

Biotechnological improvement of hemp fibre quality

Marcel Toonen



Aim

- Improve knowledge on fibre development
- Develop 'Tailor-made' hemp varieties for specific applications



Approach

- Study fibre characteristics
 - IAF Reutlingen
- Gene expression study
 - connect genetic information to fibre properties
- Transfer genetic information



Fibre quality

- Fineness
- Filling of the lumen
- Chemical composition
 - Decortication
 - Splitability
 - Colour
- Bottom to top difference

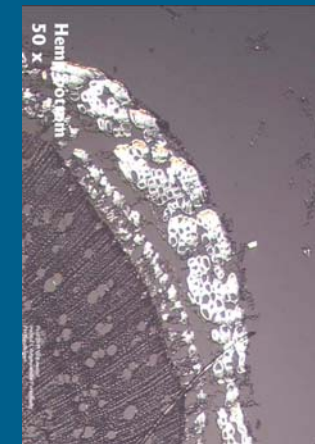


Photo: IAF Reutlingen

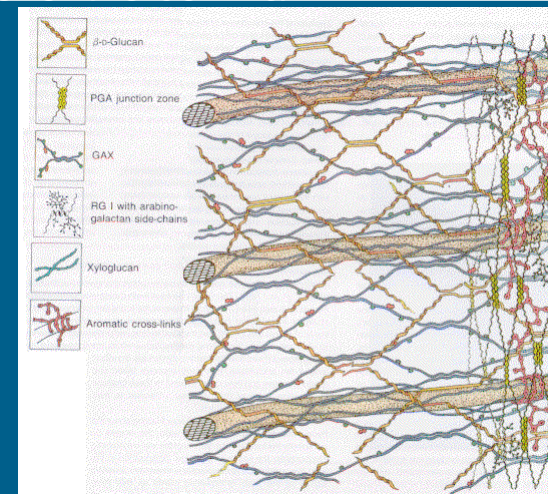
Fibre quality

- Fineness
- Filling of the lumen
- Chemical composition
 - Splitability
 - Decortication
 - Colour
- Bottom to top difference

Plant development

- Growth of the plant
- Development of cell wall
 - cellulose deposition
 - lignin/pectin deposition
 - modification of compounds
 - alteration in time

A model of the cell wall



From: Carpita & Gibeaut (1993) Plant J. 3, 1-30

Genes for cell wall biosynthesis

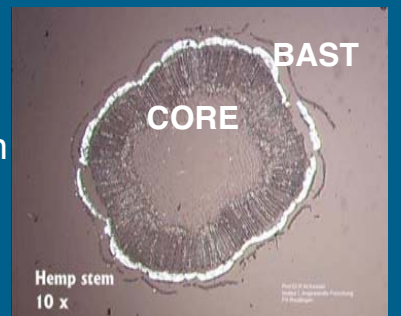
- Cellulose biosynthesis
 - Cellulose synthase catalytic subunit
 - Secondary xylem cellulose synthase
 - Sucrose synthase
- Hemicellulose biosynthesis
 - λ α -L-arabinofuranosidase
 - Xyloglucan endotransglycosylase
 - Endo-xyloglucan transferase
 - λ β -mannosidase
 - λ β -galactosidase
- Pectin biosynthesis
 - Pectin esterase
 - Pectin acetyl transferase
 - Pectin methyl esterase
 - Polygalacturonase
- Lignin biosynthesis
 - Phenylalanine ammonium lyase
 - 4-Coumarate:CoA ligase
 - Caffeic-O-methyltransferase
 - Cinnamoyl-CoA-reductase
 - Caffeoyl-CoA 3-O-methyltransferase

Genes for cell wall biosynthesis

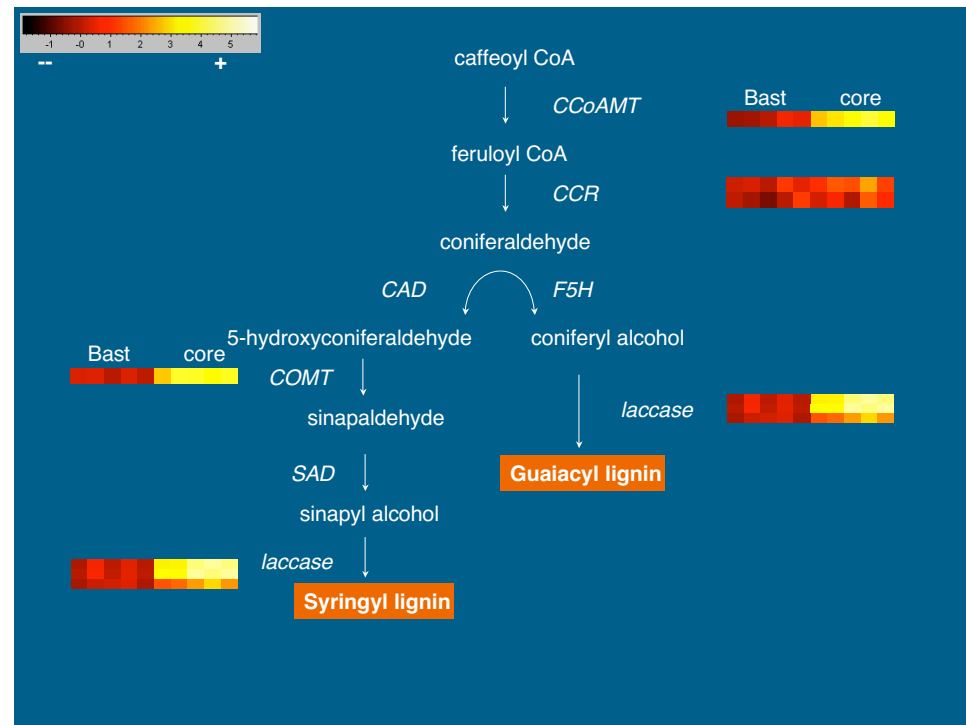
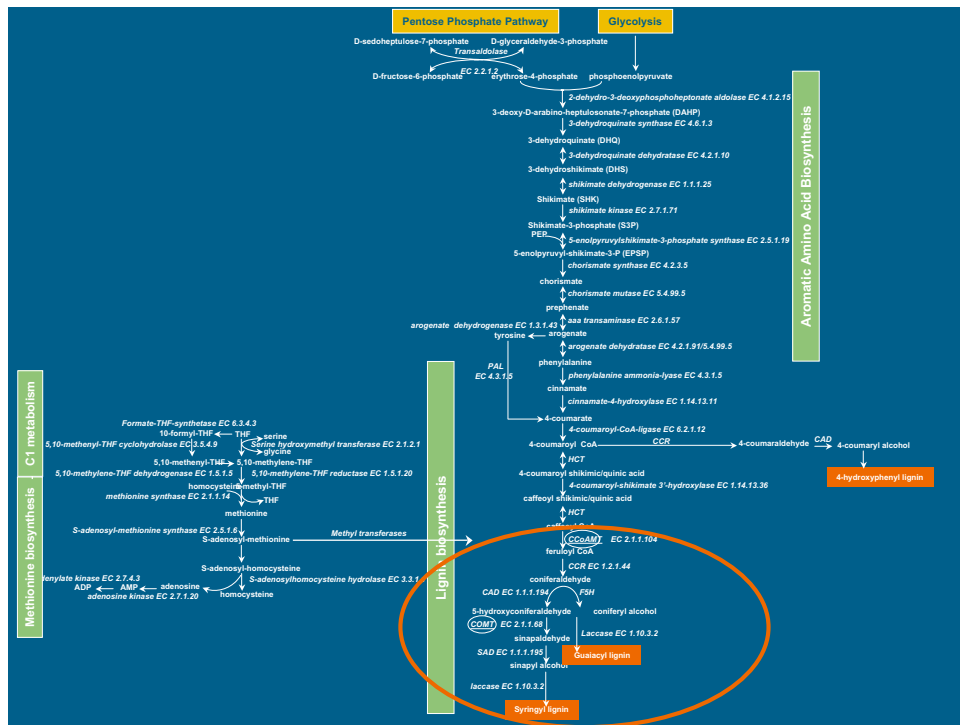
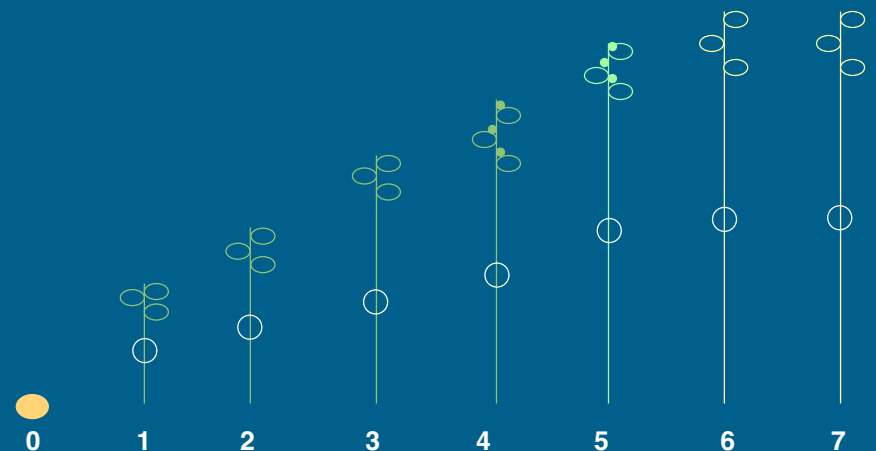
- Cellulose biosynthesis
 - Cellulose synthase catalytic subunit
 - Secondary xylem cellulose synthase
 - Sucrose synthase
- Hemicellulose biosynthesis
 - λ α -L-arabinofuranosidase
 - Xyloglucan endotransglycosylase
 - Endo-xyloglucan transferase
 - λ β -mannosidase
 - λ β -galactosidase
- Pectin biosynthesis
 - Pectin esterase
 - Pectin acetyl transferase
 - Pectin methyl esterase
 - Polygalacturonase
- Lignin biosynthesis
 - Phenylalanine ammonium lyase
 - 4-Coumarate:CoA ligase
 - Caffeic-O-methyltransferase
 - Cinnamoyl-CoA-reductase
 - Caffeoyl-CoA 3-O-methyltransferase

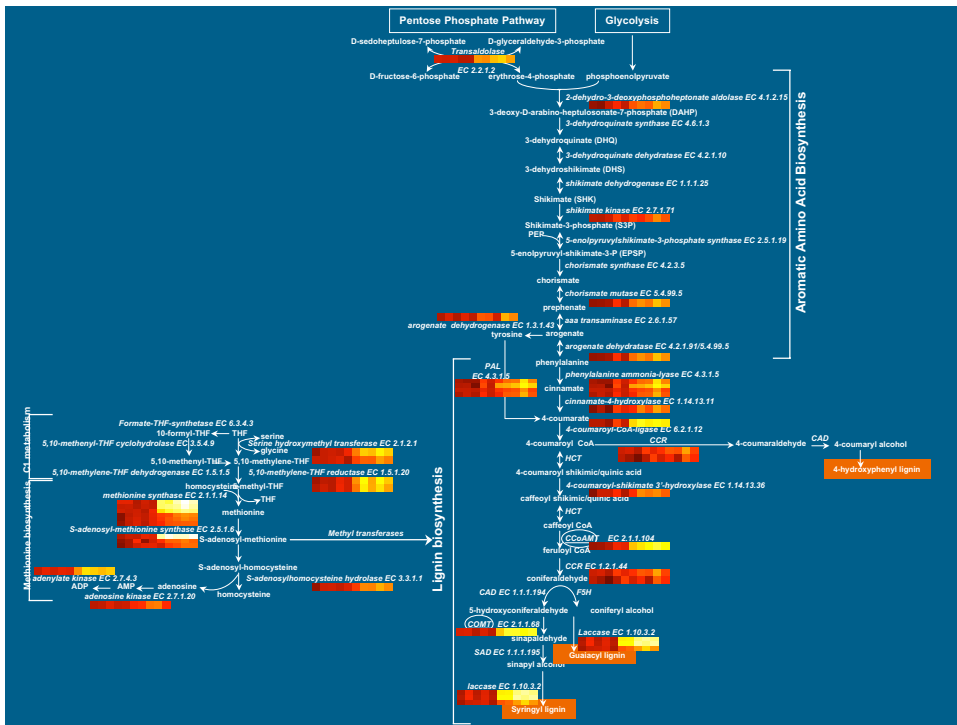
Lignin biosynthesis

- Well known pathway
- Differential gene expression
 - between core and bast
 - during development in time
 - between varieties



Development





Gene expression studies

- 24 genes in lignin biosynthesis
- 300 genes upregulated in core
 - lignin, cellulose, hemicellulose, pectin & others
- Use key genes for quality improvement
 - study function in detail

Transfer genetic information

- Transfer target genes
 - study gene function
 - 'transgenic crops'
- Develop hemp transformation protocol
 - regeneration
 - transformation

Hemp regeneration

- Shoot meristems
 - adult plants
 - isolation of shoot meristems
 - various plant-hormone treatments
- Hypocotyls
 - two week old seedlings
 - cut hypocotyls
 - various plant-hormone treatments



Hemp transformation protocol

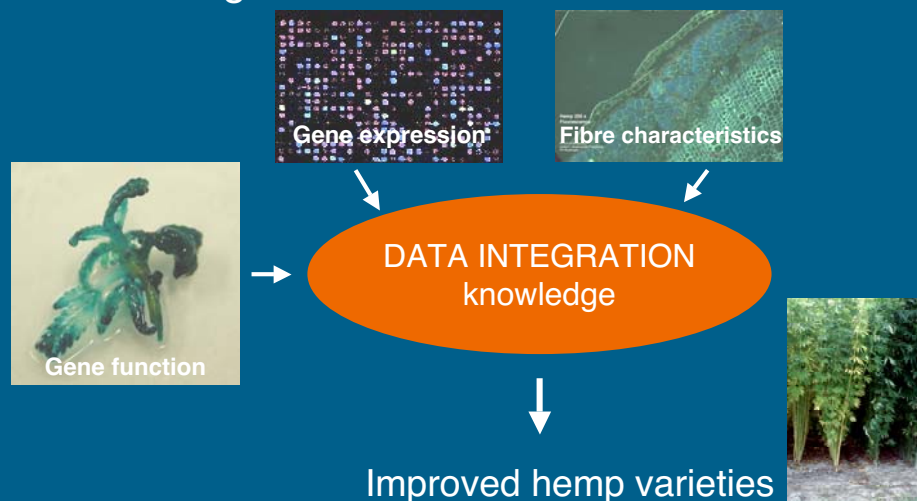
- *Agrobacterium* transformation
 - shoot meristems
 - hypocotyl parts
- Use 'dye' gene
 - indication by blue colour



Hemp transformation protocol

- Determine function of genes
 - specific target genes e.g. lignin
- Improve knowledge
- Use information in breeding

Combining information



Acknowledgements



- Hetty Busink-v.d. Broeck
- Iris Tinnenbroek-Capel
- (Michel Ebskamp)
- (Kitty Huijben)
- Marcel Toonen



- Rudolf Kessler
- Kai Nebel

HARMONIA is funded by the Quality of Life program



