



Food and Health Research at JHI

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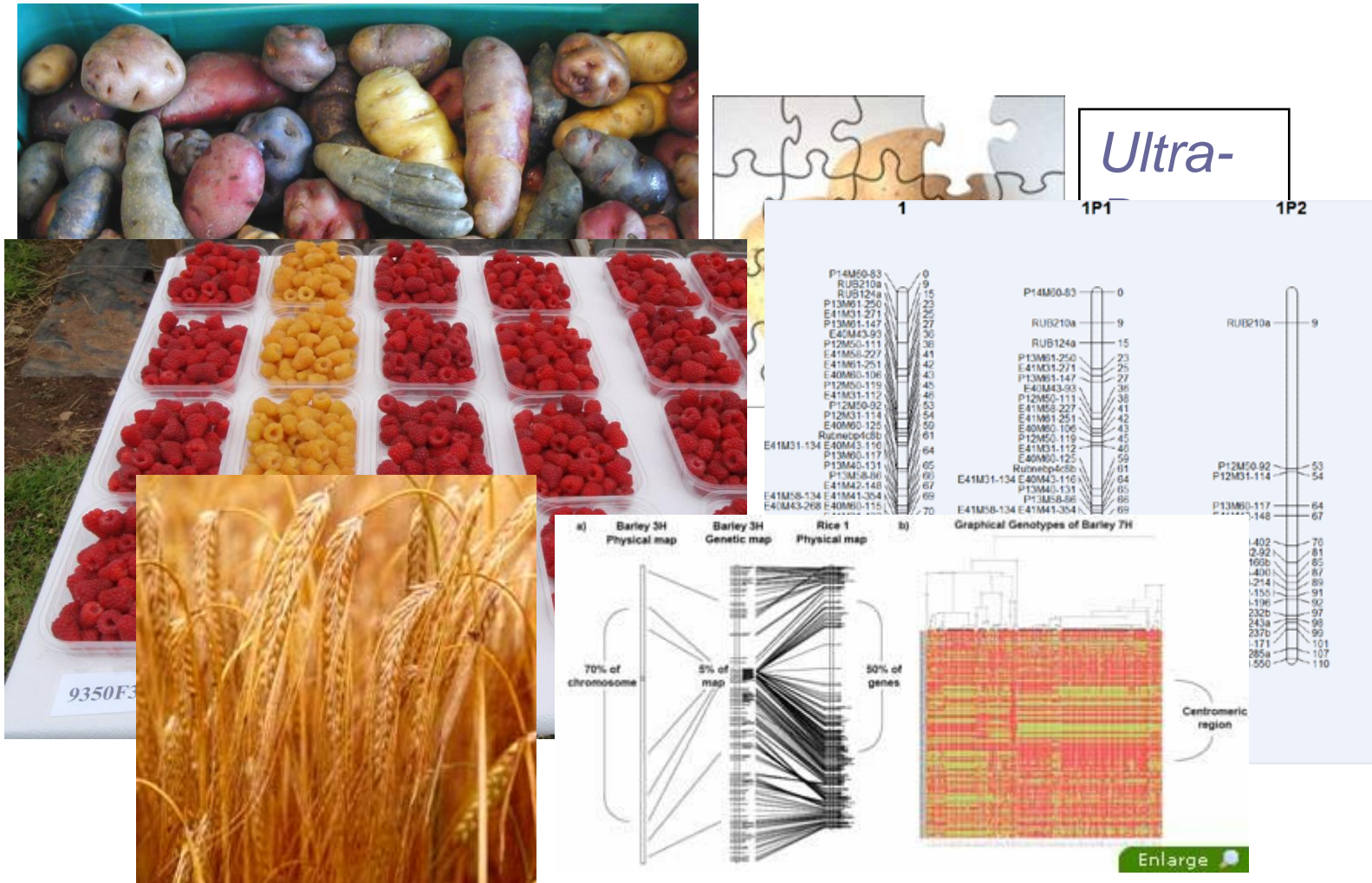


We breed new varieties of fruit
and vegetables

Mainly focused on
potato, barley and berries

JHI at Invergowrie

World class germplasm and genomic resources in potato, berries and barley



Overall Approach to HBCs

Breed New Varieties
with elevated levels of
health beneficial
components (HBCs)

Germplasm

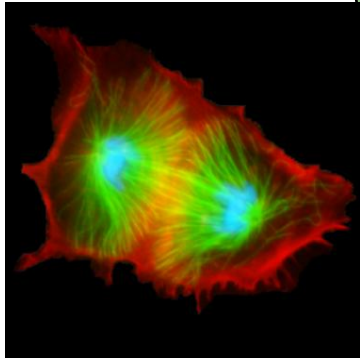
Bioactivities

Establish
Health
Benefits

QSARs

Confirm Mechanisms &
Bioavailability

Define Phytochemistry (Metabolic profiling)



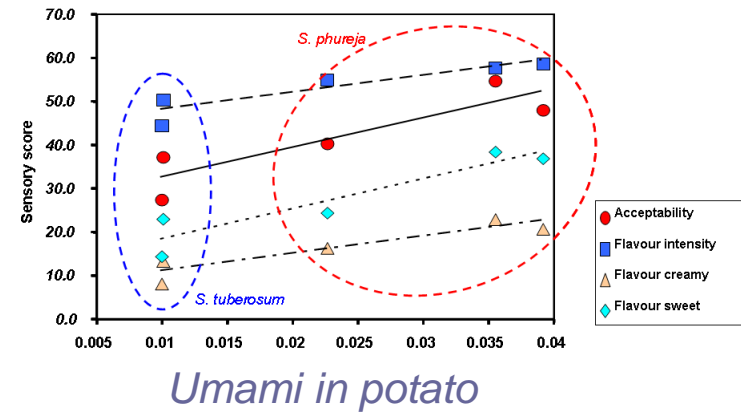
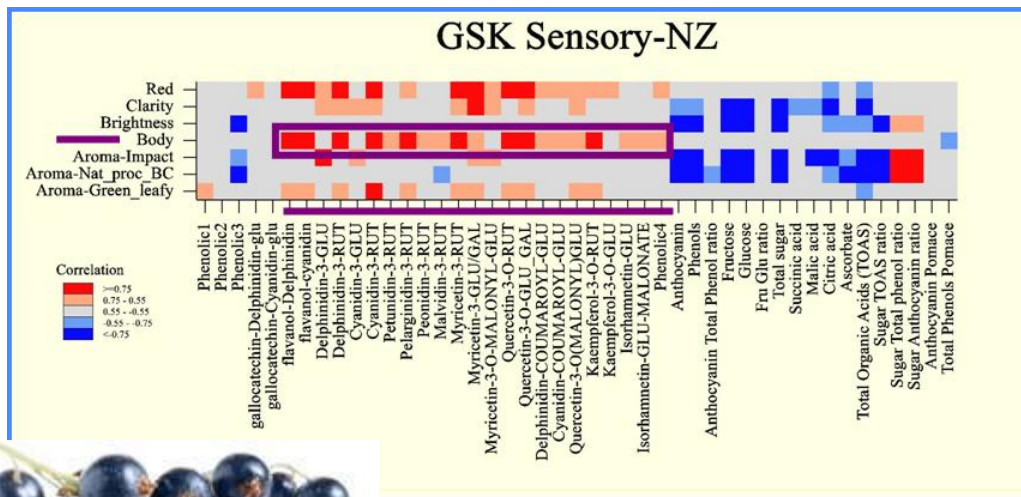
We work on HBCs in other foods



Food Quality

Translation of raw material composition to processed quality

- Methods for the early prediction of potato quality
- Mechanisms for quality generation: taste & texture
- Identification of key pathways/genes for organoleptic properties



From field to fork

Health beneficial components are also affected by

- Shelf life, stability, processing
- Post-harvest treatments, packaging



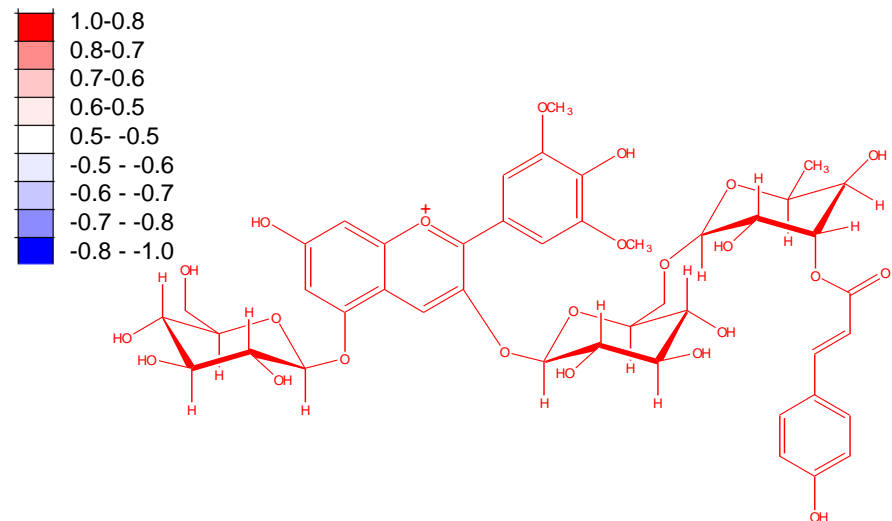
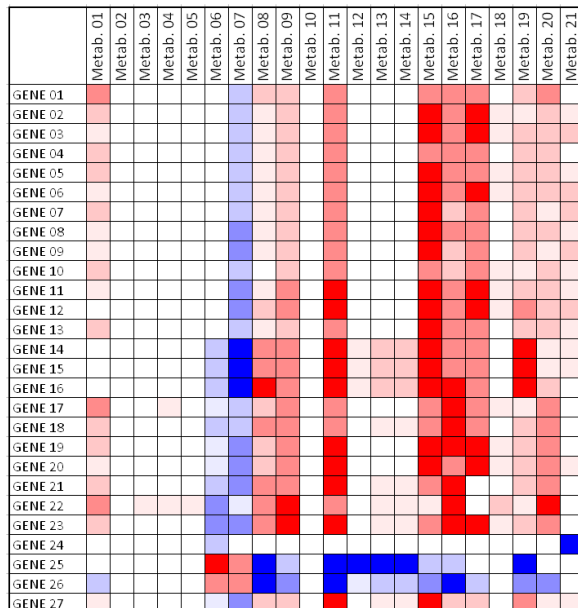
Development of high throughput approaches to optimize the nutritional value of crops and crop-based foods



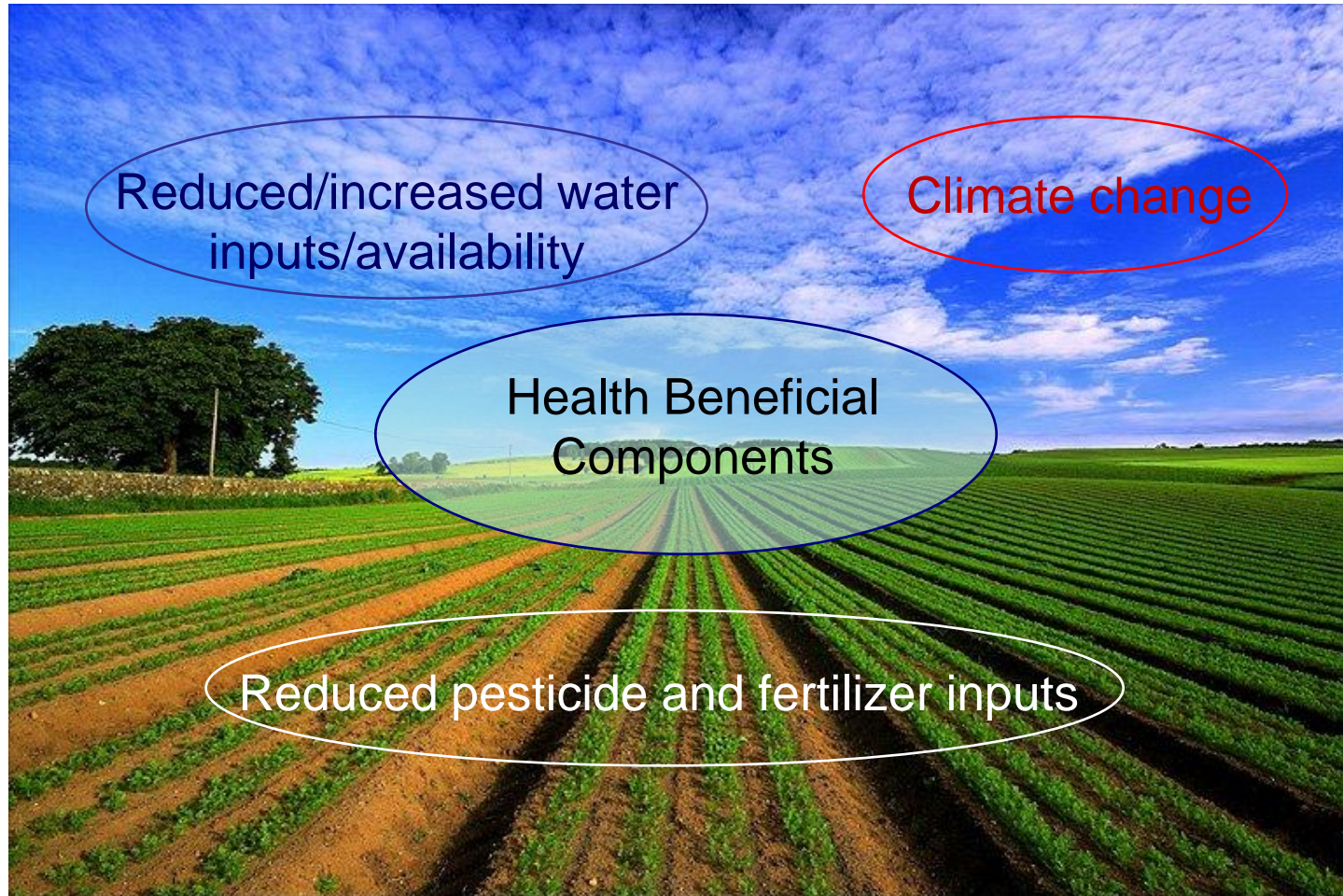
Developing a knowledge base that can aid food business

Accumulation of health-beneficial components and gene expression

- Measure changes in metabolic profiles using MS-based techniques
- Correlate accumulation of purple anthocyanin pigments with gene expression



Environmental/agronomic effects on health-beneficial components

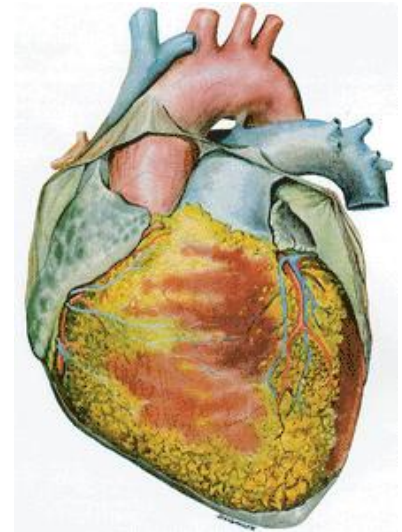


e.g. Balruddery Field Experiment on Sustainable Practices

BarleyBread - Improving human health by modifying a staple food

β -glucan has been proven to influence cholesterol levels and has an approved health claim

- *“Soluble fibre from barley foods that contain at least 4 % β -glucan may, as part of a diet low in saturated fat and cholesterol, reduce the risk of heart disease”*
- This EU-supported research project identified which barley varieties had the best attributes – antioxidants and β -glucan content



Products = breads with added barley



Bread → Health(ier) Bread

- β -Glucan has an approved health claim.
- Preference surveys were done to assess public “likes and wants” for bread
- Optimised milling process to retain nutrients and β -glucan (~75%).
- A baking process was developed to give a bread with $\leq 60\%$ barley and $\leq 0.4\%$ salt.
- Blind preference testing in Scotland: JHI Open day and Kingsway technical college (800 and 700 people respectively).
- Results showed a 80% preference for BarleyBread (25% barley).
- Being further developed.





BrainHealthFood



EU-supported project to develop polyphenol-rich extracts from black currant (BC) juice waste for use against Alzheimer's Disease (and other conditions)

Multi-Partner Collaboration between

MTT Agrifood, Finland

JHI

TTZ, Germany

Univ. Kuopio, Finland

& SME partners across Europe



JHI role included

Provide and characterize BC extracts

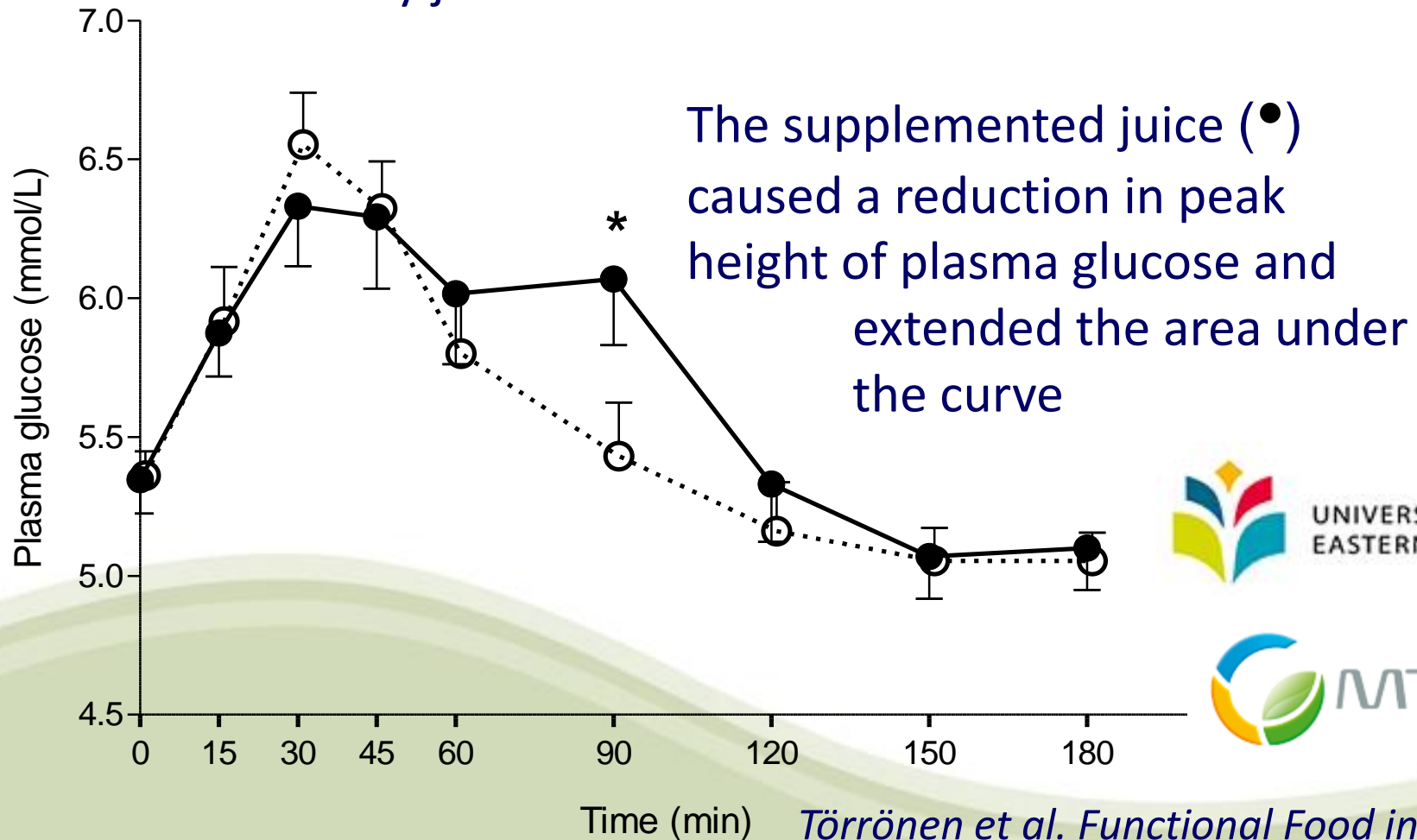
Characterize effective extracts and assess stability

Analyse blood and urine samples for bioavailability data

Advise on formulation of + BC products with SMEs

Human trial – modified glycemic response

Volunteers given sucrose-loaded black currant (BC) juice or sucrose-loaded BC juice supplemented with crowberry juice



Effect of processing methods on herb quality



Flat parsley, basil and dill

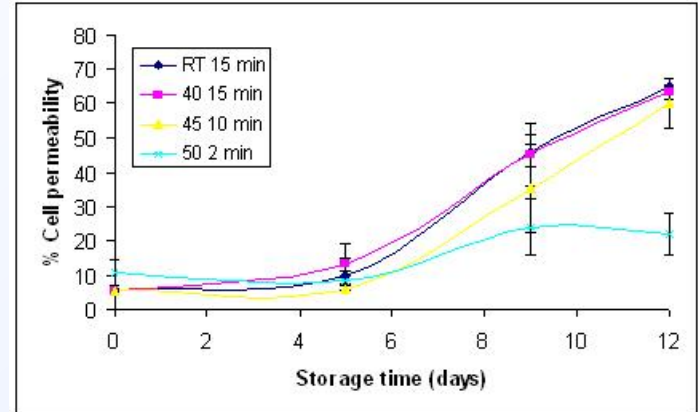
Effects on antioxidant capacity, appearance, oil content, aroma.

Mild thermal treatments and shelf extension

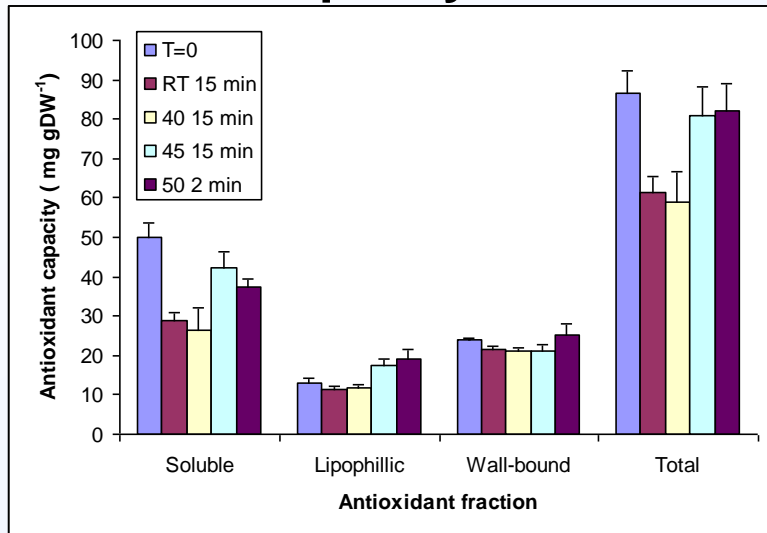
Appearance



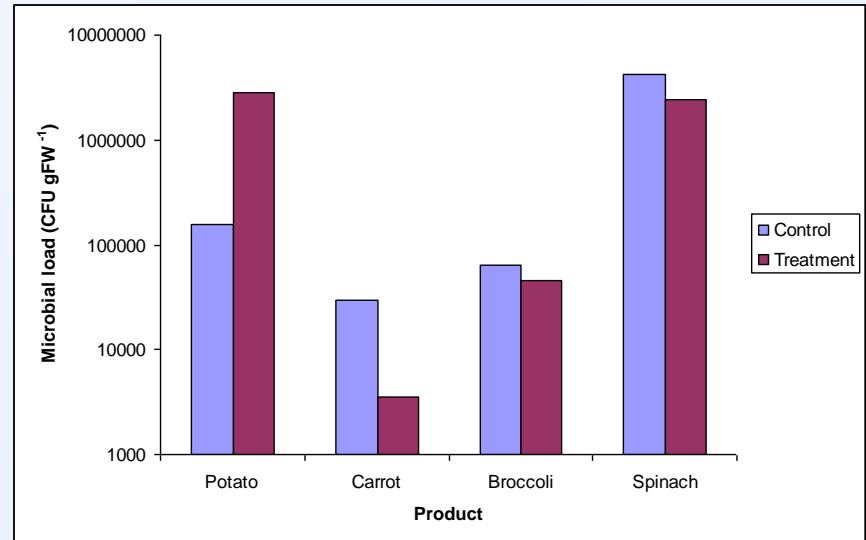
Texture



Nutritional quality



Microbial load



The Rhubarb story

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Effect of different cooking regimes on rhubarb polyphenols

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ABSTRACT

Polyphenolic components, such as anthraquinones and stilbenes, from species of the genus *Rheum* have been shown to have a range of bioactivities relevant to human health. This paper outlines the polyphenolic composition of edible petioles of garden rhubarb (*Rheum rhabarbarum*) and describes the effects of common cooking methods on total polyphenolic content, anthocyanin content and total antioxidant capacity.

Most cooking regimes (fast stewing, slow stewing and baking) except blanching increased total polyphenol content and overall antioxidant capacity, compared to the raw material. The patterns of anthocyanin content and total polyphenol content between the different cooking regimes suggested a balance between two processes; cooking facilitated the release of polyphenol compounds from the rhubarb but also caused breakdown of the released compounds.

Baking and slow stewing offered the best maintenance of colour through preservation of anthocyanin and the highest antioxidant capacity. Baking for 20 min provided well-cooked rhubarb with the highest antioxidant capacity and the highest anthocyanin content, which is important for the aesthetic quality of the dish.

Liquid chromatography–mass spectrometric (LC–MS) analysis putatively identified over 40 polyphenol components in raw rhubarb, including anthraquinone, stilbene, anthocyanin and flavonol derivatives. Baking caused selective effects on the stability of the different polyphenol components. Initially, the yield of all components increased but there was a drastic decline in the relative stability of anthraquinone aglycones with increasing cooking time and initial evidence for the turnover of other anthraquinone derivatives was obtained.



Impact!



Wha's like us... Dr Gordon McDougall

Scotland on Sunday - sub-leader 14 February 2010

RHUBARB is perhaps the most reviled of vegetables. Unloved and unlovely, it grows like a weed in some forgotten corner of the garden to be harvested only in the most straitened of times.

Marco Polo is widely blamed for bringing the stringy acidic plant to Europe from China in the 13th century, but it was not until the rationing of the Second World War that it became part of Britain's staple diet. Since then, stewed rhubarb and custard has been gradually edged off the nation's dinner tables in favour of far tastier fare.

But the vegetable's image was transformed last week thanks to Scottish-led research. Dr Gordon McDougall of the Scottish Crop Research Institute analysed ways of cooking rhubarb to produce the best combination of the plant's polyphenols and chemotherapy agents, which kill cancer cells. Baking gently for 20 minutes was found to be the most effective.

Where others saw an ugly and unappetising pudding, McDougall saw an unexplored avenue of science. Thanks to his work, millions of sufferers may benefit.

Other JHI areas

Analysis & validation of component content

Polyphenols in juices, tea & coffee, vitamin C, lipids, carotenoids in sea buckthorn & carrot products

Shelf-life assessment of berry juices/colour quality

Advice on reformulation for improved health (salt, fats, fibre, viscosity, product quality)

Advice on health claims and marketing approaches



Questions?



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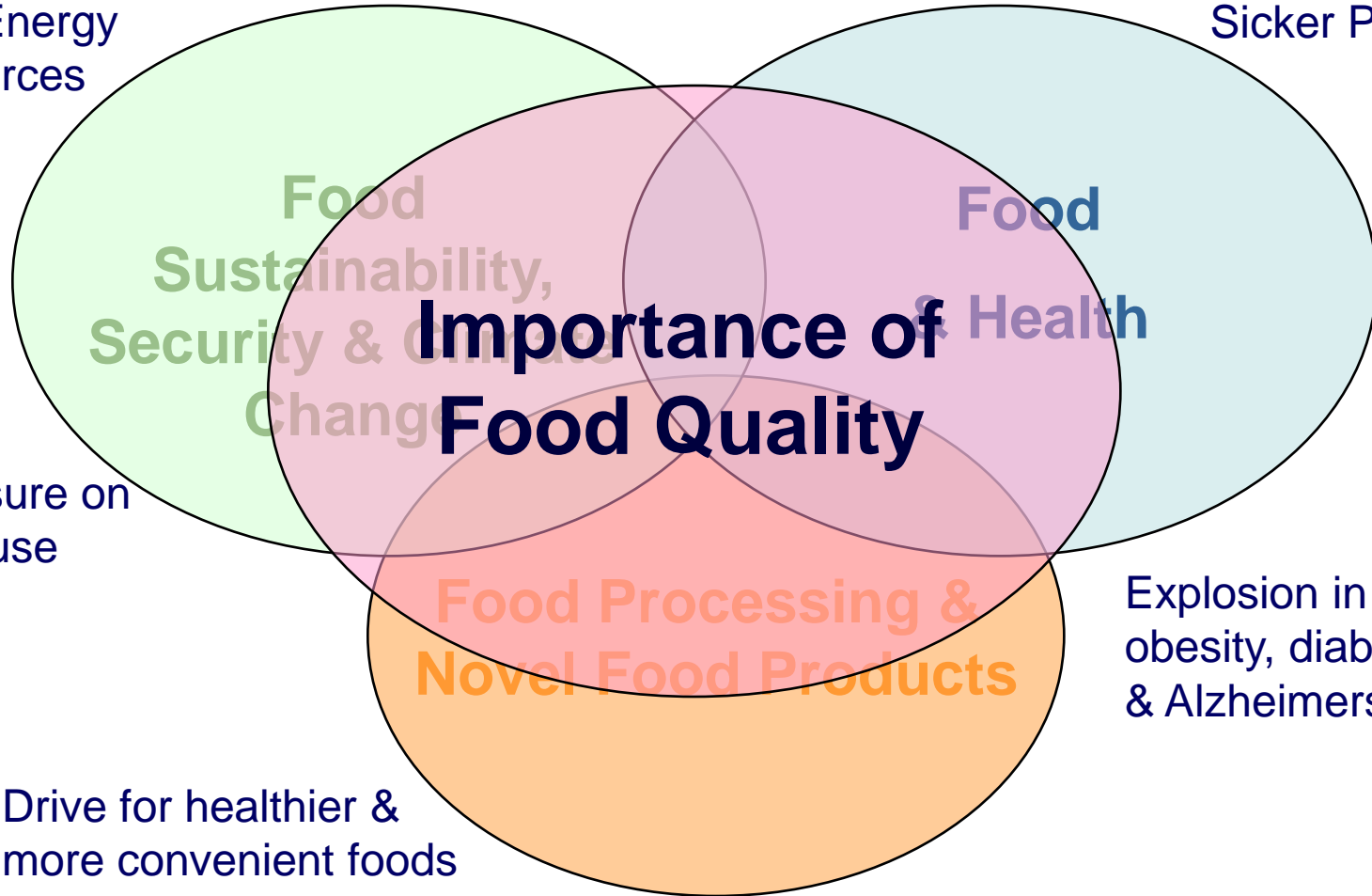
The James
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Institute

Forward look

Future challenges

Limited Water
and Energy
resources

More Aged &
Sicker Population



Food
Sustainability,
Security & Climate
Change

Food
& Health

Food Processing &
Novel Food Products

**Importance of
Food Quality**

Pressure on
land use

Drive for healthier &
more convenient foods

Explosion in
obesity, diabetes
& Alzheimers

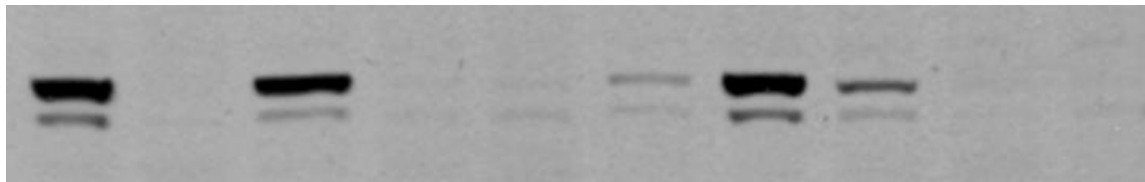
Polyphenols as insulin mimics

Previous work* showed that tea polyphenols could stimulate phosphorylation of the FOXO1a transcription factor – a crucial control in insulin sensing

Current joint PhD has established that berry polyphenols share this ability

Foxo1A phosphorylation

+ - LB UB1 UB2 B1 B2 CB UB B



Controls

Lingonberry

CB



Dr Graham Rena

* *Cameron et al 2008. Aging Cell 7, 69-77*

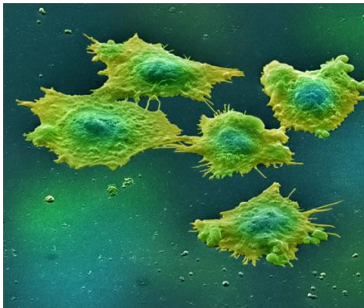
Berry polyphenols and cancer



PhD on berry polyphenols and colon cancer

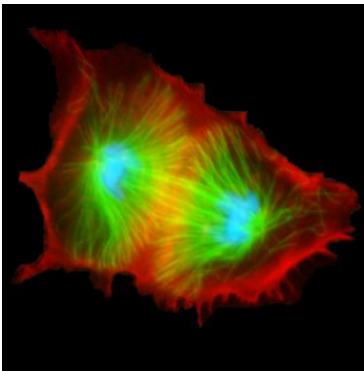
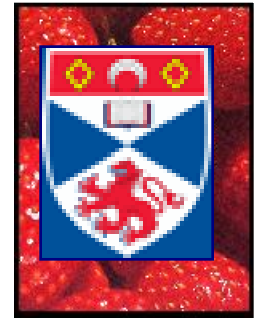
School of Biomedical Sciences

University of Ulster, Coleraine



Strawberry polyphenols in tumourigenic and non-tumourogenic cell lines

University of St. Andrews



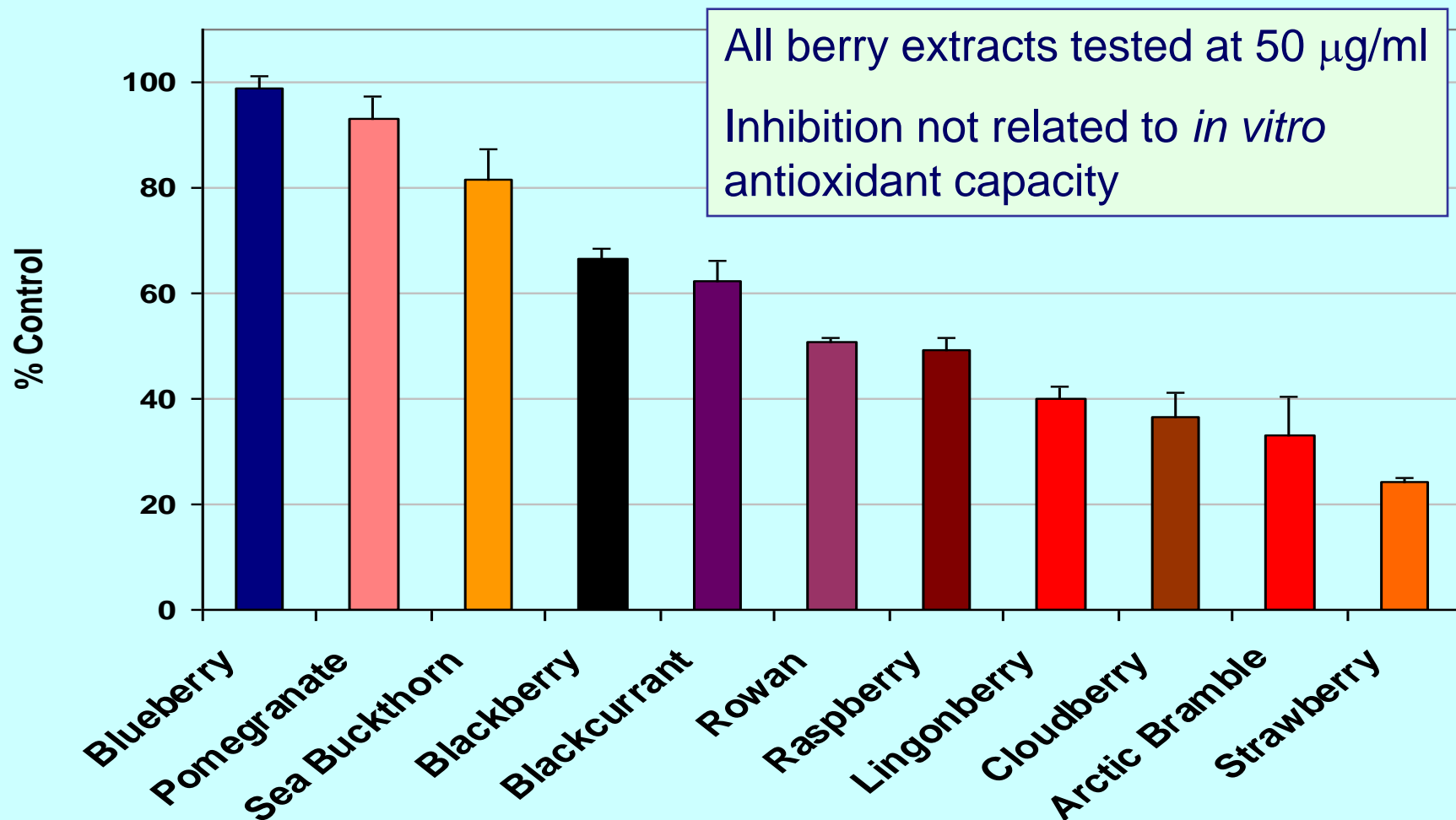
Studies on polyphenol fractionation

Coates et al. J. Carcinogenesis (2007) 6, 1-13

Weaver et al. Int. J. Oncol. (2009). 34, 777-786

Ross et al. (2007) Phytochemistry 68, 218-228.

Berry polyphenols and cancer

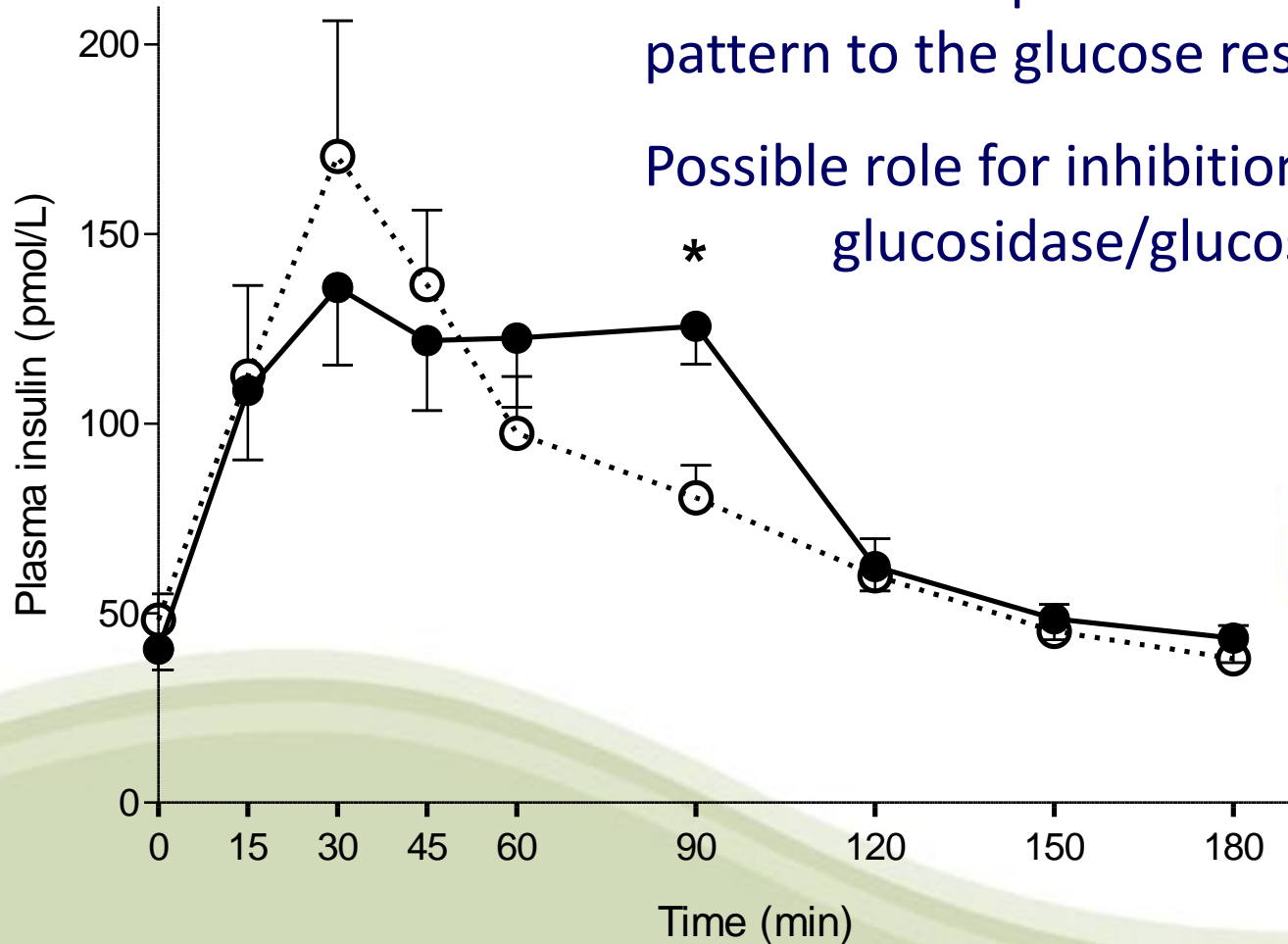


McDougall et al. (2008) JAFC 56; 3016-3023

Human trial – insulin response

The insulin responses showed a similar pattern to the glucose response

Possible role for inhibition of
glucosidase/glucose transport?



UNIVERSITY OF
EASTERN FINLAND





Latham

X



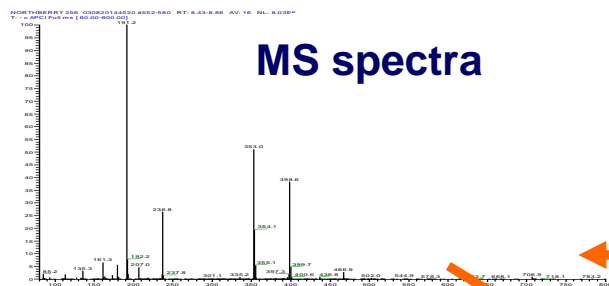
Moy

Two environments, 5 seasons

Targeted analysis

Yield, flavour, aroma taste, texture, disease resistance, bioactivities, antioxidant capacity, polyphenol content, ascorbate, anthocyanins

Untargeted analysis: Hi-through-put metabolic profiling



MS spectra

Direct Infusion MS
No chromatography

SC-MS/uPLC

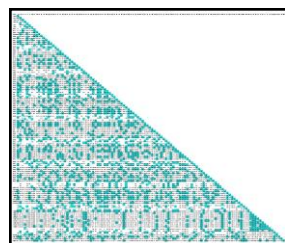


Hierarchical cluster analysis:

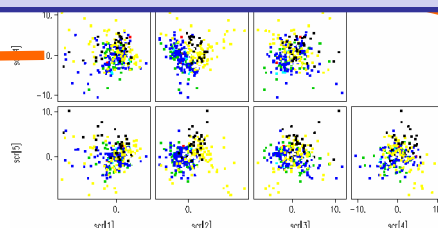
Understand inheritance of HBCs

Chromatogram compounds)

Compounds 1-500



Correlation Network:
Interrelate metabolite changes.



Principal component analysis of MS data

