Quality, Health & Nutrition

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In general the public, industries and policymakers perceive food as a basis for long term health, nutrition and quality of life and this aligns with the research aims of the programme. Through research we endeavour to establish the basis of health properties and organolepsis in major and minor crops with a view to optimising these and to determine what factors throughout the production chain impact upon these and other quality attributes. These aims are being achieved both under the auspices of the new SEERAD Science Programme as well as a raft of externally funded projects.

Health and Nutrition Ascorbic acid (Vitamin C) biosynthesis and regulation are still foci of research and *in planta* demonstrate a strong genetic component with regard to absolute levels whilst their agronomic manipulation have proved elusive. Elevation of ascorbic acid in blackcurrant through breeding is not a short process so current research is focussed on the development of predictive biochemical or genetic markers related to absolute ascorbic acid levels. This has involved sampling a seedling population which is being biochemically characterised using metabolomic technologies and the expression of four ascorbic acid biosynthetic genes assessed. This will allow us to assess genetic diversity within the ascorbic acid biosynthetic genes with a view to using them as predictive markers of fruit ascorbic acid concentration.

Fruit polyphenols are rapidly gaining credence as beneficial dietary bioactive compounds whose actions *in vivo* are suggested to impact positively on many human pathologies and conditions such as cardiovascular disease (CVD), cancer, inflammation etc. A concerted effort has been made to establish and validate efficacy for these compounds and we found that berry extracts

exhibited significant anti-cancer effects in a human model cancer screen. Subfractionation of *Rubus* extracts resulted in significant inhibition of cancer cell growth with the constituent ellagitannins much more efficacious than the anthocyanins. Attempts to attribute a structure–activity relationship to the anti-cancer effects of these polyphenolics are ongoing. Supportive evidence for this was obtained in collaboration with the University of Ulster, wherein raspberry extracts were shown to be effective against the initiation, growth and invasiveness of colon cancer cells.

Interestingly the anthocyanins and ellagitannins were also shown to exhibit significant inhibitory activities against α-glucosidase and α-amylase, respectively. These enzymes are responsible for our ability to digest starch. Inhibition of α-glucosidase by drugs such as acarbose is a current therapy for controlling post-meal blood glucose levels in patients with non-insulin dependent diabetes mellitus (NIDDM). This raises the attractive idea of partial control of starch digestion and thereby blood glucose levels by dietary means, and this could at least in part ameliorate the impact or onset of NIDDM.

Research into the interdependency of food and health has been further strengthened by the appointment of two PhD students via the SCRI joint studentship scheme. These studentships will focus on the mechanism and preventative effects of soft fruit phytochemicals against cancer. These studies will further cement relationships with the Biomedical Research Centre (University of Dundee) and the Northern Ireland Centre for Food and Health (University of Ulster).

Aroma and Taste in Potato Aroma and taste are powerful drivers for repeated food purchases and potato is no exception. To establish the basis of these parameters in potato we have studied the components responsible for unique potato organoleptic parameters at the chemical, biochemical and molecular levels with a view to establishing markers in the raw tuber that can predict properties in the cooked/processed material. European (*Solanum tuberosum* Group Tuberosum) and Phureja potatoes (*S. tuberosum* Group Phureja, also known as *S. phureja*) have been shown to be distinct in sensory panels with respect to aroma and taste with Phureja adjudged to be the "better tasting". Metabolite and volatile compound profiling of raw and cooked Tuberosum and Phureja lines followed by multivariate analysis suggested that there was a clear relationship between the elevated abundance of certain branched amino acids in tubers of raw Phureja relative to Tuberosum and similarly elevated levels of branched short-chain aldehydes in the volatile profile from cooked Phureja. In addition the levels of some fatty acids (*n*-hexadecanoic acid, 15-methylhexadecanoic acid and *n*-heneicosanoic) and some *br*-aldehydes (2-methylpropanal, 2-methylbutanal, 3-methyl-butanal) and methyl esters of short-chain branched acids (2-methyl propanoic acid methyl ester and 2-methylbutanoic acid methyl ester) were elevated in Phureja. Many of these compounds have been reported to have desirable organoleptic properties in other foodstuffs.

Studies into the differences in matrix chemistries between European and Phureja revealed that they differ with respect to umami taste. This is a heightened or elevated taste *per se*: a flavour enhancement category. We have compared the levels of one such class of compounds that give rise to the umami taste, in potato tubers that can be discriminated by taste trials. In tubers that score higher for acceptable flavour there are much higher levels of the umami compounds in cooked tubers. We believe this may be an important advance in our understanding of potato flavour and are extending this observation to a range of germplasm and segregating populations.

Food Quality and Safety Assessment Recent food safety incidents and the introduction of genetically modified foods in Europe have resulted in an intense public debate regarding the safety of the European food supply. Consumers have little confidence in the safety of their food supply and remain sceptical and distrustful of the management procedures currently in place. The overall objective of the EU project SAFEFOODS is to change the scope of decision-making on food safety from single risks to considering foods as sources of risks, benefits and costs that are associated with their production and consumption, and taking into account the social context in which decisions are made. With this framework in

mind the 3.5 million Euro work package co-ordinated by SCRI is using modern profiling techniques (transcriptomics, proteomics and metabolomics), to provide comparative analyses of crops produced by different breeding approaches (including GM), production practices (conventional, low input and organic) and in a range of geographic locations (e.g. UK, Germany, Poland, South Africa). Maize and potato are used as the model species. Data are emerging which illustrate the range and sources of variation in gene, protein and metabolite expression in crops which have a history of safe use. This data will be useful as a starting point in building global databases which will facilitate comparative safety assessment of GM crops, for example.

In a complementary study potato metabolite data derived from current and previous potato projects are being used as part of an FSA funded project to develop unified data models and data pre-processing strategies that should allow meaningful, standardised statistical analyses of metabolome variability to be undertaken in crop plants. This project, in collaboration with the University of Wales (Aberystwyth) and BioSS, will facilitate the unification of metabolite reporting globally and allow for the cross comparison of unique metabolomic datasets.

The advances made in both metabolomics, data handling and interpretation are being used to bridge the link between diet and health. One such study will use metabolomics to assess the impact of high anthocyanin-containing blackcurrant consumption on markers of CVD in early-stage CVD volunteers (in collaboration with University of Dundee School of Medicine). Similarly, within the EU project NOFORISK, metabolomics is being assessed as a platform technology to assess the safety of novel foods. Within NOFORISK metabolomics is being used to monitor an animal feeding trial for any unintended effects following consumption of a GM potato that has an altered and reduced glycoalkaloid content in comparison with the wild type potato. Both of these studies are ongoing.