Feasibility study on three furfurylated non-durable tropical wood species evaluated for resistance to brown, white and soft rot fungi

IRG/WP 08-40395

Thomas Mark Venås

DANISH TECHNOLOGICAL INSTITUTE

Andrew H. H. Wong

UNIVERSITI MALAYSIA SARAWAK UNIMAS

Purpose

- To study the treatability of three decay susceptible tropical wood species by furfurylation
- To investigate the effectiveness of the modification treatment towards brown, white and soft rot fungi

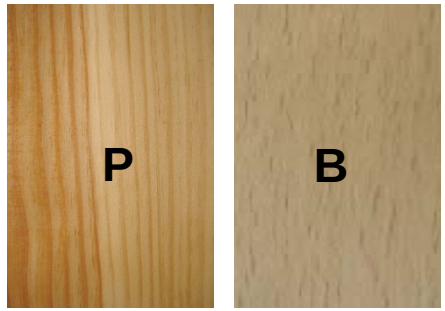
Furfurylation – some important variables

- Temperature and pH determine the resinification rate
- The choice of catalyst can/may affect the polymer yield and leaching properties
- Vacuum drying for solvent recovery reduces leaching
- Constant atmosphere important during curing
- Wood anatomy and cell wall polarity –

  await further studies

Wood material – 2 x 2 x 2 cm^3 blocks

Species	Density $r_{(0.12)}$	Wood type
Kelempayan	320 kg/m^3	sap+heart
Rubberwood	610 kg/m^3	sap
Sena	666 kg/m^3	heart
Scots pine	485 kg/m^3	sap
Beech	701 kg/m^3	sap



K: *Anthocephalus spp.* syn *Neolamarckia cadamba*, **R**: *Hevea braziliensis,* **S**: *Pterocarpus indicus,* **P**: *Pinus sylvestris*, **B**: *Fagus sylvatica.* All wood used for this trial came from plantations in Sarawak and Denmark.

Impregnation liquids and modification process

wt-%	FA	EtOH	MA	CA	H_2O
I	20	78	0.4	0.8	1.4
II	55	39	1.1	2.1	3.8
III	90	-	1.7	3.5	6.3

I, II and III refer to impregnation liquids, FA: furfuryl alcohol, EtOH: ethanol, MA: maleic anhydride, CA: citric acid
6 replicates pr. solution, wood species and fungus – 360 in total

1) Wet vacuum: 0.10 bar for 0.5h
2) Pressure: 12 bar for 2h
3) Evaporation of solvent (solutions I and II): 20-40 °C for 4h (temperature ramp)
4) Curing: 103°C for 16h wrapped in aluminium foil
5) Final drying to evaporate condensation water and unreacted monomer

Decay testing

- ASTM D-2017 for basidiomycetes
- Soft rot test according to Wong (2006)

- *Gloeophyllum trabeum*
- *Pycnoporus sanguineus*
- *Chaetomium globosum*

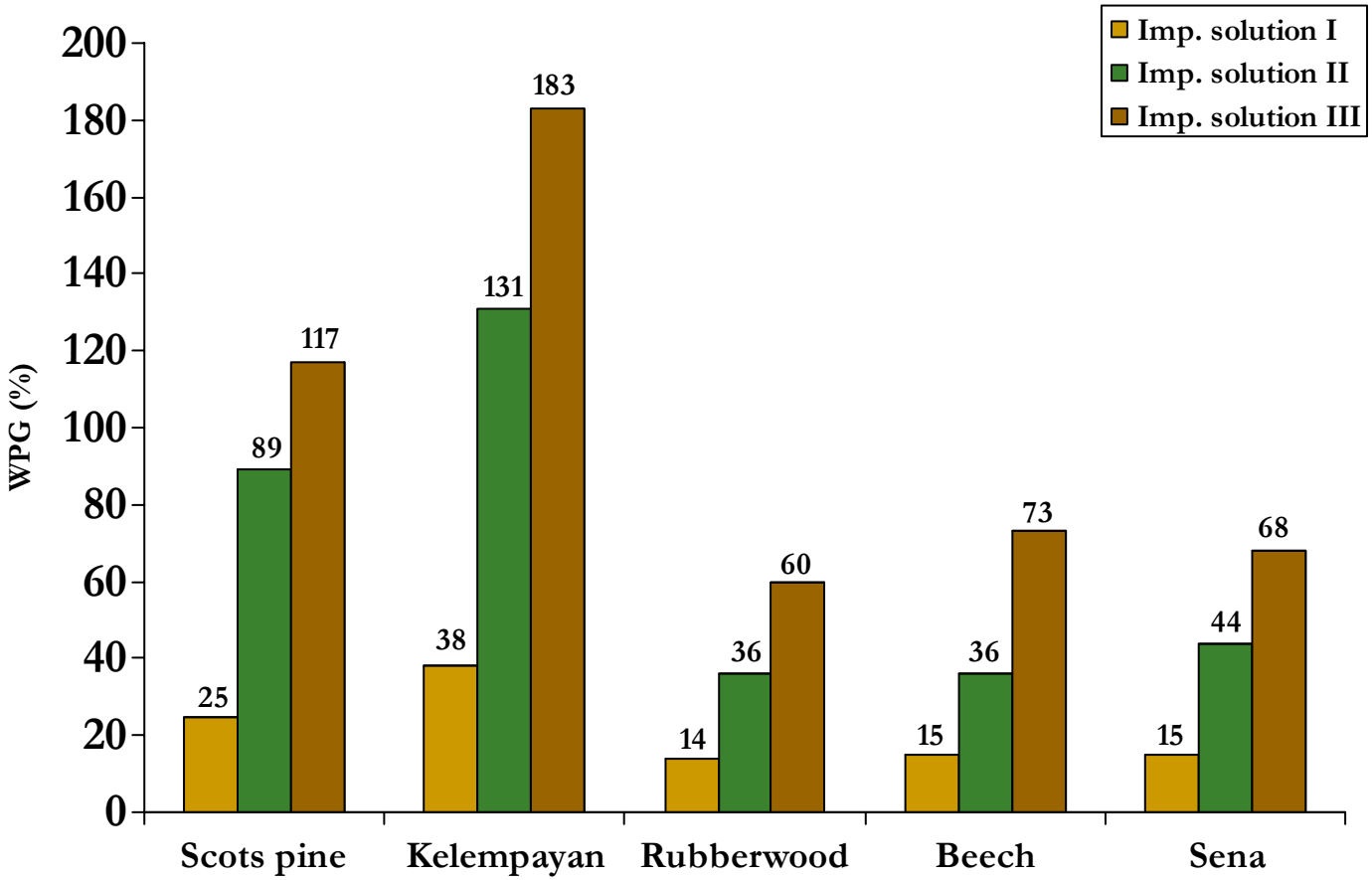
AIM: < 10 % mass loss

Class of wood decay resistance expressed as either weight loss or residual weight according to ASTM D 2017-81 [2]

Average weight loss (%)	Average residual weight (%)	Class resistance
0–10	90–100	Highly resistant
11–24	76–89	Resistant
25–44	56–75	Moderately resistant
45 or above	55 or less	Slightly resistant or non-resistant

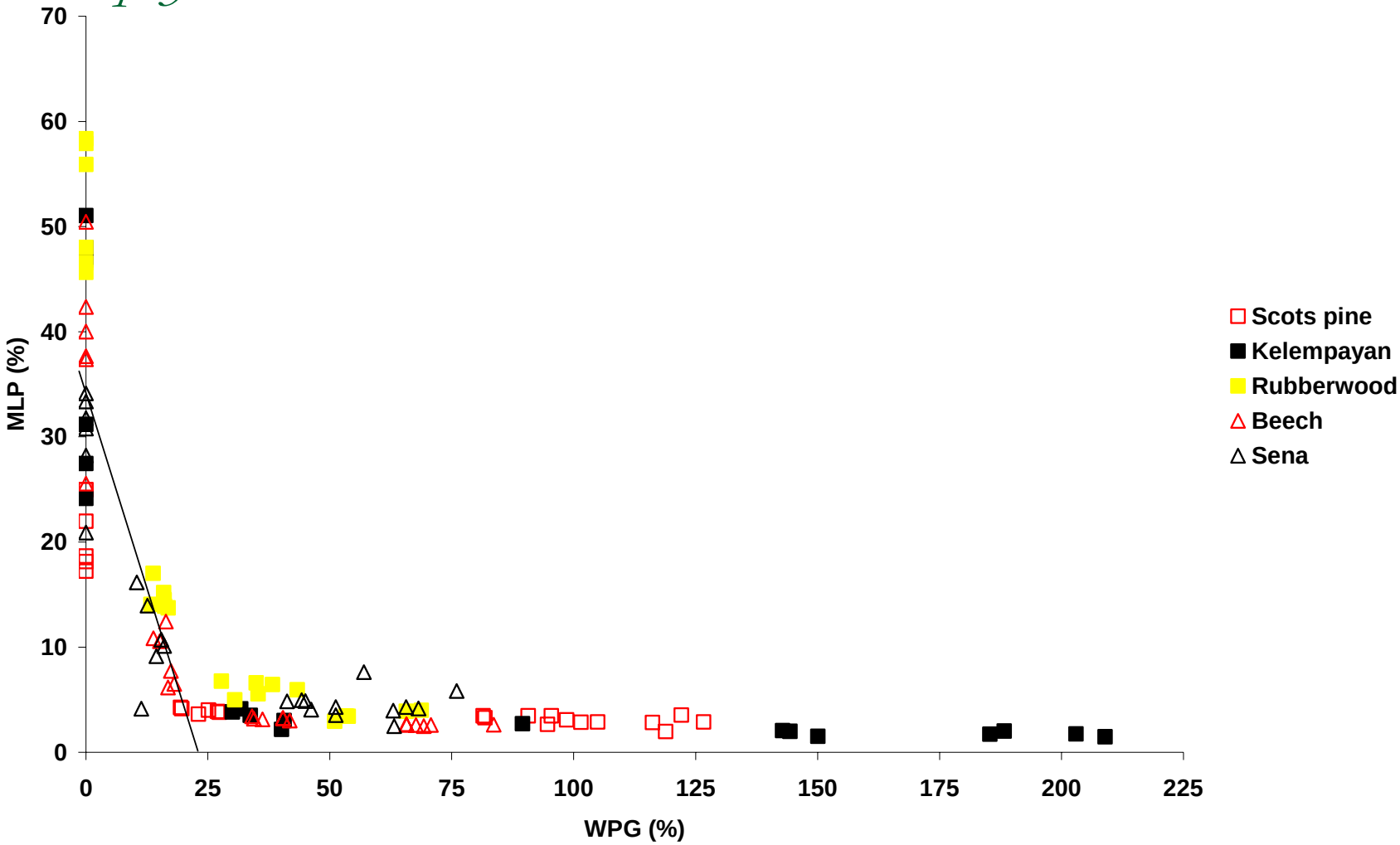
Wong, A.H.H. (2006): Laboratory Evaluation of Soft Rot Resistance of Non-Durable Lesser-Known Malaysian Hardwoods. IRG/WP 06-10582

Results of modification – mean WPG (%)



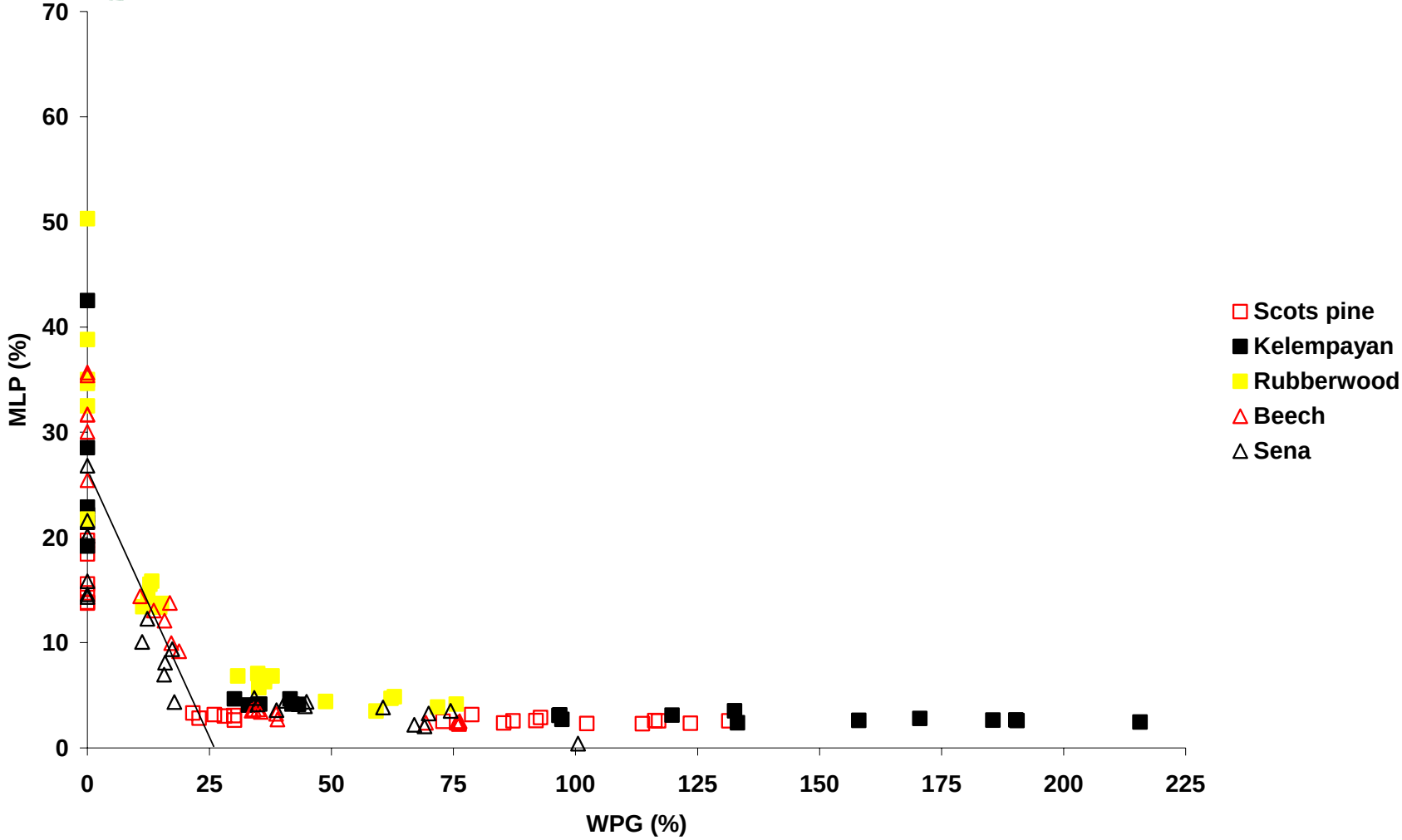
Results of decay trial – brown rot

Gloeophyllum trabeum



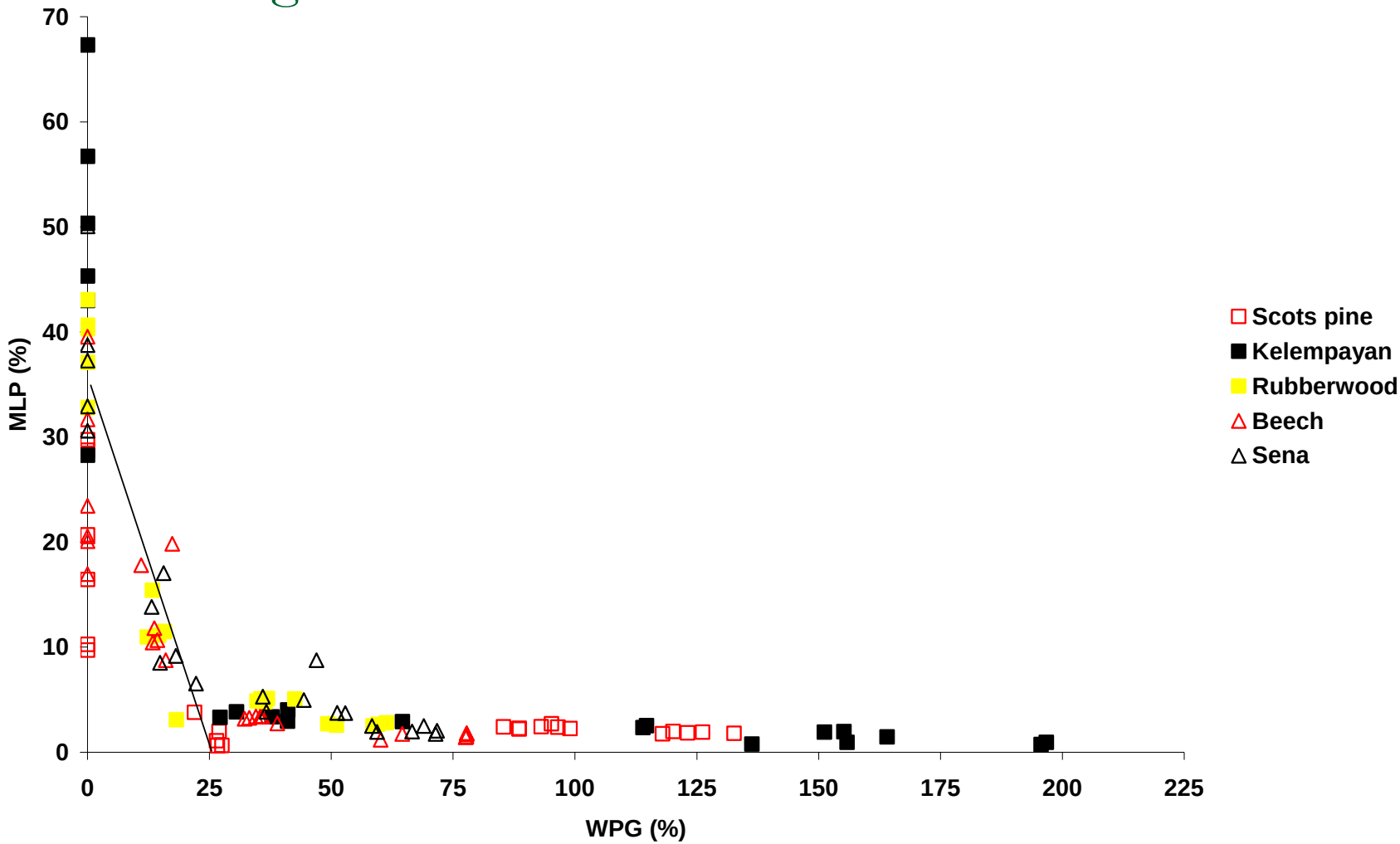
Results of decay trial – white rot

Pycnoporus sanguineus



Results of decay trial – soft rot

Chaetomium globosum



Conclusions I

- **Treatability**
  - Kelempayan can be impregnated in both sap and heartwood
  - Rubberwood more difficult to impregnate than expected
  - Density (between species)
  - Density (within species)
  - Viscosity of solution

- **Effectiveness**
  - Threshold around WPG 25 % for all species (*not 0% mass loss*)
  - 'Highly durable' (MLP < 10 %) around WPG 15-20

Conclusions II

Furfurylated Kelempayan is an interesting candidate for further studies

Kelempayan is easy to impregnate in both sap and heartwood and protected equally well as furfurylated Scots pine sapwood at equivalent WPGs

Kelempayan 1 year after planting
5-6 m in height, d = 8-10 cm →

Picture: Forestry Department Sarawak