Cereal and Beverage Research at UCC

Prof Elke Arendt
School of Food and Nutritional Sciences
University College Cork




14th of May 2015

University College Cork

Students	
18.000	Students
2.470	Postgraduate students

Staff	
1.390	Staff
460	Teaching staff

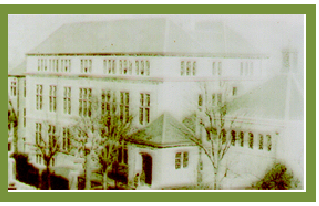
Budget	
117 Mio. €	Total budget
22 Mio. €	Research income

Economic impact	
191 Mio. €	Economic impact
4.300	Jobs

School of Food and Nutritional Science

1920er

Dairy Science Institute



1978

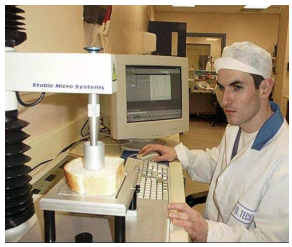
Food Science and Technology Building
Food Processing Hall
Department of Agriculture

1994

Food Science and Technology Research Complex
Department of Education

Cereal and Brewing Science at the UCC

- Prof. Elke K. Arendt
  - 3 Post Docs
  - 12 PhD students
  - 4 MSc students
  - 3 Researcher



CEREAL RESEARCH

- ✓ Gluten free cereal products
- ✓ Medical foods
- ✓ Reduction of salt, fat and sugar
- ✓ Starter development (LAB and yeast)
- ✓ Improving the nutritional quality of products
- ✓ Proteins for the future
- ✓ Clean label

BEVERAGE RESEARCH

- ✓ Starter culture development for malting and brewing
- ✓ Functional beverages (wort based , cereal milks, kombuch
- ✓ Malting and brewing with alternative cereals
- ✓Enzymes in grain processing

Cereal Science and Advanced Miscropcopy

Malting and Brewing facilities

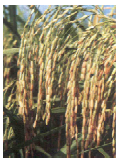
Cereal grains

Fagopyrum esculentum
Buckwheat

Amaranthus cruentus
Amaranth

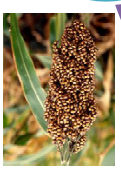
Chenopodium quinoa
Quinoa

Pseudocereals



Oryzoidae
Rice

Panicoideae zea mays
Maize



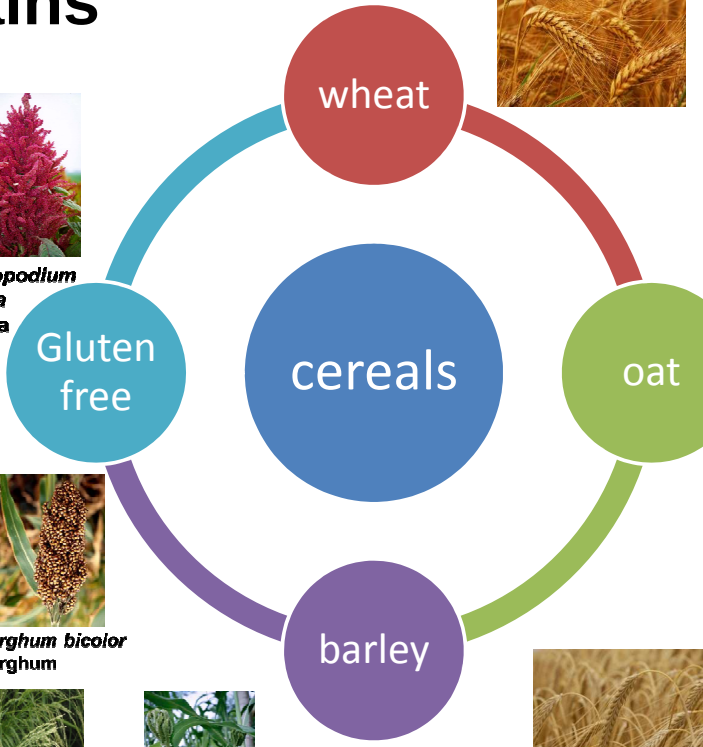
Sorghum bicolor
Sorghum

Pennisetum glaucum
Perl Millet

Setaria italica
Italien Millet

Eragrostis tef
Teff

Eleusin coracana
Finger millet



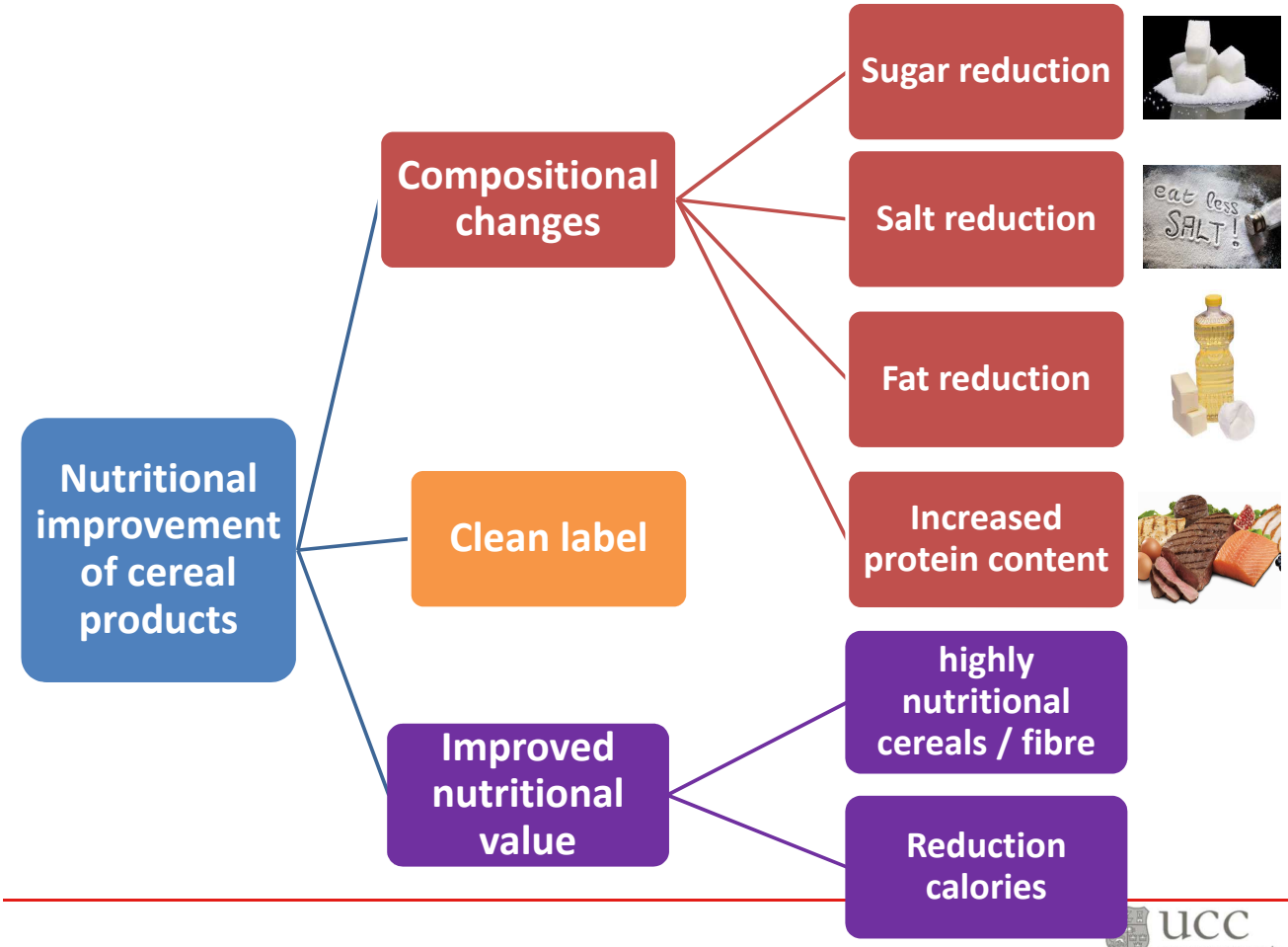
Cereal based medical foods

"free from" foods

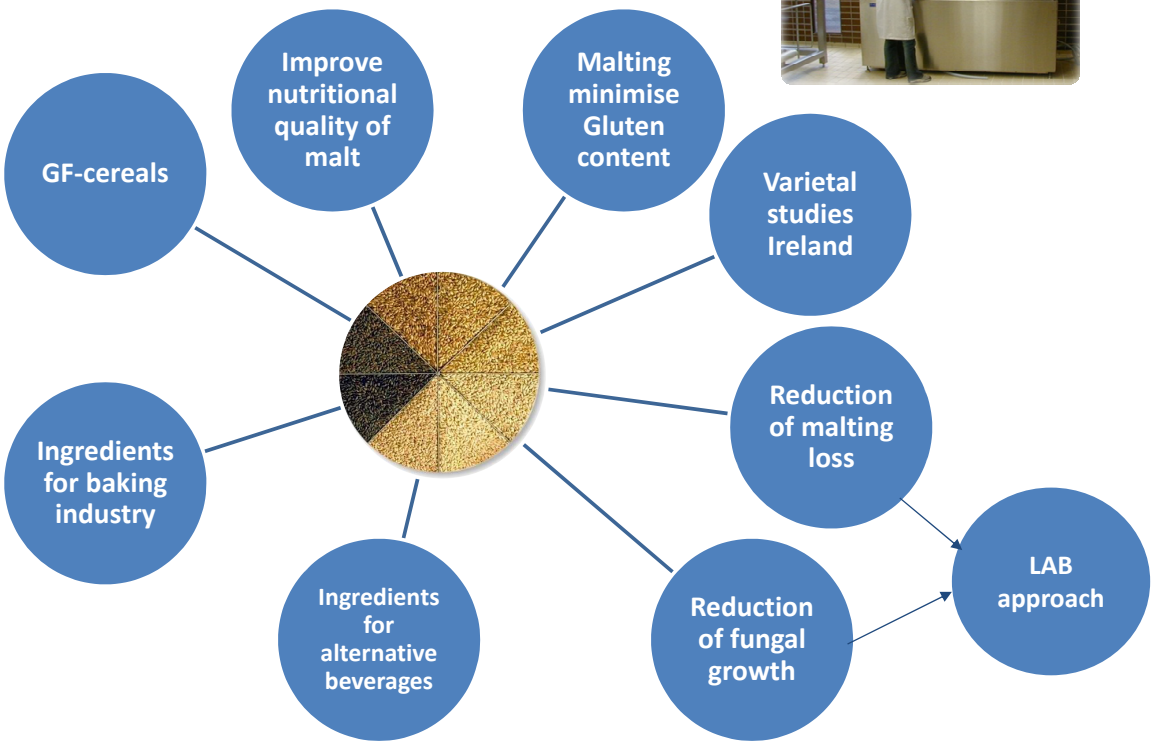
- Gluten free
- Allergen free
- Lactose free

Disease prevention / special dietary needs

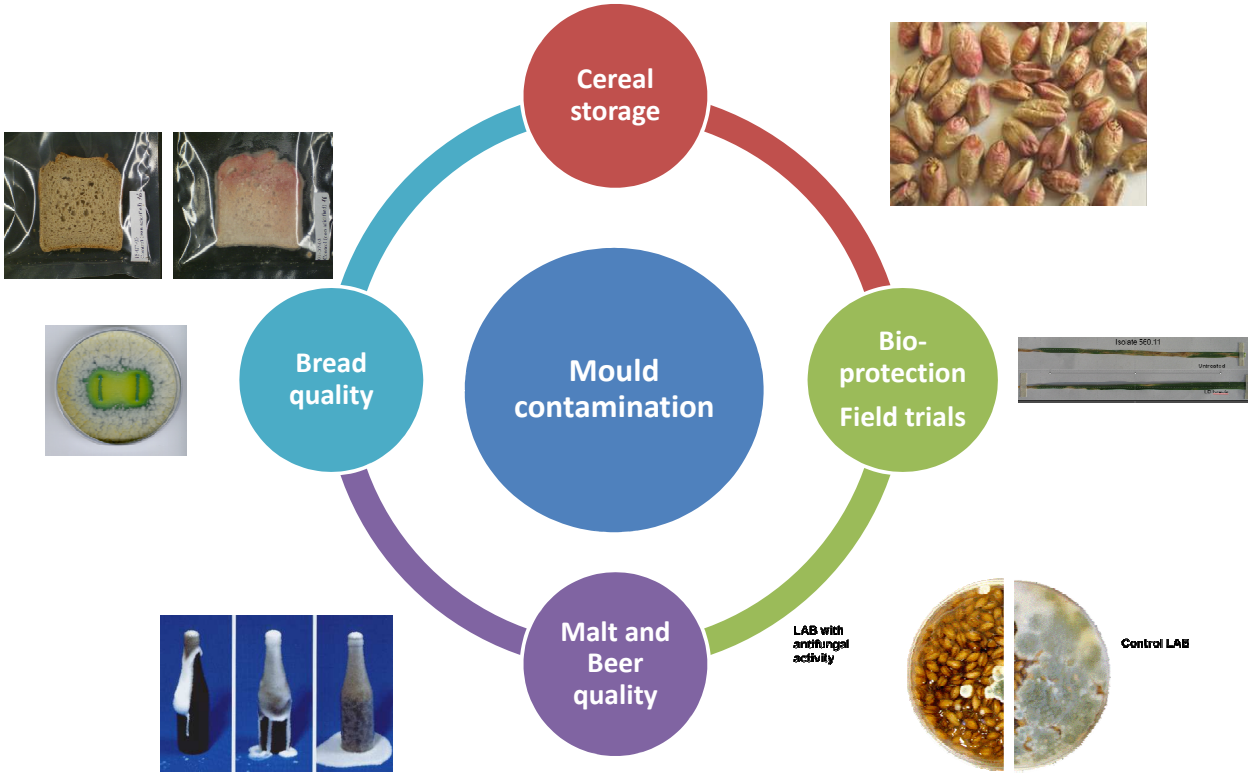
- Heart disease
- IBS
- Coeliac disease
- Lactose intolerance
- Elderly
- Obesity



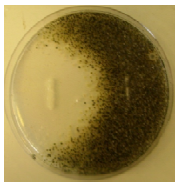
Malting research

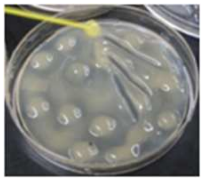


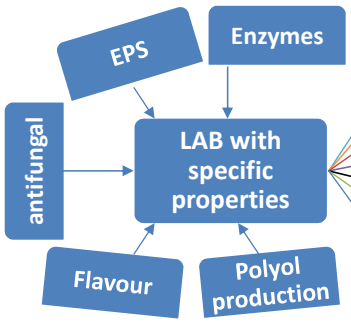
Fungal based research

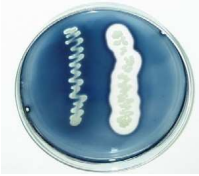


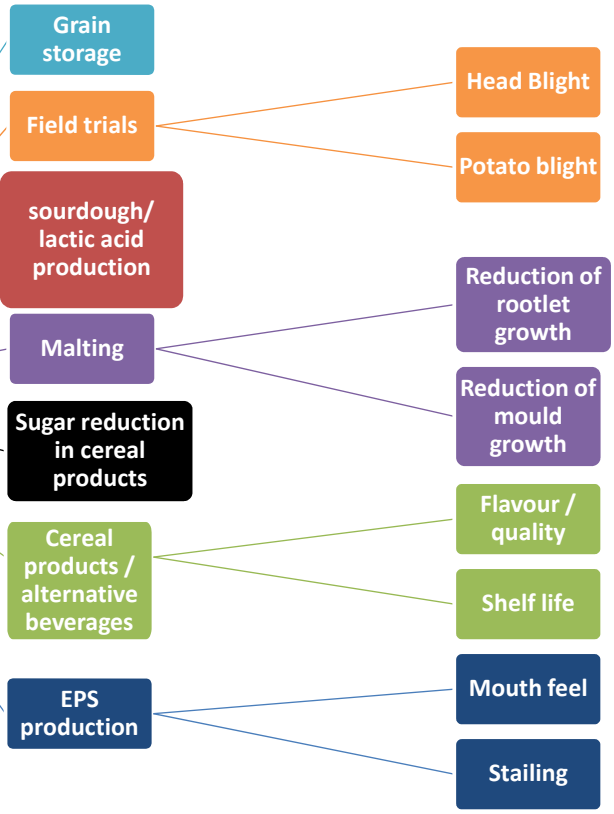
Lactic Acid Bacteria (LAB)



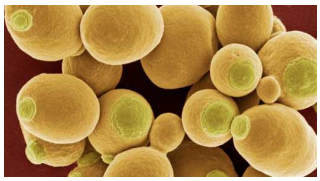








Research on Yeast - Overview



yeast

- Kombucha
- β-defencins and yeast containing β-defencins
  - Malting/ Brewing
  - Baking
- Brewing / wine yeast applied in bakery products
- Characterisation of sourdough yeast

Alternative beverages

Alternative beverages from cereals

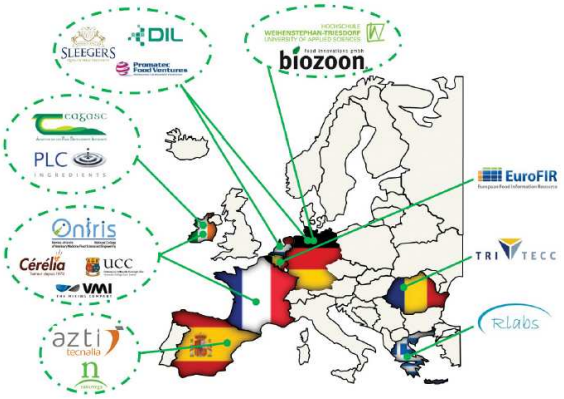
- **Kombucha**
  - **Characterisation Kombuch cultures**
  - **Beverage production**
  - **Defined starter cultures**

- **Cereal milks**
  - **Lactose intolerance**
  - **Dairy intolerance**
  - **Vegans**

- **Wort bases fermented beverages**
  - **Barley**
  - **Gluten free**

Pleasure project is funded by the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 289536

Project title: Novel **P**rocessing approaches for the development of food products **L**ow in f**A**t, **S**alt and s**U**gar **R**educed. "When less sugar, salt and fat brings the same taste"



A consortium of 16 partners from 8 different European countries, have joined forces, through the FP7 funded research project PLEASURE

State of the art: **Fat, salt and sugar** represent an **important cause** in the prevalence of **malnutrition**, their excessive consumption leading to enormous health problems.

- The PLEASURE project aims at developing **innovative processes and/or implementing novel technologies** to allow for the development and production of cheese, puff pastry, sauce and meat with **low content of fat (saturated and trans-fatty acids), as well as salt and sugar.**
- New micro structured and naturally reduced foods with similar sensory properties compared to conventional products are the key for success.

UCC
Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

TRAFOON project is funded by the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 613912

trafoon
Traditional Food Network to improve the transfer of knowledge for innovation

Project title: **Traditional Food Network to improve the transfer of knowledge for innovation**

State of the art: in **rural areas**, many **traditional food-producing SMEs** use special techniques of production using local ingredients and poorly mechanized processes which are often dependant on handcraft.

The *TRAFOON* consortium consists of 28 partners from 13 European countries

***TRAFOON* means:**

- a concentrated effort to **reverse the trend of losing century-old recipes and traditional food products** to preserve a diverse, healthy and tasty diet for the European citizens and to secure the income of traditional food producing SMEs.

- the **implementation of a successful and sustainable technology transfer** by giving **SMEs** a central role in the innovation process through a dedicated feedback mechanism

UCC
Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

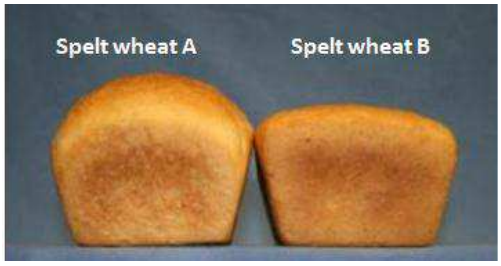
FLOURPLUS project is funded by the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 606198

Project title: **Intelligent and easy tool to categorise and characterise flour quality for consumer-driven wheat baked goods in European SME-bakery and cereal sector "**

The *FlourPlus* consortium consists of 8 partners from 4 European countries

State of the art: SMEs and industrial associations have realized the non-detectable and thus incontrollable fluctuations in wheat quantity and quality due to the progressing climate change.

FlourPlus will deliver a modern / ready-to-use /resource-efficiency and smart process control system (FLOURplus system) directly connect to existing and innovative analytical tools , which **enables to accurately determine the flour quality and to counterbalance varying qualities** throughout the main processing steps and quality determining stages (fermentation, proofing, selection of yeast and other ingredients) in manufacturing.



PROTEIN 2 FOOD

"Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020)"

Project title**: Development of high quality food protein from multi-purpose crops through optimized, sustainable production and processing methods**

The *Protein2Food* consortium consists of 19 partners from 12 European countries and 2 extra European countries (Uganda and Peru)

State of the art: **Meeting the globally growing demand for high quality, protein-rich food, that can satisfy the need of a growing world population while considering environmental sustainability, adapted land-use practices and food security is a special challenge**

PROTEIN2FOOD project **aims to develop innovative, cost-effective and resource-efficient plant protein –rich food sources with a positive impact on human health, the environment and biodiversity by selecting highly nutritious seed crops (quinoa, amaranth and buckwheat), and legumes with high protein content (lupin, faba beans, pea, chickpea, lentil)** will be significantly economically enhanced **through the use of a multi-disciplinary approach.**

Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara

TASTY

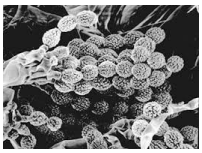
Project title: **Novel Technological ApproacheS for the developmenT of low-sugar - highlY consumer accepted food products**

<u>State of the art</u>: The c**hallenge for industry is to reduce the concentration of conventional tastants (e.g. sugar, sal**t etc) in foods while **maintaining both flavour and processing parameters**. Sugars play several roles in foods, so when they are replaced with low calorie substitutes, more than just sweetness must be provided for by their replacement products**.**

The TASTY project aims at **developing innovative processes, ingredients and/or implementing novel technologies** to allow the development and **production of food and beverages** products **with low content of sugar**. New micro structured and naturally reduced foods with similar sensory properties compared to conventional products are the key for success.

Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara

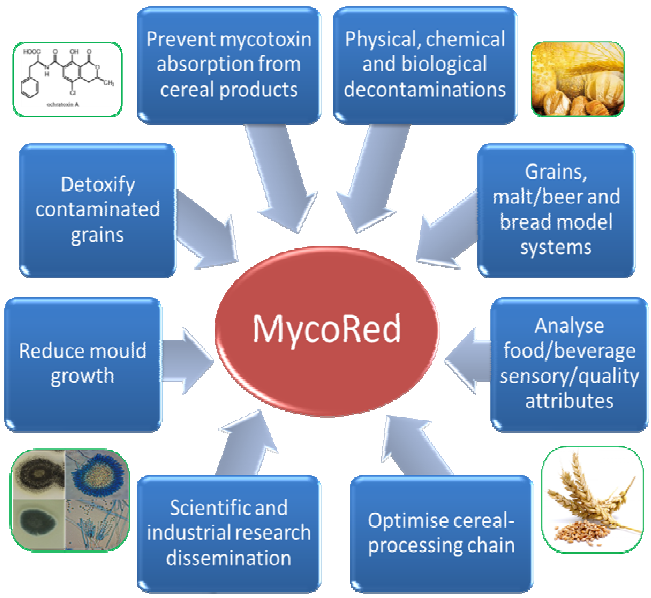
Mycored



Project title: **Reducing Mycotoxin levels in plant derived foods and beverages**

A team from three research institutions (Teagasc, Queens University Belfast, University College Cork in Ireland are working on this topic

<u>State of the art</u>: Fungal contamination is problematic in a wide range of food products. Fungal growth, leading to **spoilage**, is the main cause of product and concomitant **economic losses**. Furthermore, fungal **mycotoxin production** can cause serious public health hazards in foods.



Fungal based research




Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara

PeptideProtectants

Project title: **Natural peptides to enhance food quality and safety**

A team from three research institutions Teagasc Moorepark, Trinity College, University College Cork in Ireland are working on this topic.



State of the art: Food processors are facing an extraordinary dilemma as they try to address consumer demands for healthy, minimally-processed foods, while, paradoxically, being required to meet ever-increasing microbial safety standards. Antimicrobial peptides (AMPs), such as novel bacteriocins and defensins, offer viable solutions to the development of natural food biopreseratives to replace the current market leader

The overall Objective of **PeptideProtectants** is the development of novel antimicrobial combinations to control food pathogens and spoilage organisms associated with the dairy foods, meat, bread and beer

NutriCerealIreland

Project title: **Exploitation of the nutritive properties of safe Irish-grown milled oat and barley varieties as functional ingredients in new healthy food formulations.**

A team from three research institutions Teagasc, UCD, UCC are working on this topic.

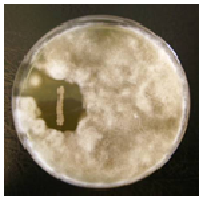

State of the art: The agri-food sector is a key part of Ireland's economy, and agricultural research is vital to keep our industry competitive. Ireland is excellently placed as a crop-producing nation, with our cereal yields being amongst the highest in the world. These cereal crops are now known to contain significant levels of soluble fibre (beta glucan), phenolics and essential amino acids.


The overall objective of **NutriCerealIreland** is to develop new, innovative and healthy cereal-based ingredients and food products from Irish-grown barley and oats, targeting new market opportunities such as functional foods and beverages, and health-enhanced processed foods.

Potato blight

Project title: **Novel antifungal agents derived from lactic acid bacteria for the biological control of potato blight.**



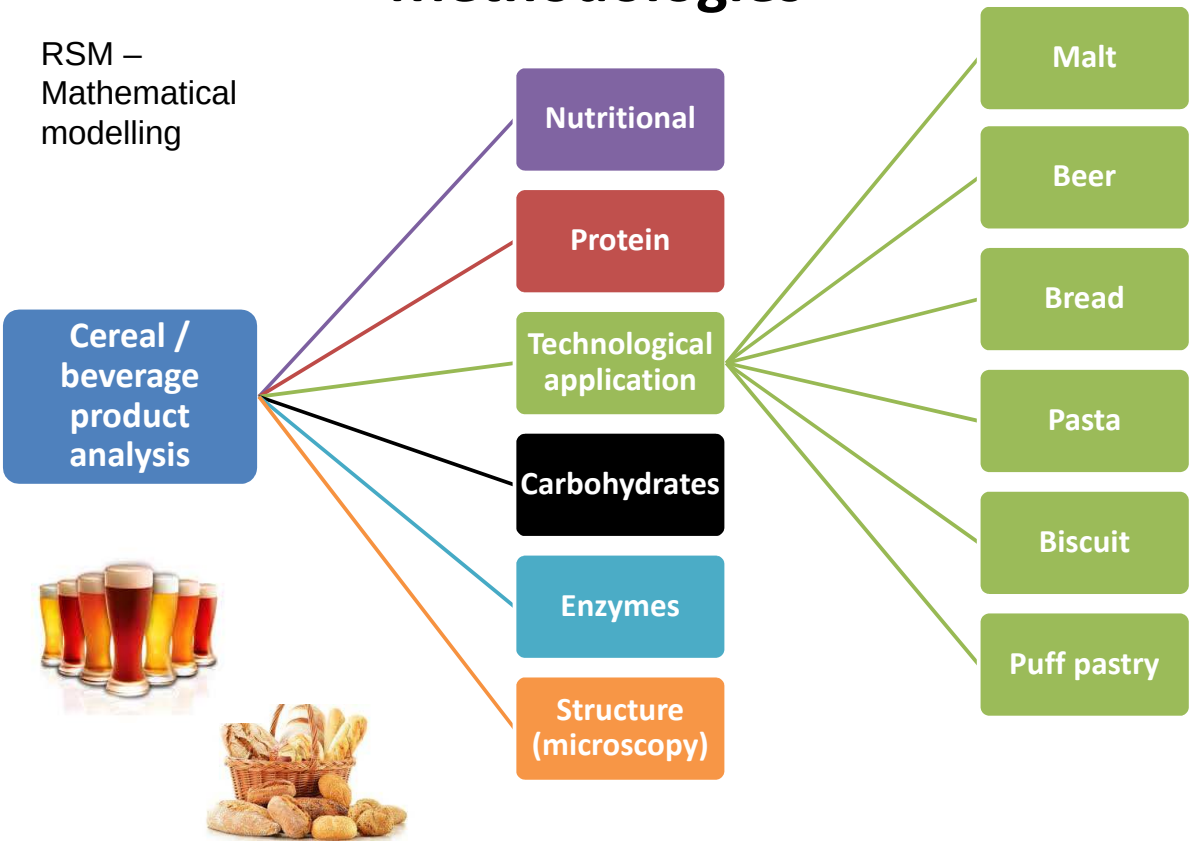



State of the art: Potato late blight caused by *Phytophthora infestans* is the most important foliar and tuber disease of potato, both in field and in storage (Figure). The plant pathogen P. infestans was the causes of a devastating disease on potato that led to the Irish potato famine during 1845–1847

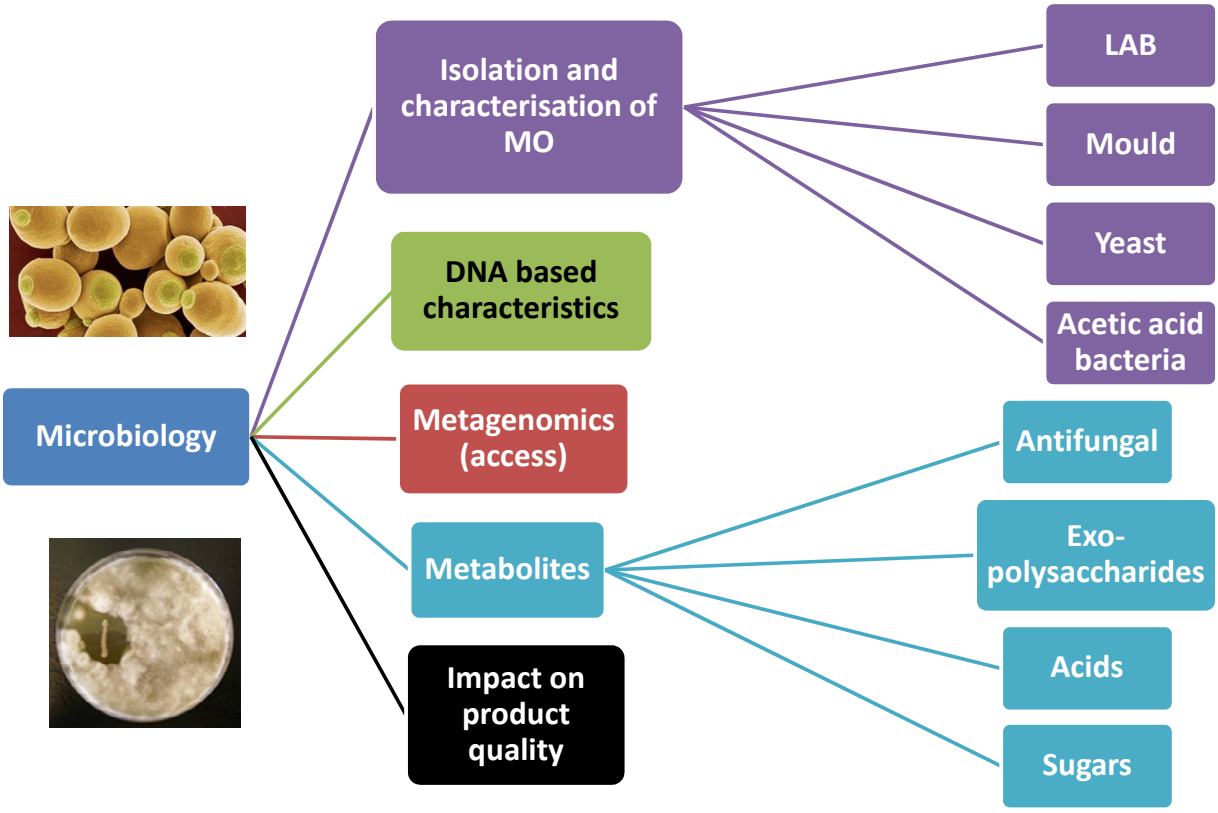
The objective of this project is to develop fungal biocontrol agents based on lactic acid bacteria (LAB) against *Phytophthora infestans*, which causes potato late blight.

Methodologies

RSM – Mathematical modelling



Methodologies



Bread Dough Analysis

- **Rheofermentometer**

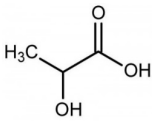

→ Dough fermentation
Recording of dough's height and gas production during fermentation

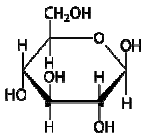
- **Texture Analyser**


→ Resistance to its extensibility and its stickiness

- **Composition**

→ HPLC-UV/DAD and RID for sugar and acid analysis





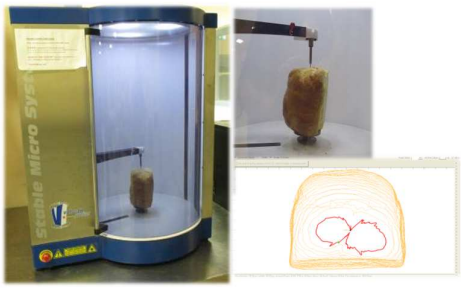
- **Rheology**

→ Fundamental
Anton Paar Rheometer
→ Empirical
Farinograph
Extensiograph
Glutopeak



Bread Analysis

- **Vol-scan profiler**



→ Measures the height, length and weight and calculates the specific Volume

- **Texture Analyser**

→ Bread staling
hardness, springiness and chewiness over time; day 0 (the baking day), storage day 2 and 5

- **Colorimeter CR-400**

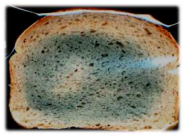
→ Crust and crumb colour (L*, a*, and b* referred to CIE standard illuminant D65)

- **C-Cell Analyser**

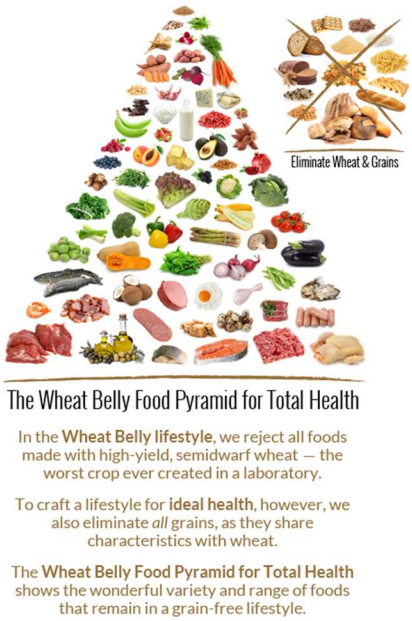
→ Dedicated image analysis of size, Shape and cell structure of sample

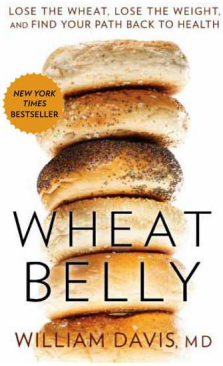
- **Shelf life**

→ challenge test against environmental moulds, monitoring over 14 days

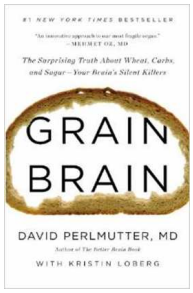


Bread under Threat, Why ?

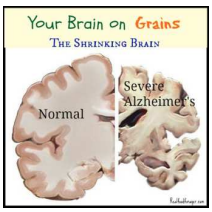




Davis says that all modern wheat, which he refers to as "Frankenwheat", is as toxic and as addictive as many drugs and makes people want to eat more food, especially junk foods.



The Surprising Truth about Wheat, Carbs, and Sugar--Your Brain's Silent Killers



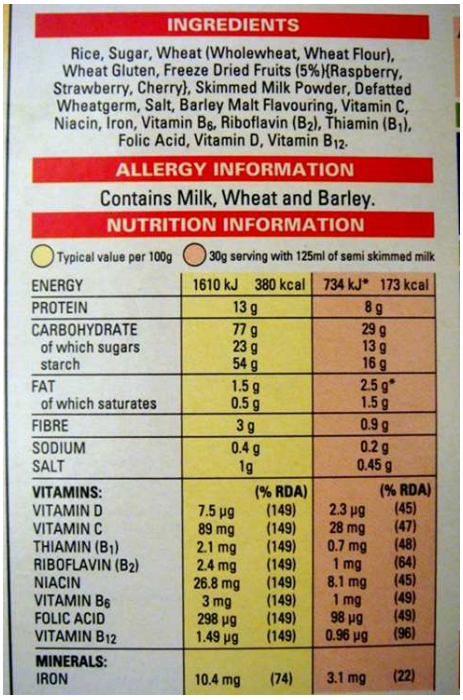
New York Times Bestseller and No 1 Best seller in Germany

Bread – Not a healthy option ?

MINTEL

- Packaged bread is eaten most frequently, with 53% of adults eating it at least daily
- Bought by 70% of users, white bread is by far the most common type of packaged bread
- 50 % wholemeal bread
- 40 % granary/multigrain
- Eating occasions beyond lunch and breakfast remain niche
- 63% of users report to eat bread for lunch at home
- Snack remains rare (22% in the evening)
- Intense competition from alternative breakfast foods such as breakfas cereals, cereal bars and yogurts
- 51% of users eat bread for breakfast during the week, and 47% at the weekend.
- 44% of users thinking that other breakfast options (eg cereals, breakfast bars) are healthier than bread/baked goods.

Is bread less healthy than breakfast cereal ?



INGREDIENTS

Rice, Sugar, Wheat (Wholewheat, Wheat Flour), Wheat Gluten, Freeze Dried Fruits (5%){Raspberry, Strawberry, Cherry}, Skimmed Milk Powder, Defatted Wheatgerm, Salt, Barley Malt Flavouring, Vitamin C, Niacin, Iron, Vitamin B_6, Riboflavin (B_2), Thiamin (B_1), Folic Acid, Vitamin D, Vitamin B_{12}.

ALLERGY INFORMATION

Contains Milk, Wheat and Barley.

NUTRITION INFORMATION

	Typical value per 100g		30g serving with 125ml of semi skimmed milk	
ENERGY	1610 kJ	380 kcal	734 kJ*	173 kcal
PROTEIN	13 g		8 g	
CARBOHYDRATE	77 g		29 g	
of which sugars	23 g		13 g	
starch	54 g		16 g	
FAT	1.5 g		2.5 g*	
of which saturates	0.5 g		1.5 g	
FIBRE	3 g		0.9 g	
SODIUM	0.4 g		0.2 g	
SALT	1g		0.45 g	
VITAMINS:		(% RDA)		(% RDA)
VITAMIN D	7.5 µg	(149)	2.3 µg	(45)
VITAMIN C	89 mg	(149)	28 mg	(47)
THIAMIN (B_1)	2.1 mg	(149)	0.7 mg	(48)
RIBOFLAVIN (B_2)	2.4 mg	(149)	1 mg	(64)
NIACIN	26.8 mg	(149)	8.1 mg	(45)
VITAMIN B_6	3 mg	(149)	1 mg	(49)
FOLIC ACID	298 µg	(149)	98 µg	(49)
VITAMIN B_{12}	1.49 µg	(149)	0.96 µg	(96)
MINERALS:				
IRON	10.4 mg	(74)	3.1 mg	(22)

There are 4.2 g of sugar in a teaspoon

100 g of breakfast cereal contains equivalent of 5.5 teaspoons of sugar

McVitie's Breakfast Porridge Oats

Nutritional Information Typical values per 100g of dry product	
Energy	**1902kJ/ 452 kcal**
Protein	**9.5g**
Carbohydrates **Of which sugar**	**70 g** **23.6g**
Fat **Of which saturates**	**13.8g** **3.8 g**
Fibre	**5.1g**
Sodium	**0.4g**
Salt equivalent	**1.0g**

50 g per two biscuits
Claims: source of B vitamins, Vitamin D and Iron; Source of Fibre

There are 4.2 g of sugar in a teaspoon
100 g / 4 biscuits of breakfast biscuits contain
5.6 teaspoons of sugar

5 g of butter in a teaspoon

Nearly 3 spoons of butter in 100g or 4 biscuits

Special K Cereal Bars Red Berry

Nutritional Information Typical values per 100g of dry product	
Energy	1643kJ/ 388kcal
Protein	4.9 g
Carbohydrates of which sugar	80 g 36 g
Fat of which saturates	5.2 g 3 g
Fibre	2.6 g
Sodium	0.23g
Salt equivalent	0.58

23 g per Bar
Claims: 89 calories per bar

There are 4.2 g of sugar in a teaspoon
100 g cereal bars (4 bars)
8.6 teaspoons of sugar
1 bar contains approx. 2 spoons of sugar

5 g of butter in a teaspoon

1 spoons of butter in 100g

Typical Sliced White Bread

Nutritional Information Typical values per 100 g of dry product	
Energy	1032kJ/ 244 kcal
Protein	10.5g
Carbohydrates Of which sugar	45.8g 2.3g
Fat Of which saturates	1.2g 0.4g
Fibre	2.7g
Sodium	0.43g
Salt equivalent	1.1g

There are 4.2 g of sugar in a teaspoon

There is only
½ a spoon of sugar in 100g of bread

There is only
1/5 of a spoon of fat in 100g of bread

Everyday Solutions Under Threat

Bord Bia
Irish Food Board

EUROMONITOR INTERNATIONAL

41%
Buying a wider variety of baked goods overall, while also actively reducing white bread consumption.

MINTEL

55 %
of the consumers feel guilty about eating white bread

More than 6 out of 10
consumers can' t recall any innovation in baked good category

Bread
is one of the first products removed when a consumer tries to lose weight

Heath is the main driver for the future of the category of baked goods

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What is important for the consumer?

MINTEL

- **60% of buyers: freshness** is by far the most important factor when buying bread and baked goods.
- **Low price** plays a relatively **small role** in the market.
- Price is slightly more important to bread shoppers (41%) tha baked goods shoppers (38%), reflecting the treat positioning the latter.

- **High fibre** is considered the most important for bread (30%), suggesting that the market‟s continuous efforts to promote bread as a good source of fibre

- **'low salt' and 'low calorie'** on a par (12%), suggesting that the concerns about salt levels by various bodies are not widely shared by consumers

- **'Free from' baked goods** are becoming increasingly interesting because these products, normally aimed at consumers with food intolerances, are increasingly demanded **by people with no intolerances**, but who consider gluten-free products as being easier to digest and as such more suitable for their active lifestyles.

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The Lost Art of Bread in Everyday

Bord Bia
Irish Food Board

- **Bread traditionally synonymous with artisan, quality, purity and provenance**. The purity and honesty of bread (mass produced) has been diluted in the category.
- Driven by **poor PR of white** (the mainstay of the category psychologically for most) and lack of reinforcement/re-owning of the provenance messages for newer "healthier" varieties.
- **The values and art of traditional bread which delivers many emotions, tones of nostalgia and theatre/experience are being lost** – artisan bakers and producers are the exception, but mass produced health varieties becoming more about nutritional values rather than the core values of

There is a danger that over time bread loses the connection to its provenance and natural hooks as health and functional food solutions emerge.

The industry needs to protect the art of bread across all varieties

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Category Education is Urgently Needed

Bord Bia
Irish Food Board

- There is a strong need and appetite **for education in category**. Shoppers have key issues top of mind which bring many questions.
- They have a **health challenge** to the category which they are looking for assistance in solving.
- Currently **poor information and poor understanding** leads to weak choices in category, where shoppers do not feel empowered and have doubt over whether they have made, and continue to make, the right choice for them.

56%

Interested in learning more about the actual health benefits of some of the ingredients added to bread

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Lack of Information

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- Despite the volume and frequency of bread consumption and the discussions around the health impact of bread, there is a notable dearth of real understanding about bread……..
- How much bread is ok to eat each day?
- How much bread is it recommended that I eat each day?
- What are the positive nutritional benefits of bread?
- What are the negative nutritional drawbacks of bread?
- How does the nutritional value of different breads vary?

42 % Feel confused about the health benefits of different types of bread

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Importance of bread as a staple food in the Irish Diet

- **Bread was consumed by over 98%** of the population in the recent NANS study.
- **Bread is healthy**: low in fat (particularly saturated), low in sugar, source or high in fibre.
- **Macronutrients**: Bread accounts for (14%) total energy intake, (24%) of total carbohydrate intake, (5%) of total fat intake and (12%) of total protein daily intake.
- **Micronutrients:** Bread contributes to (14%) of folate, (20%) of calcium, (19%) of iron, (22%) of salt and (26%) of fibre daily intake.

Bread is good for you!

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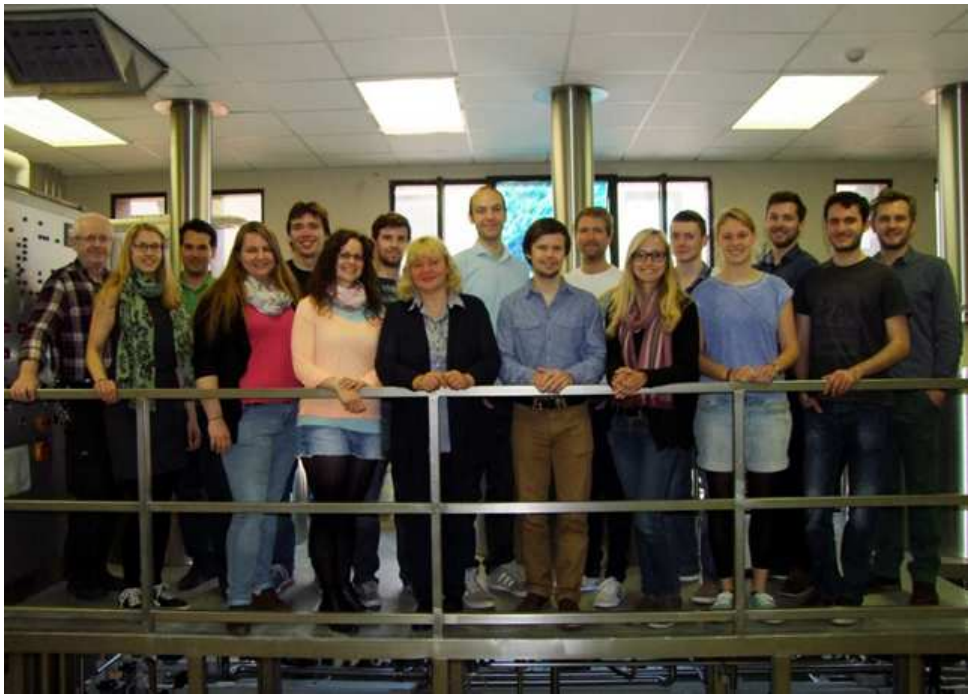

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