Development of high-throughput phenotyping of Scots pine heartwood stilbenes
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Why stilbenes?
Scots pine heartwood stilbenes

- Pinosylvin and its monomethyl ether (PS & PSM)
- Vary a lot among individual stems
- Are related to the decay resistance of heartwood timber against brown rot fungi

Photo E. Matikainen
Scots pine heartwood stilbenes

- Intelligent exploitation of variation in stilbene concentration by
  - sorting, grading, selection
  - existing timber, tree breeding

- Stilbenes are measured by chromatographic chemical methods → slow process

- Fast, low cost and reliable measurement technologies are needed → measurement from solid wood
What have we done?
Aim: high-throughput phenotyping of stilbens

- Methods to be compared
  1) Gas chromatography mass spectrometry, GC-MS
     - Luke
  2) UV resonance Raman spectroscopy, UVRRS
     - Aalto University
  3) Near infrared spectroscopy, NIRS
     - INRA
Material

- Samples originate from a 44-year-old progeny trial
- One sample per tree, 51 half-sib families, 469 trees in total

[Image of a tree being cut with a drill, with text overlay: "Photo M. Venäläinen"]

[Diagram showing steps of analysis: Chemical analysis (GC-MS) and Optical analysis (UVRRS)]

[Logos and text: INRA, GenoBois, METLA, Luke]
Results: correlation of family averages

- Chemical GC-MS measurements as reference method
- NIRS and chemical analysis separate PS and PSM
- UVRRS cannot separate PS and PSM, thus it gives the sum of stilbenes (STB)
- Calibration set $n = 212$, validation set $n = 257$
Conclusions

- NIRS measurements predict well observed concentration of stilbenes
- Estimated heritabilities from NIRS measurements coincide with those from GC-MS
  - High $h^2$ & $CV_A$
- UVRRS requires adjustments
- NIRS is a good candidate for further development
  - the measurement speed needs to be developed
  - Imaging NIRS?
- Sampling and sample preparation are still quite laborous, although samples are not grinded
Prospects of breeding for stilbene concentration of Scots pine heartwood
Stilbene biosynthesis

- Developmental during heartwood formation: begins between 15 to 20 years of age
- Induced to other tissues due to
  - wounding, ultraviolet radiation, ozone, pathogens
- Is there connection between developmental and induced production of stilbenes?
- Tools for early selection?

Reseach, development & innovation

- Development of automated stilbene measurement technology based on the UV-fluorescence of stilbenes
  - ERDF project 2015-2016 in Luke/Punkaharju
- Faster application of existing knowledge of heartwood quality in forest regeneration
  - Selective seed harvest from existing seed orchards
- The role of stilbenes in resistance of living Scots pine trees against biotic and abiotic stresses?
Collaborators

- Natural Resources Institute Finland (Luke)
  • Katri Kärkkäinen, Jukka Antikainen, Tarja Tapanila
- Mikkeli University of Applied Sciences (MAMK)/Savonlinna
  • Hannu Leinonen, Elmar Bernhardt, Henri Montonen
- GenoBois - Wood Technological Platform, INRA Val de Loire Orléans
  • Jean-Paul Charpentier, Vincent Segura, Luc Paques
- Aalto University (A!)
  • Anna-Stiina Jääskeläinen, Antti Kivioja, Rita Hatakka
- Helsinki University
  • Teemu Teeri, Kean-Jin Lim, Tanja Paasela
Thank You!

Photo: K.-J. Lim