Understanding potato quality traits important to consumers

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Background
Potato flavour and texture are important factors in consumer preference traits. In order to improve germplasm we need to increase our understanding of the molecular basis of these traits. Our studies were based on the comparison of Phureja with Tuberosum tubers. Phureja tubers not only score higher in professional sensory evaluation panels but they also cook more quickly than Tuberosum tubers. This led us to make comparisons of flavour metabolites from boiled tubers from a range of Phureja and Tuberosum cultivars and investigate differences in tuber texture.

Results
Matrix associated umami compounds
The non-volatile matrix associated umami compounds enhance flavour and mouth feel. The major umami compounds present in potato tubers are the amino acids, glutamate and aspartate and the 5'-ribonucleotides, GMP and AMP. The synergistic effect between certain free amino acids and 5'-ribonucleotides can be measured using an equivalent umami calculation (EUC). Previous studies at SCRI have shown that Phureja tubers contain significantly higher levels of umami compounds compared to Tuberosum correlating strongly with acceptability scores from sensory evaluation data.

Flavour and metabolite correlations
Quantitative descriptive analysis of potato samples by a trained taste panel was performed, comparing tubers from Solanum tuberosum group Phureja with those from Solanum tuberosum group Tuberosum, both at harvest and following storage. The cooked tuber volatile profile was analysed by solid phase micro-extraction followed by gas chromatography-mass spectrometry analysis in sub-samples of the tubers that were assessed by taste panels. A range of non-volatile metabolites including the major umami compounds, glycoalkaloids and sugars was also measured in tuber sub-samples. Correlation and principal component analysis revealed differences between the potato cultivars and storage conditions and demonstrated associations of metabolites with the different sensory attributes.

Principal component analysis revealed that component 1, explaining 45% of the variation, separates the two Phureja lines from the two Tuberosum lines. Score 3 explains 14% of the variation and shows all four cultivars responding in a similar manner to storage.

Potato tuber texture
Tuberosum and Phureja tubers exhibit distinct textural properties. Tuberosum tubers (A and B) show no evidence of tissue sloughing after cooking while Phureja tubers (C and D) show marked browning of the tissue in the region of the vascular ring and cortex and the cortical/epidermal region sloughs off as the tissue cooks.

Previous work10 has identified tuber pectin methyl esterase activity (PME) as a potential factor impacting on textural properties with the isoform encoded by PEST1 being particularly important. Tuberosum cultivars exhibit higher levels of PEST1 gene expression and associated enzyme activity compared with Phureja. Potato transgenic lines were generated expressing either the PEST1 sense or antisense transgene. Tuber PME activity and gene expression profiles were determined in the transgenic lines.

FT-IR analysis was used to investigate the level of pectin methylation in cell walls from the transgenic tubers. There were pronounced differences between the FT-IR spectra of the wild type and the transgenic PEST1 sense lines suggesting reduced pectin methylation.

Transgenic plants overexpressing the PEST1 gene exhibit a firmer texture compared to wild type and empty vector controls.

Summary
Correlation and principal component analyses revealed differences between the potato cultivars and storage conditions and demonstrated associations of metabolites with the different sensory attributes.

Manipulation of PEST1 expression level altered total PME activity and resulted in changes in the pectin methylation status of cell walls and cooked potato textural properties.

A genetic approach is currently being used to identify quantitative trait loci (QTL) associated with tuber flavour and texture.

Acknowledgements
This work was funded by the The Scottish Government Rural and Environment Research and Analysis Directorate (RERAD). We are grateful to Ian Pitkethly (SCRI, UK) for poster design.

References
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