Metabolomics as a route to fruit flavour and functionality: Blackcurrant as a model study.

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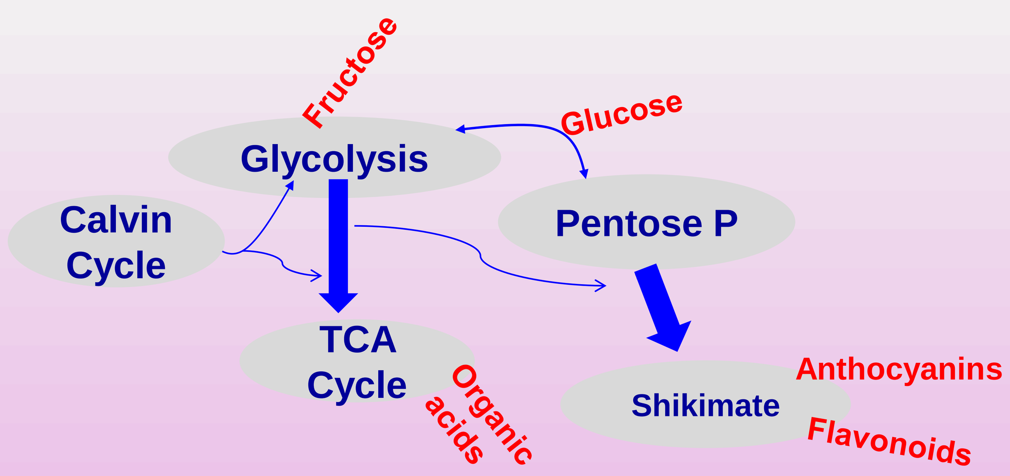
BACKGROUND

The selection of new varieties in breeding programmes depends upon multiple targeted analyses for complex traits such as flavour. Due to their complexity, maintaining or enhancing flavour and aroma are the greatest challenge for geneticists when trying to introduce desirable agronomic traits. In this respect, metabolomic analysis has become an alternative for variety selection by simultaneously characterizing multiple key traits in commercial varieties.

Recently, as part of SCRI's blackcurrant breeding programme, a segregating population derived from contrasting blackcurrant parental lines (high juice quality X gall mite resistant) was been established. To decide which flavour and health traits should be considered in future studies of inheritance and fruit functionality, metabolomics and sensorial analysis were performed on juices of blackcurrant commercial varieties.

METHODS

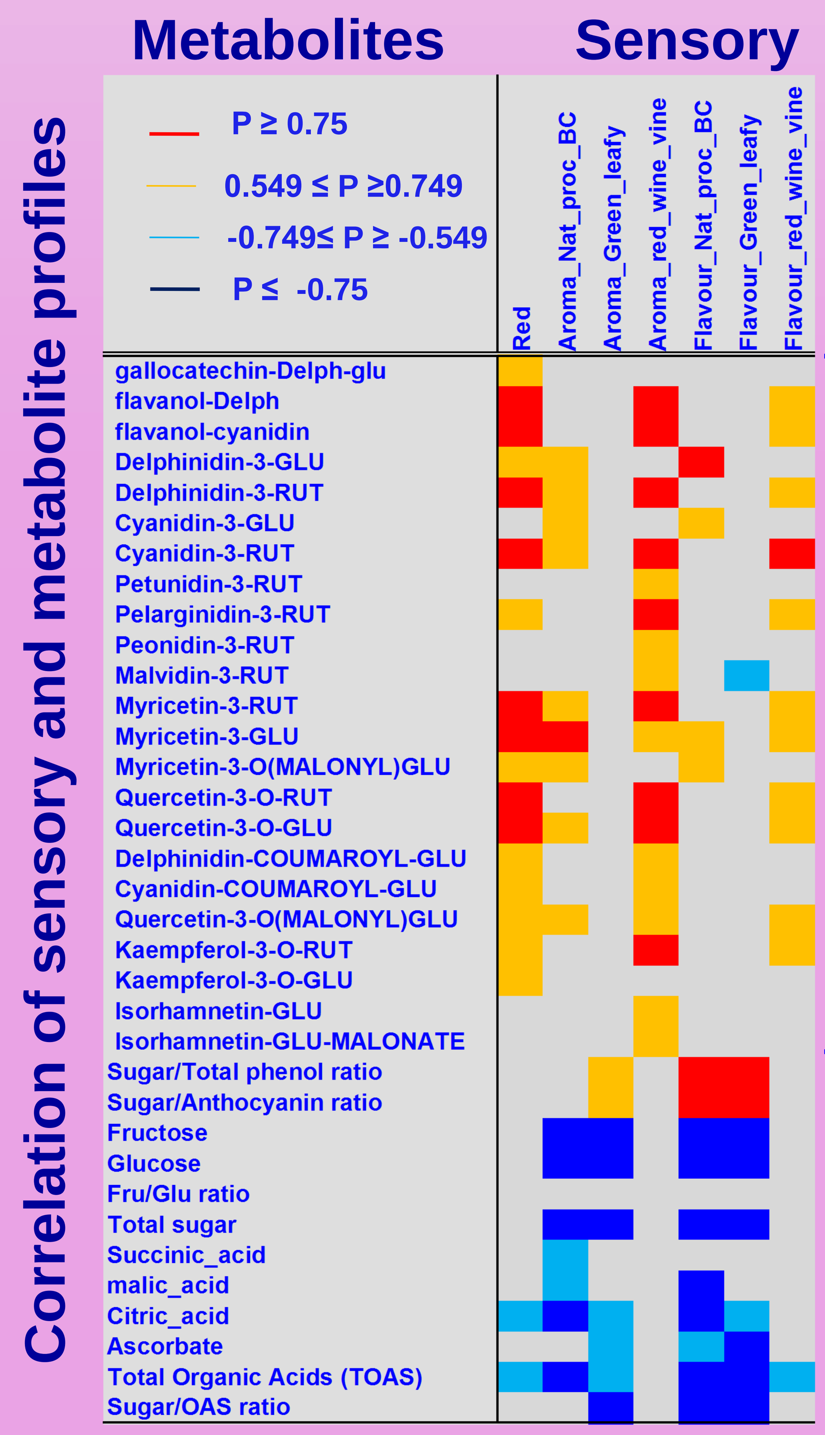


LC Chromatography - Sugars, organic acids and phenolic compounds were characterised and quantified using different chromatographic methods such as LC-PDA, LC - Ion chromatography and LC-PDA-(Orbitrap)MS. In additional, colorimetric analysis was used to determine total phenolics (TP) and anthocyanins (A).

Sensory analysis - Clarity, body, aroma, flavour, etc. analysis were performed by a specific panel provided by GlaxoSmithKline.

Statistical Analysis – Correlations were performed using GenStat 12.0.

RESULTS



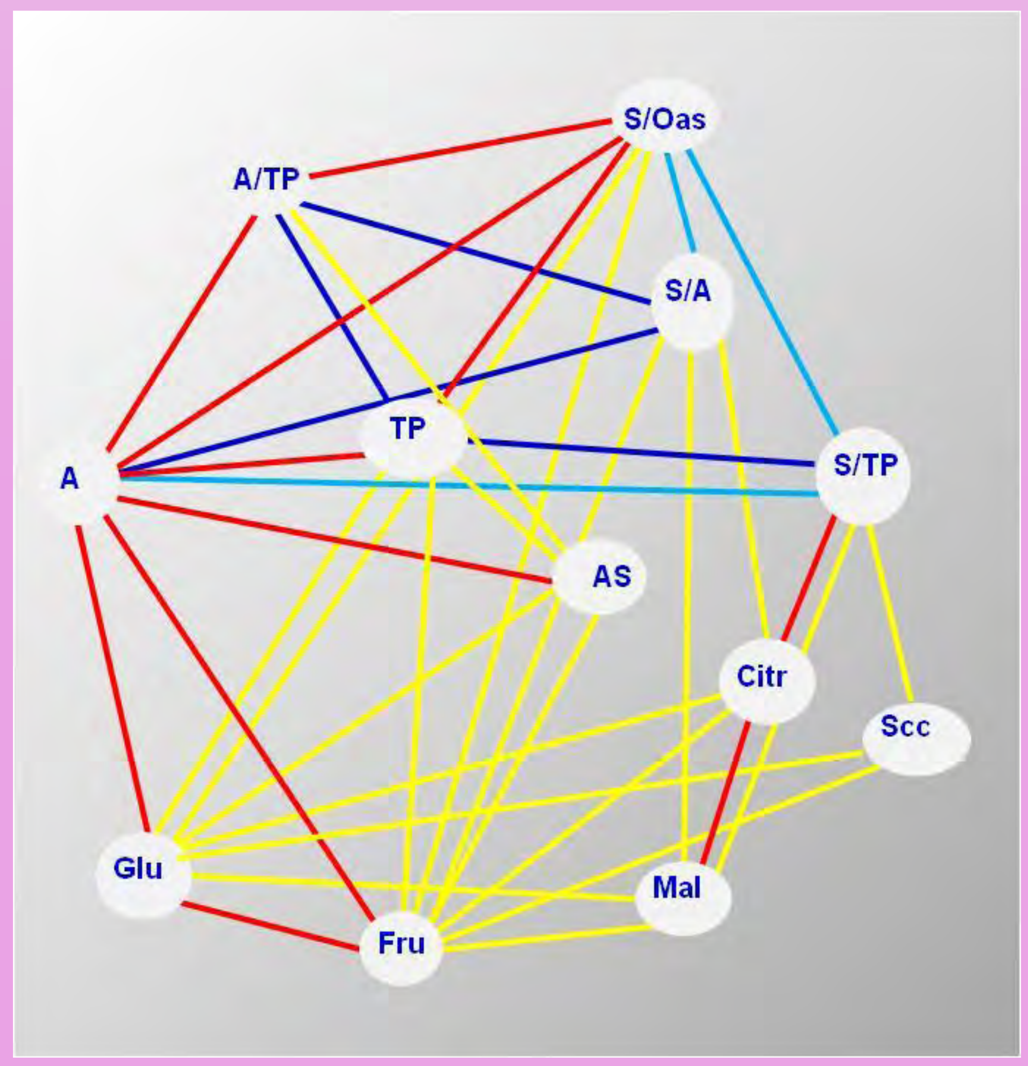
How do phenolic compounds impact on blackcurrant juice sensory attributes?

Metabolic model

A and TP $\xrightarrow{+}$ S/Oas: ↑OAS → ↓S/OAS and ↓A or TP

Citr and Mal $\xrightarrow{+}$ S/TP and A: ↑A or TP → ↓S/TP or A and ↓OAS

A – Total Anthocyanins; TP – Total Phenolics; AS – Ascorbic acid; Fru – Fructose; Glu – Glucose; Scc- succinic acid; Citr – Citric acid; Mal – Malic acid; A/TP – Ratio A/TP; S/OAS – Ratio Sugars/Total organic acids; S/A – Ratio Sugars / A; S/TP – Ratio Sugars / TP.



Metabolite Correlation Network

P ≥ 0.75, 0.55 ≤ P ≥0.74, P ≤ -0.75, -0.74≤ P ≥ -0.55,

- The selected sensory parameters were correlated with sugars, organic acids and different classes of phenolic compounds.
- To understand the metabolic importance of phenolic compounds that may impact upon flavour, we correlated the Total Phenolic (TP) and Anthocyanins (A) with individual levels of sugars and organic acids and their ratio with sugars.
- From the above correlation network diagram: A and OAS are not directly correlated, only through sugars; A and TP are positively correlated with the ratio S/OAS which means that high levels of OAS result in a lower ratio and consequently less anthocyanins (A). Citric and malic acids (the major OAS in blackcurrant juice) are also positively correlated with the ratio S/TP or S/A , meaning that high anthocyanins result in lower ratio and consequently less OAS.

CONCLUSION

The metabolic interplay in blackcurrant (and undoubtedly other fruit) determines the end product sensory attributes. Polyphenolic compounds impact on flavour and aroma as a result of the ratio sugar/organic acids. The cross-correlation of metabolites with sensory data highlighted the delicate impact that changing one (class of) compound can have on other metabolites and the consequences for end products sensory characteristics. The metabolomic approach will used to probe large segregating populations and will facilitate the identification of key points in the metabolism to be targeted for enhanced sensory and health benefits.

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