

A systems approach for improving tea aroma

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Background

Tea researchers aim to understand the genetic and biochemical connections that govern the flavour and aroma of tea, given a specified set of growth conditions. Conventional crop breeding is often used as a tool to improve crop varieties, but, tea plants have a life-cycle of one century, so crop breeding is not an option for improving tea aroma. This proposal focuses only on the aroma aspect of this work, and we are concentrating on terpenoid / isoprenoid pathways, as these show most transcriptional changes. The data that is currently available includes:-

- Detailed knowledge of the biochemical pathways involved.

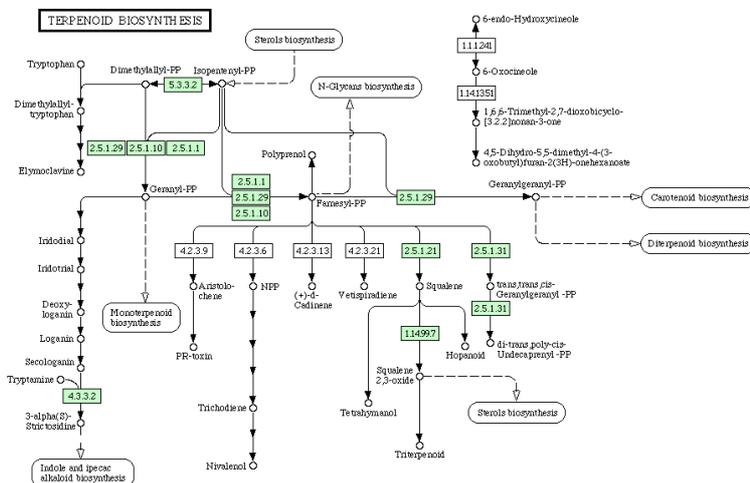


Figure 1: A plant KEGG metabolic map of terpenoid biosynthesis

- Metabolite profiles for key molecules in two tea varieties at nine time points during the harvesting and production process.
- Gene expression profiles for a restricted set of genes in the same two tea varieties, also at nine time points.
- Equivalent processes in other species (e.g. Model plant *Arabidopsis*).

There are two tea varieties involved: *Camellia sinensis* variety *sinensis* and *Camellia sinensis* variety *Assamica*. The *Camellia sinensis* var. *sinensis* plant produces a strong floral aroma whereas the other does not. An initial examination of the data suggests that the different aroma profiles may be due to differences in expression levels of genes. This hypothesis needs to be tested, and we propose that dynamical models of the biochemical pathways and gene expression levels alone can account for the observed quantitative metabolite profiles.

The constituents of fresh tea leaves change from year to year depending on manufacturing process, fertilisation regime and weather conditions. The manufacturing process includes wound-

ing and withering of the tea leaves after picking, this process changes the transcript and metabolite levels, therefore changing the blend of aroma.

Currently, we have adopted a top-down approach looking at global expression and changes in aroma. We would like to refine this down to terpenoid and isoprenoid biosynthesis for dynamic modelling, thus giving an enhanced understanding of the pathways over several time-points during the different stages in the manufacturing process.

Key questions:

Can we produce a simple dynamical model of terpenoid and isoprenoid biosynthesis that can account for the changes in floral notes that correspond to the levels of metabolites, and build on this model to account for observations?

Can we use a predictive mathematical model to define parts of the pathway that are amenable to change using the manufacturing process in order to produce new types of tea with desirable characteristics (e.g. floral notes)?

How should the manufacturing process be changed so that the final product is the same irrespective of the differences in picked tea leaves from one year to the next?

How might growth conditions and manufacturing process be changed to produce new aroma profiles for the preferences of the consumer?