

Development of high-throughput phenotyping of Scots pine heartwood stilbenes

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First HealGenCAR conference:

“Challenges in tree resistance breeding”

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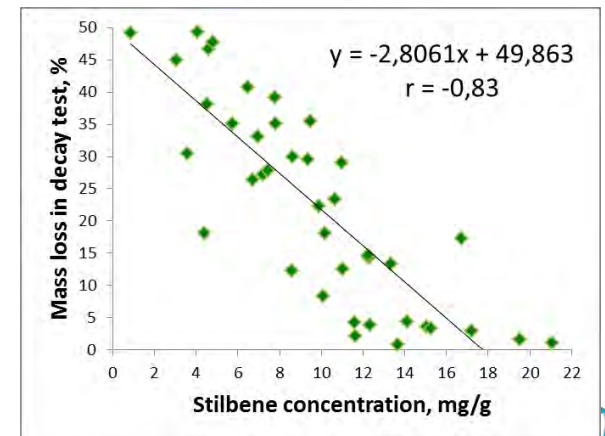
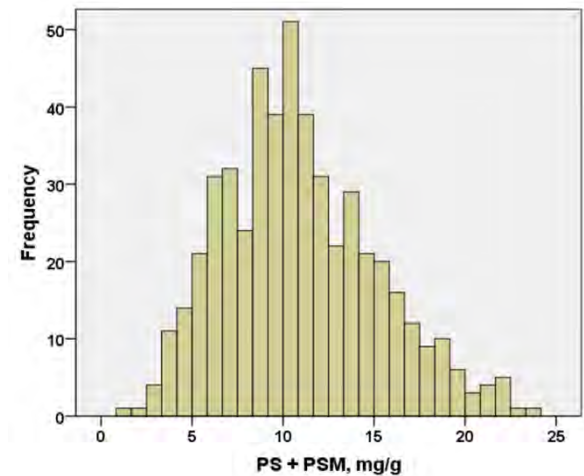
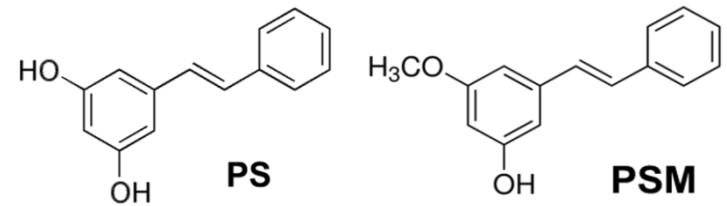
- Why stilbenes?
- What have we done?
- Prospects of breeding for stilbene concentration of Scots pine heartwood



Why stilbenes?

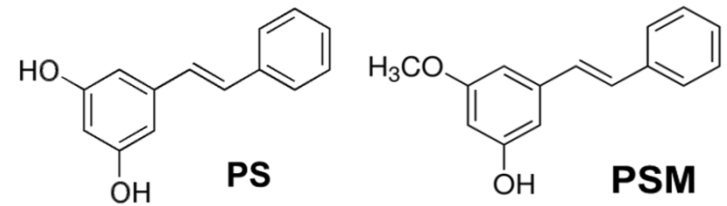
Scots pine heartwood stilbenes

- 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



Scots pine heartwood stilbenes

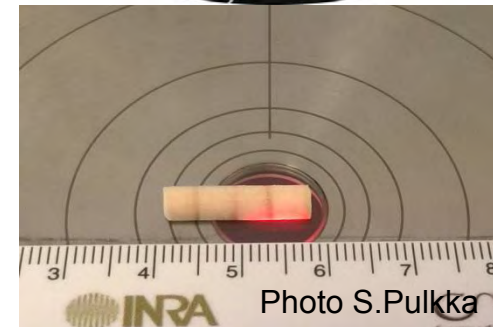
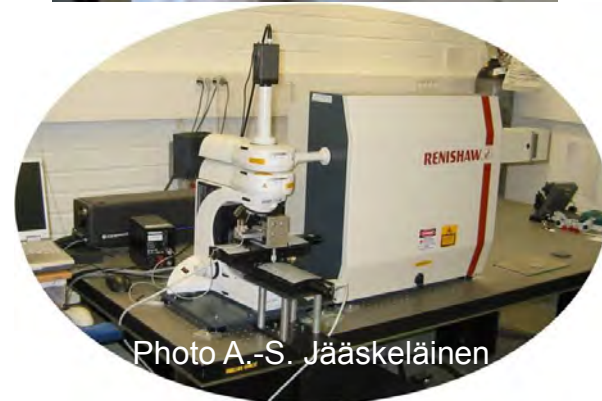
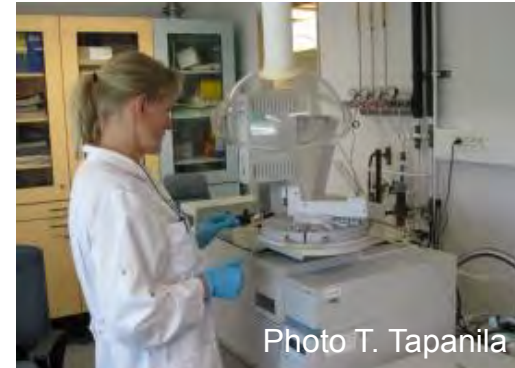
- Intelligent exploitation of variation in stilbene concentration by
 - sorting, grading, selection
 - existing timber, tree breeding
- Stilbenes are measured by chromatographic chemical methods → slow process
- Fast, low cost and reliable measurement technologies are needed → measurement from solid 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, URRS
 - Aalto University
 - 3) Near infrared spectroscopy, NIRS
 - INRA

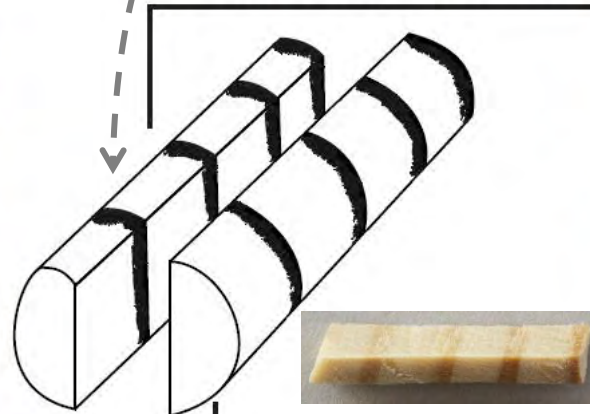


Material

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



Chemical analysis (GC-MS)



METLA

Optical analysis (UVRRS)

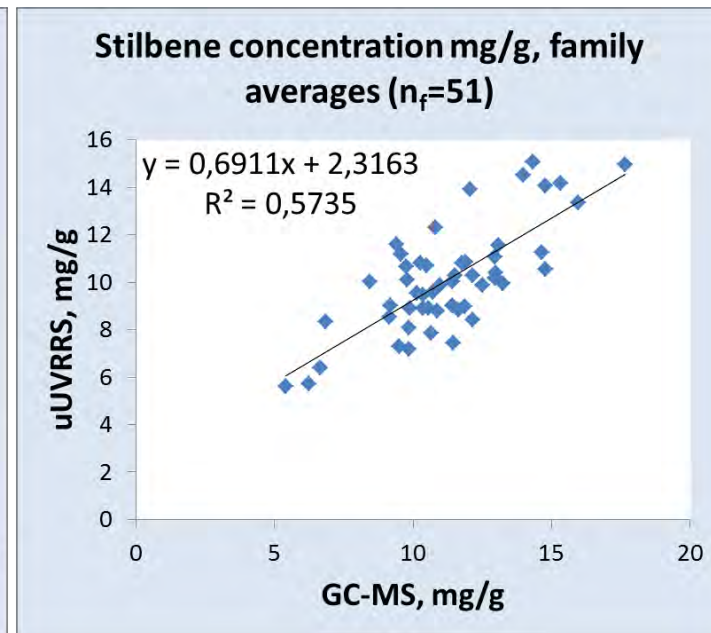
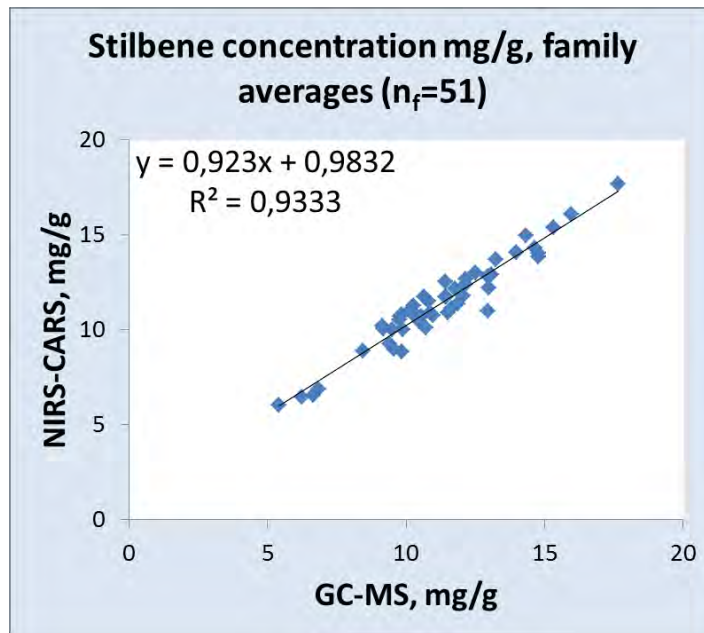


(FT-NIRS)



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?



Photo M. Venäläinen

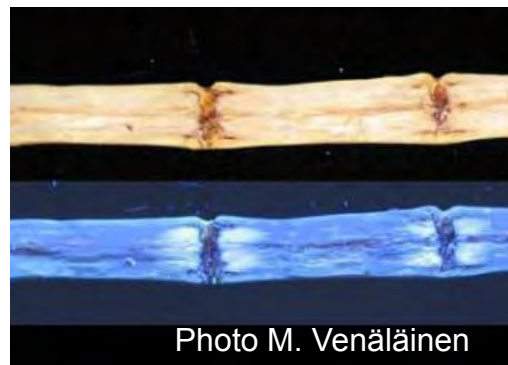


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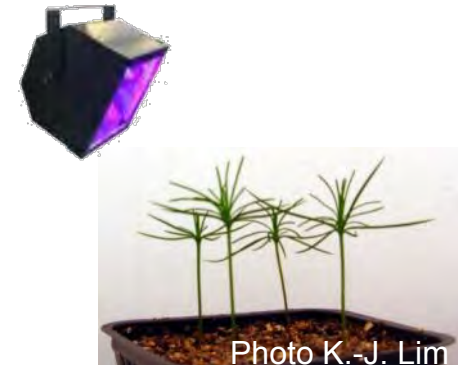


Photo K.-J. Lim

Harju et al. 2009. *Tree Physiology* 29(1):19-25.

Research, 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 !