Metabolic engineering in mint plants: increasing essential oil yield through genetic manipulation of biosynthetic pathways

Supervisory team:
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Host institution: Cardiff University

Project description:

This studentship is an excellent opportunity to become part of an international Global Challenges Research Fund project to enhance the yield of high-value essential oil compounds in Mentha (mint) plants in order to produce elite mint varieties for cultivation and commercial exploitation by local farming communities in rural Uganda. Different Mentha species have been shown to preferentially accumulate particular oil components, with the terpenoid compounds menthol and carvone being most abundant in peppermint (M. x piperita) and spearmint (M. spicata) respectively, and these are used extensively in a broad range of foodstuffs, beverages, cosmetics and medicinal products. Other essential oil compounds such as nepetalactone, the active ingredient in catnip, are produced in the closely related Nepeta genus and research has shown that nepetalactone has good insect repellence qualities, making it an excellent candidate for the developmental of low-cost mosquito repellents in order to reduce the incidence of malaria.

The biosynthetic pathways for menthol, carvone and nepetalactone are well-understood, and this project will employ plant metabolic engineering via genetic modification to enhance the yield of these compounds in the essential oils. Using advanced modular DNA assembly techniques such as the Golden Gate cloning system, key enzymes involved in the biosynthesis of menthol, carvone or nepetalactone will be manipulated by overexpression or down-regulation using RNA interference in order to optimise the production and accumulation of these compounds in transgenic plants. This will involve the creation of single and multi-gene constructs using different combinations of promoters, terminators and regulation mechanisms to identify the optimum combination of genetic modifications to maximise oil compound yield. Oil composition will be analysed by GC-MS and lines producing optimum oil profiles will be selected for growth trials in Uganda.

Transgenic lines sent to our partner organisations in Uganda will be cultivated and the oils extracted and sold directly or used for the development of local food, beverage and cosmetic products. Through partnerships established between Cardiff and Makerere Universities and with our local business partner organisation CEMPOP, this project will ensure that sustainable financial benefits accrue principally to local communities in Uganda, via cooperative groups set up to grow, harvest and exploit new mint crops.

The student will join a dynamic team of scientists working on the BBSRC GCRF-funded project and will be supervised by a highly-experienced plant molecular biologist and a world-class biological chemist.