no SEC was produced during cheesemaking. *L. monocytogenes* was found at a level of 300 colony forming units/ml in the milk of one cow with sub-clinical infection. While the numbers of naturally occurring *L. monocytogenes* increased in milk and during cheesemaking, this increase did not appear to be due to growth.

This research was carried out as part of a national network, Risk Assessment Network of Ireland which focused on the application of microbial quantitative risk assessment to underpin risk management actions. Teagasc research assessed the risk posed by two pathogens on the safety of raw milk cheese.

Main Results

- None of the *S. aureus* isolates recovered from raw milk or cheese produced the endotoxins SEA, SEB or SED, nor did they harbour the enterotoxin encoding genes *sea*, *seb*, *sed* or *see*.
- 17% of *S. aureus* isolates produced Staphylococcal enterotoxin C (SEC).
- Cheesemaking inhibited staphylococcal toxin production as did storage temperatures below 14°C.
- Optimum conditions for toxin production in reconstituted skim milk were 37°C at pH 6.5.
- *Listeria monocytogenes* was found in raw milk from one cow at a level of 300 cfu/ml, though there was with no evidence of infection in the animal.
- Although numbers of naturally occurring *L. monocytogenes* increased in milk and during cheese making, this increase did not appear to be due to growth.

Opportunity/Benefit

The opportunity was to assess the impact of *S. aureus* and *L. monocytogenes* on the safety of raw milk cheese

for the benefit of raw milk cheesemakers and the public in general. The study showed that there were different risks associated with each pathogen.

Collaborating Institutions

University College Dublin

Project number: 5855

Funding source: DAFM

Date: June, 2014

Project dates: Nov 2007 – Nov 2012

How to Proceed

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Safe and Healthy Foods

Key External Stakeholders

Aquaculture, pork, poultry, beef, egg and honey producers; regulatory agencies, retailers, importers, animal health companies, food safety laboratories and consumers

Practical Implications for Stakeholders

Safe & Healthy Foods programme set out to improve the safety of food consumed or produced on the island of Ireland through the development of new analytical methods and food databases.

A suite of new residue test methods were developed that cover nearly 150 different analytes. The range of compounds covered included veterinary drugs, feed additives, hormonal agents and pyrrolizidine alkaloids in different foods. The application of these tests showed that food consumed on the Ireland is generally of high purity. Residues were detected in a very small proportion of samples rendering them non-compliant. However, >99.6% of samples were residue free. A range of food safety databases were developed or updated on the project including the National Food



Residue Database, Veterinary Drug and Feed Additives Databases (VetFAD) and the Central Microbial Database. A new comprehensive food ingredient database (INFID), which has been used to estimate the intake of four sweeteners (aspartame, saccharin, acesulfame K, sucralose) were within the Acceptable Daily Intake levels for preschool children. The Irish Food Compositional Database was updated with current data on nutrients and bioactive components for a range of different foods.

Main points

- The newly developed databases and technologies will allow stakeholders to significantly improve the safety and quality of food products produced on the island.
- The newly developed tools will allow the stakeholders to more effectively target resources and give better value for money.

Main Results

- New multi-residue test methods developed for nearly 150 contaminant residues in food.
- New databases were developed covering the area of food safety and food consumption.
- Food surveys and exposure assessments were completed showing that the food we eat is very safe.

Opportunity/Benefit

During the project, new knowledge and technologies have been developed that can be used to improve the quality and safety of food products consumed or produced on the island.

Collaborating Institutions

AFBI, QUB, UUU, UCD, CVRL-DAFM, UCC, CIT

Project number: 5856

Date: November, 2014

Funding source: 07FHRITAFRC

Project dates: Dec 2007 – Dec 2013

How to Proceed

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Irish Seaweed Polysaccharides for Gut Health

Key External Stakeholders

Consumers, society, government authorities/legislators and the food industries

Practical Implications for Stakeholders

Seaweed is a natural source of bioactive components such as polyphenols, vitamins, antioxidants, polysaccharides and dietary fibres. This project is aimed at understanding the role of seaweed derived polysaccharides in gut health and targeting prebiotic potential of Irish seaweeds for development of functional food products.



Main Results

- Four Irish seaweeds viz. *Laminaria*, *Fucus*, *Ulva* and *Palmaria* were collected from the west coast of Ireland and were used for extraction and separation of polysaccharides.
- A hot HCl extraction method was used for the extraction of polysaccharides. Following neutralisation the extracts were electro-dialyzed for desalination and polysaccharides were precipitated using ethanol. The extracts were then freeze dried.
- In vitro digestion using digestive enzymes was undertaken and the digests were used for testing through faecal fermenters.
- Diafiltration was used to separate the polysaccharides and oligosaccharides depending on their molecular weight cut offs.

Opportunity/Benefit

Considering the nutritional profile of Irish seaweeds and functional food product development is the target of this project. Cost effective methods for extraction and purification of the polysaccharides and desalination are being developed. These methods will help to develop cost effective products for the food industry. Prebiotic potential studies through clinical trials would support health claims pertaining to gut health for these products.

Collaborating Institutions

Teagasc Food Research Centre, Moorepark

National University of Ireland, Galway

Teagasc Food Research Centre, Ashtown

Project number: MDBY 6588

Date: May, 2015

Funding source: DAFM

Project Dates: July 2014 – Nov 2017

How to Proceed

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Sensory Acceptance of Low Salt Ready Meals

Key External Stakeholders

Food manufacturers, food policymakers, food safety policymakers, food researchers

Practical Implications for Stakeholders

Chilled ready meals are becoming increasingly popular but often contain appreciable amounts of salt. Food manufacturers are under increasing pressure from regulators and consumers to reduce salt in food. The present project focused on the impact of salt reduction and reformulation on sensory acceptability of low salt ready meals.

- The addition of key herbs and spices individually can help compensate for shortfalls in sensory acceptability for chilled ready-meals.
- The addition of salt substitutes into all 3 frozen ready-meals made it possible to achieve the FSAI salt reduction targets of 0.63g salt (250mg sodium) per 100g in ready-meals and 0.58g salt (230mg sodium) per 100g in soup.



- By adopting a gradual salt reduction strategy the following salt reductions could be achieved without adversely affecting sensory properties and consumer preference for the meals.

Main Results

Sensory perceptions of low salt ready meals were investigated and the impact of reformulation on sensory acceptability was probed.

- A number of herb/spice blends were formulated that resulted in satisfactory sensory acceptability in comparison to meals with normal salt contents.
- The use of herbs and spices also increased the microbial stability of the meals and enhanced their antioxidant status.
- In conjunction with an industrial manufacturer the reformulated low salt meals were manufactured and analysed for sensory acceptability using a consumer panel. In all cases the reformulated meals were of comparable sensory acceptability to their full salt counterparts.

Opportunity/Benefit

The outputs of this project have shown that research driven reformulation can off-set perceived losses in flavour as a result of salt reduction. The strategies developed could be applied to a range of prepared foods and identify effective measures for reducing salt levels in foods without comprising on sensory acceptability. Expressions of interest in this research are welcome.

Collaborating Institutions

University of Limerick, Dawn Fresh Foods Ltd., All in All Ingredients

Project number: 5712

Funding source: DAFF (06/R&D/AFRC/519)

Date: March, 2012

Project Dates: Oct 2006 – Sep 2011

How to Proceed

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Studies on the Microbiology and Sensory Properties of Novel Low Sodium Ethnic Ready Meals

Key External Stakeholders

Food manufacturers, cheese producers

Practical Implications for Stakeholders

- A ready-made meal salt reduction reformulation approach is feasible at manufacturing scale, when combined with microbiological and sensory optimization.
- A market survey revealed that salt levels in ready-made meals were $\geq 50\%$ of the recommended daily allowances (RDA) for salt in 77% of meals evaluated, with 8 meals containing 100% of the RDA for salt.
- Market surveys also revealed that salt levels were not clearly labelled on most ready-made meals.



- The use of specific commercial salt replacers could facilitate further salt reductions in selected products.

Main Results

- A comprehensive study was undertaken on the microbiological quality of commercial ready-made meals in comparison to reduced salt counterparts. No difference in microbiological populations was evident between ready-made meals with and without salt reduction over controlled storage conditions. This indicates that bacterial survival during commercial processing and frozen storage was not affected by the range of salt levels in full and reduced salt products.
- Evidence of bacterial migration during storage in lasagne ready-made meals was demonstrated.
- Salt levels could be reduced in selected ethnic ready meals by 29–50% without impacting on sensory quality. The difference was dependent upon the product type.
- The use of commercial salt replacers enabled a salt reduction of 48–66%.
- The impact of salt reduction on the quality of Cheddar cheese was assessed and highlighted that incorporating process changes could be used to lower salt levels without adversely impacting on quality.

Opportunity/Benefit

Consultancy and contract research opportunities are available to both national and international clients in salt reduction in processed foods and cheese.

Collaborating Institutions

University of Limerick

Project number: 5437

Funding source: DAFM

Date: November, 2015

Project dates: Jan 2005 – June 2008

How to Proceed

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Technological Advances in Spray Drying of Functional Ingredients for Automated Beverage Vending

Key External Stakeholders

Manufacturers of milk powders and dairy ingredients

Practical Implications for Stakeholders

Technologies were developed to produce functional powders suitable for reconstitution/dispensing as either hot or cold beverages.

- Installing an in-line high pressure gas/liquid injection system on the concentrate feed to the spray atomiser of a milk-drier facilitated the production of dried ingredients with extensive foaming properties suitable for use in cappuccino-based beverage formulations.
- *Development of foaming powder for hot beverage formulation and vending* – a knowledge-base was established on the performance of different injection gases used and their interactions with concentrate formulation and process variables on powder characteristics.



- *Development of cold mixed smoothie-style beverages from textured dairy-fruit dry blends* – ‘smoothie’ style powders containing fruit/dairy ingredient blends with desired physical characteristics e.g. texture, viscosity and phase stability were successfully developed for dispensing in prototype vending machines.

Main Results

The immediate effect of using either nitrogen gas or liquid CO₂ injection during atomisation, was improved powder agglomeration and an associated decline in bulk densities (from 0.56g/cc to 0.12g/cc) as well as reduced moisture contents. This was also reflected in changes to the particle size distribution and particle density – the latter reduced from 1.2334g/cc to 0.599g/cc.

Interrelationships were established between drying parameters and powder properties (bulk density, particle size distribution, occluded air, interstitial air, particle density, wettability, foam height using a coffee dispenser at t=0 min, foam height after 5 min, and moisture content) specific to cappuccino beverages. Significant relationships, in particular, were established between powder bulk density and cappuccino foam stability using CO₂ (foam stability = 5.556-(5.532*Bulk Density)) and N₂ (foam stability = 5.017-(4.573*Bulk Density)) dosing.

Opportunity/Benefit

This research provides the opportunity to add functionality and value to spray dried ingredients. This technology may be incorporated, with some adaptation by ingredient drying manufacturers, to prepare fat-filled base or fully-formulated

powders for supply to branded food companies with channel dominance in food service markets. Relevant pilot scale technologies at Moorepark may be availed off to support technology transfer initiatives.

Collaborating Institutions

N/A

Project Number: 5435

Funding Source: FIRM 04/R&D/TD/320

Date: Nov, 2012

Project Dates: Jan 2005-Sept 2008

How to Proceed

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The Milk Proteome: A Tool for Understanding Milk Quality and Functionality

Key External Stakeholders

Cheese manufacturers

Practical Implications for Stakeholders

This study thus has a very high relevance for the Irish cheese industry, and its need to supply high quality products over the whole year. As milk composition changes over the lactation cycle, milk at late lactation stage is less suitable for cheese manufacturing due to the changing plasmin levels.



Main Results

- We clearly demonstrated differences in proteolysis in cheeses made from milk taken over different stages of the lactation cycle.
- From this study, it could be seen that there are significant changes in the profile over the lactation cycle and, while similar studies have been done on this topic, the application of proteomic tools gives another a deeper insight into the specific changes occurring due to proteolysis.
- Proteomics is a very helpful tool to characterize the differences between cheese samples during ripening and also over lactation.

Opportunity/Benefit

This project has developed significant additional research capacity in a very new field (proteomic analysis of food systems) which offers new advanced analytical capability of interest in the context of a range of new research project areas, including analysis by food companies. In addition, the project involved applying these tools to applied research questions of direct scientific and industrially-relevant interest (e.g., impact of seasonality and somatic cell count on dairy product quality). Additional knowledge on milk quality issues is of indirect economic impact by providing additional knowledge for dairy companies in Ireland.

Collaborating Institutions

Teagasc and University College Cork

Project number: 5550

Date: Spring 2014

Funding source: FIRM

Project dates: Mar 2005 – Sept 2008

How to Proceed

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Understanding the Perception of Creaminess in Dairy Foods

Key External Stakeholders

Food and food ingredient manufacturers, dairy industry

Practical Implications for Stakeholders

- High pressure processing was shown to enhance the creaminess of yogurts and produce low-fat yogurts as creamy, or *even creamier*, than their conventionally produced full-fat counterparts.
- A better understanding of the relationship between product structure and creaminess perception, based on composition and processing has been developed.

The results of this work have led to further funding from Enterprise Ireland under the Commercialisation Fund and Teagasc researchers are currently developing a new platform technology for manufacturing size controlled protein particles, specifically to be used as novel fat replacer



ingredients. Access to such an energy efficient and innovative food processing technology would benefit dairy and food ingredient companies greatly by allowing them to produce higher quality, low fat dairy-based products with enhanced nutrition at significantly lower production costs.

Main Results

- High pressure milk processing (microfluidisation) was shown to significantly improve the creaminess of low fat yogurts.
- The development of a new dynamic imaging technique for assessing product quality.
- A predictive model for creaminess based on composition, rheology and microstructure.
- Increased understanding of how microstructure can be controlled to enhance creaminess.
- Demonstration that fat release from food matrices can be controlled by pH and emulsifier type.

Opportunity/Benefit

There is an opportunity for dairy food ingredient manufacturers to partner with Teagasc to investigate the true potential of such high quality low fat dairy based ingredients using this novel approach through optimisation and validation for specific applications. Expressions of interest from relevant companies are welcome.

Collaborating Institutions

University College Cork

Project Number: 5606

Funding Source: DAFF (06/RD/TMFRC/431)

Date: July, 2011

Project Dates: Nov 2006 – Dec 2010

How to Proceed

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Water Activity Control and Texture Stabilisation of High Protein Snack Bars

Key External Shareholders

Dairy ingredient manufacturers, nutritional food formulators

Practical Implications for Stakeholders

- The relative susceptibility of milk protein ingredients to textural change (hardening) in high protein (35%) bar formulations over time was established under standardised conditions. Hardening in mixed protein bars resulted in a broadly linear response to ratio inclusion. However, caution is required in the application of this information because of specific variation in bar formulations.
- Different windows of concentrations were observed for individual protein ingredients depending on formulation that could be related to molecular jamming and subsequent hardening.
- Minimising water activity differences between liquid and solid components provides a means of controlling or delaying textural change.



Advanced analytical techniques developed during the course of this project may be used to support further development: FT-IR measurements show whether water or solvent-induced plasticisation of protein powders in bar matrices is sufficient for protein-ingredient interactions to occur at a molecular level. Confocal scanning laser microscopy (CSLM) techniques allow good quality imaging of physical changes in protein bars during storage.

Main Results

- Hardening of protein bars varied with protein type e.g. decreased hardening occurred in whey protein-based bars compared to casein-based systems.
- Textural change in high-protein bars is related the hydration behaviour of individual components and the competition for available moisture.
- Powder packing behavior was also influenced by protein type. Rheological-based frequency dependent measurement of liquid-solid transitions link particle interactions to time-dependent ageing (hardening) phenomena.

Opportunity/Benefit

The resulting database of information allows a better choice of ingredients to be made in order to ensure improved shelf-life. Such knowledge may be utilised by technical support teams of dairy ingredient companies engaged in ingredient marketing to protein bar formulators.

Collaborating Institutions

University College Cork

Project number: 5951

Funding source: FIRM/DAFM (08/R&D/TMFRC/651)

Date: May, 2015

Project Dates: April 2009 – Mar 2013

How to Proceed

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