Plant Products and Food Quality

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The Plant Products and Food Quality programme, formerly called Quality, Health and Nutrition, conducts research into the chemical, biochemical and genetic bases of quality and bioactivity in plant-derived foods and products. It aims to enhance the health benefits of foods to the public by improving the nutritional and organoleptic properties of both raw and processed products and to establish diversification of the non-food crops sector via bioactive plant product research.

Over the last year the programme has undergone a period of repositioning and reemphasis. Managed sustainability of renewable resources is now de rigueur in all aspects of agriculture and, along with a necessity to diversify the national (and UK) economy base, significant opportunities exist with respect to the development of plant products/non-food crops in the widest sense.

Food Quality The programme still retains a major focus on plant-derived food quality and the fundamental chemical, biochemical and genetic factors underpinning this. One of the quality targets is potato flavour. Building on our previous studies, we are investigating the biosynthesis of potato volatiles, an important component of potato flavour. However the soluble, matrix-associated compounds also contribute to potato flavour and these have received less attention. Sensory taste scores gave a good correlation between high levels of umami compounds and positive aspects of potato flavour such as flavour intensity and overall acceptability. We aim to extend these observations to a wider range of germplasm and segregating populations. This approach is being extended significantly by further microarray work funded by the British Potato Council within which gene expression will be analysed and compared during tuber development and, importantly, also during the storage phase.

This core base of potato quality research has attracted significant external funding. Previous work on caro-

tenogenesis in potato tubers is being extended in an EU-funded integrated project (EU-SOL) to investigate the genetic basis of carotenoid formation amongst many quality traits. In addition the new EU-STREP DEVELONUTRI, coordinated by Dr Stewart, aims to develop and validate state-of-the-art metabolite profiling and analysis platforms that can be deployed at all stages in the crop improvement, production and processing platforms to ensure optimised quality, nutritional value and safety throughout the food chain. The project's focus crops will be potato, wheat and tomato.

Potato biodiversity and development are intimately linked with the programmes food quality research. Indeed a comparative metabolomic study of cultivars and landraces has shown considerable variation in mainly the many polar metabolites that could be exploited to manipulate quality traits. This will be further supported by a Royal Society Joint Project grant with Professor Uwe Sonnewald, University of Erlangen, Germany, to exploit the potato microarray and elucidate the mechanisms of tuber dormancy release and sprouting.

The more translational aspects of post harvest quality are being addressed via Scottish Enterprise Proof of Concept Funding to develop and exploit additive-free methods for extending the shelf-life of minimally processed foods (e.g. prepared salads).

Food quality research also extended to soft fruit with the completion of a five year horticulture LINK programme to examine vitamin C accumulation in blackcurrant. The work represents the first time that vitamin C accumulation in sink tissues (e.g. fruits, tubers) has been systematically examined on a whole-plant system level taking into account both synthesis in the sink tissue and transport from photosynthetic tissues or storage pools. Predictive molecular markers for fruit vitamin C content were identified. Incorporation of these markers into the SCRI blackcurrant breeding programme should significantly reduce the time to release of new cultivars.

Food Safety Food safety is either directly or indirectly at the heart of all food matters and genetic modification is the focus of several plant-food safety projects with two funded by the Food Standards Agency to develop a practical method for reliably determining transgene junc-

tion sequences and a metabolomics-based approach to develop unified strategies for handling processing and analysing metabolomics data with a view to using these approaches to assess GM crop safety. At the EU level, the recently completed project NOFORISK (www.noforisk.org) showed via *in vitro* and *in vivo* physiological, transcriptomic and metabolomics studies that for the selected GM potato under study, their exposure (including consumption) to mammalian systems was accompanied by no significant deleterious effects.

SCRI co-ordinates a major work package in the EU FP6 project SAFEFOODS (www.safefoods.nl) which addresses the issue of how consumer confidence in consumer protection and risk analysis can be restored and strengthened. The work package is assessing some of the key drivers of variation in gene, protein and metabolite expression in potato tubers and maize kernels using "omics" approaches. This benchmarking of variation, taken together with the concept of history of safe use, can be used to place into context any "unintended" variation revealed, for example in genetically modified crops. From an extensive analysis of field grown crops the project is demonstrating that genotype, site and season differences are major drivers of variation, but is has proven extremely difficult to distinguish GM crops from their non–GM controls in the cases studied. However, over three growing seasons it has been possible to distinguish between organic and conventionally grown crops of potato using "omics" approaches (collaboration with Prof C. Leifert, University of Newcastle). Data are now emerging on some of the genes, proteins and metabolites driving such differences.

Plant Products and Bioactivity Bioactives research within the programme has exhibited a broad brush. A study has been undertaken into the relative concentration, distribution and utility of calystegines (Figure 1), potential pharma feedstock compounds, in potatoes. Collaborations with biomedical researchers have shown that ellagitannins in raspberries exhibit anti-cancer activity *in vitro* and this is being addressed in depth via joint PhD studentships with the University of Ulster and Dundee to study the effects of fruit components on genotoxicity, apoptosis and invasiveness in colon cancer cells and cancerogenesis *per se*, respectively.

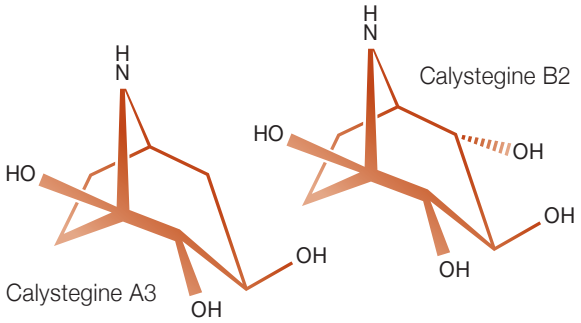

Figure 1 The main calystegines found in potato.

Finally, food functionality and bioactivity is the focus of Barleybread, an EU project aiming to use barley as a functional diluent for wheat in bread. The project aims to exploit functional diversity in barley, such as β-glucans, antioxidants etc., and to identify lines elevated in these components with a view to their inclusion in bread-making and to assess how this inclusion impacts upon taste, texture and nutritive value.