Comparative studies on the material resistance and moisture performance of four lesser utilized European grown wood species

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Background

- **Traditional durability testing:**

  Exposure to ideal conditions for decay organisms

- **Today: Consideration of**

  <u>inherent resistance</u> AND <u>moisture performance</u>

Objectives

- **Comprehensive evaluation of durability of less investigated European-grown species**

- **Application of a new factor-based model for performance modelling**

  (Meyer-Veltrup *et al.* 2016)

Wood species

Common juniper

(*Juniperus communis*)

European yew

(*Taxus baccata*)

Black cherry

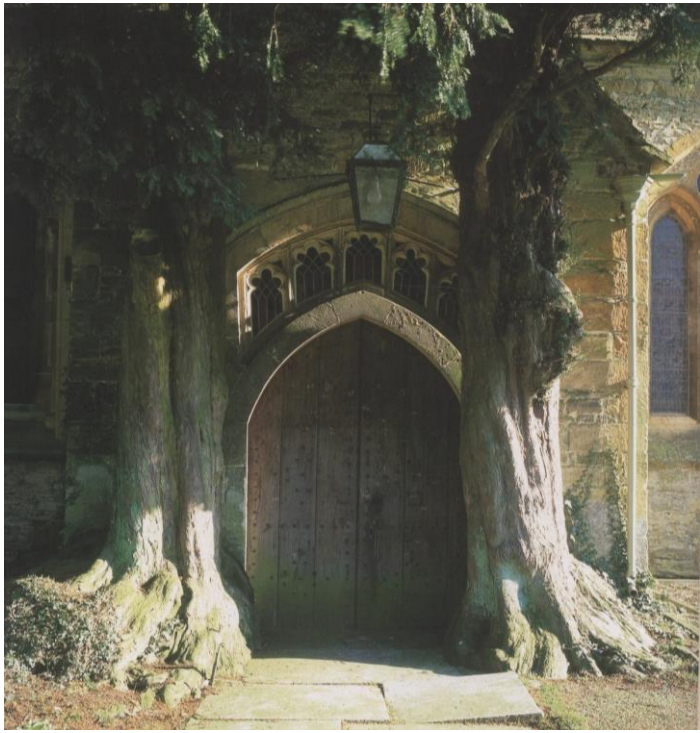
(*Prunus serotina*)

Rowan

(*Sorbus aucuparia*)

European yew

- *Taxus baccata*
  - DC 2 (EN 350)
  - Irritant and poisonous
  - Used for
    - Bows
    - Furniture
    - Veneers
    - Carvings
    - Turned objects



Common juniper

- *Juniperus communis*
  - Not listed in EN 350
  - Used for
    - Fence posts
    - Treenails
    - Small containers
    - Handicraft
    - Smoking

Rowan

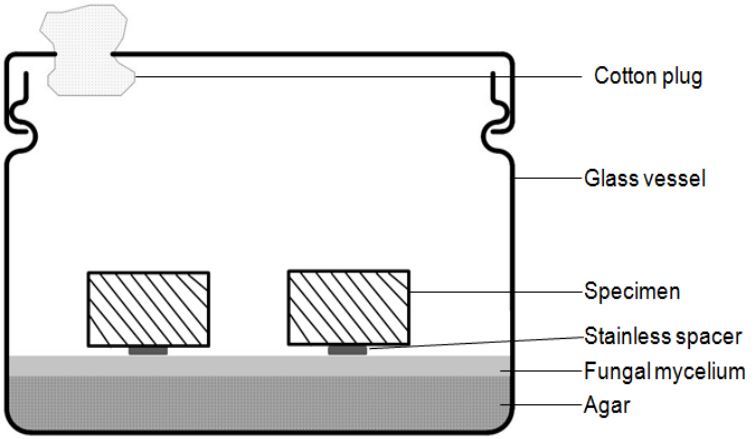
- *Sorbus aucuparia*
  - Not listed in EN 350
  - Used for
    - Cartwright's work
    - Turner's work
    - Woodcarving

Wood species

- Black cherry (*Prunus serotina*)
  - Not listed in EN 350
  - Invasive plant in Europe (introduced in 1623)
  - Used for
    - Cabinetry
    - Fine furniture
    - Flooring
    - Veneer

Experimental

- Decay tests
  - CEN/TS 15083-1
    - *Coniophora puteana*
    - *Poria placenta*
    - *Trametes versicolor*
  - CEN/TS 15083-2 (terrestrial microcosm TMC)
    - Compost soil
  - Leaching/Ageing
    - With and without EN 84 procedure



Experimental

- Water uptake and release tests
  - W 24 - tests
    - *24 h submersion (starting from oven-dry)*
    - *24 h 100% RH (starting from oven-dry)*
    - *24 h 0% RH (strating from fibre saturation)*
  - Capillary water uptake
    - Tensiometer tests
- Soxleth extraction

Results - Decay tests

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		C. puteana		*P. placenta*		*T. versicolor*	
		ML_{med} [%]	DC	ML_{med} [%]	DC	ML_{med} [%]	DC
Rowan	unleached	17.3	**4**	13.1	**3**	21.9	**4**
	leached	23.3	**4**	13.4	**3**	22.5	**4**
Black cherry	unleached	15.4	**4**	6.2	**2**	3.6	**1**
	leached	17.3	**4**	7.4	**2**	8.4	**2**
Juniper	unleached	1.6	**1**	0.3	**1**	0.3	**1**
	leached	0.4	**1**	0.0	**1**	0.0	**1**
Yew	unleached	0.7	**1**	0.0	**1**	0.0	**1**
	leached	0.3	**1**	0.0	**1**	0.0	**1**

Results - Decay tests

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Black cherry	unleached	15.4	**4**	6.2	**2**	3.6	**1**
	leached	17.3	**4**	7.4	**2**	8.4	**2**
Juniper	unleached	1.6	**1**	0.3	**1**	0.3	**1**
	leached	0.4	**1**	0.0	**1**	0.0	**1**
Yew	unleached	0.7	**1**	0.0	**1**	0.0	**1**
	leached	0.3	**1**	0.0	**1**	0.0	**1**

→ **Effect of test fungus**

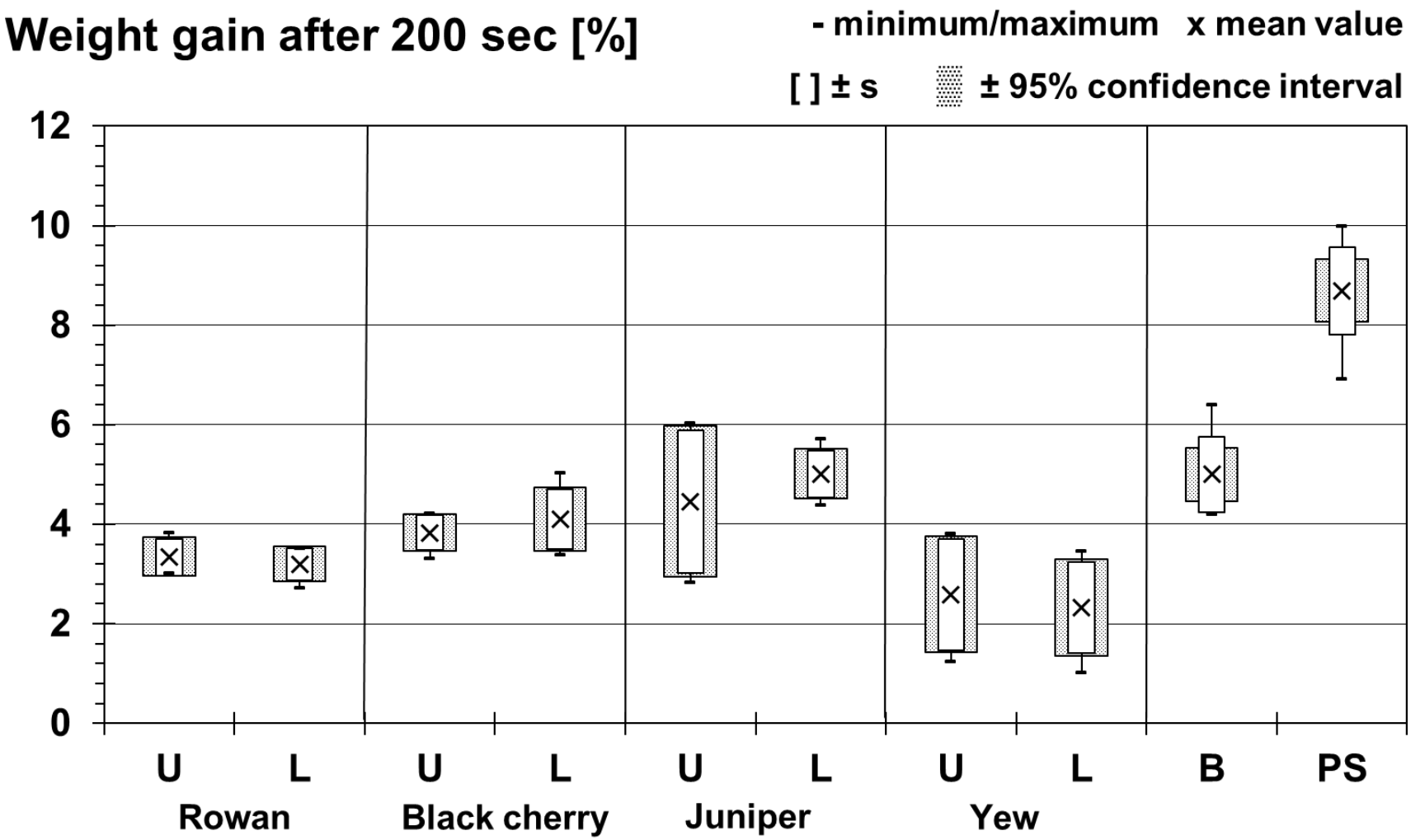
→ **Effect of leaching procedure**

Results - TMC tests

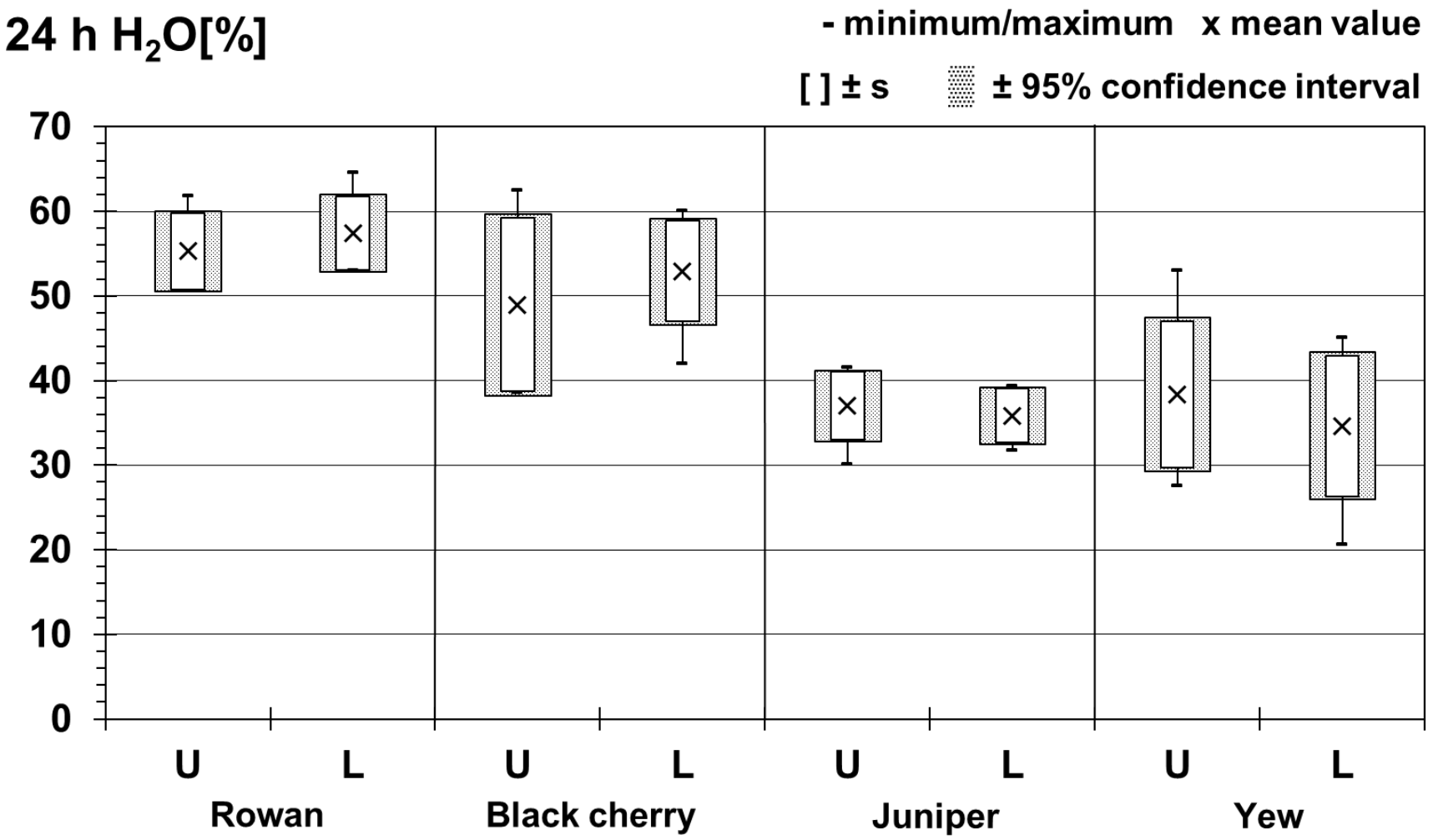
		TMC	
		ML_{med} [%]	DC
Rowan	unleached	25.3	**4**
	leached	23.8	**4**
Black cherry	unleached	16.6	**4**
	leached	19.9	**4**
Juniper	unleached	1.4	**1**
	leached	1.4	**1**
Yew	unleached	1.3	**1**
	leached	1.4	**1**

→ **Durability classification consistent with brown rot test results**

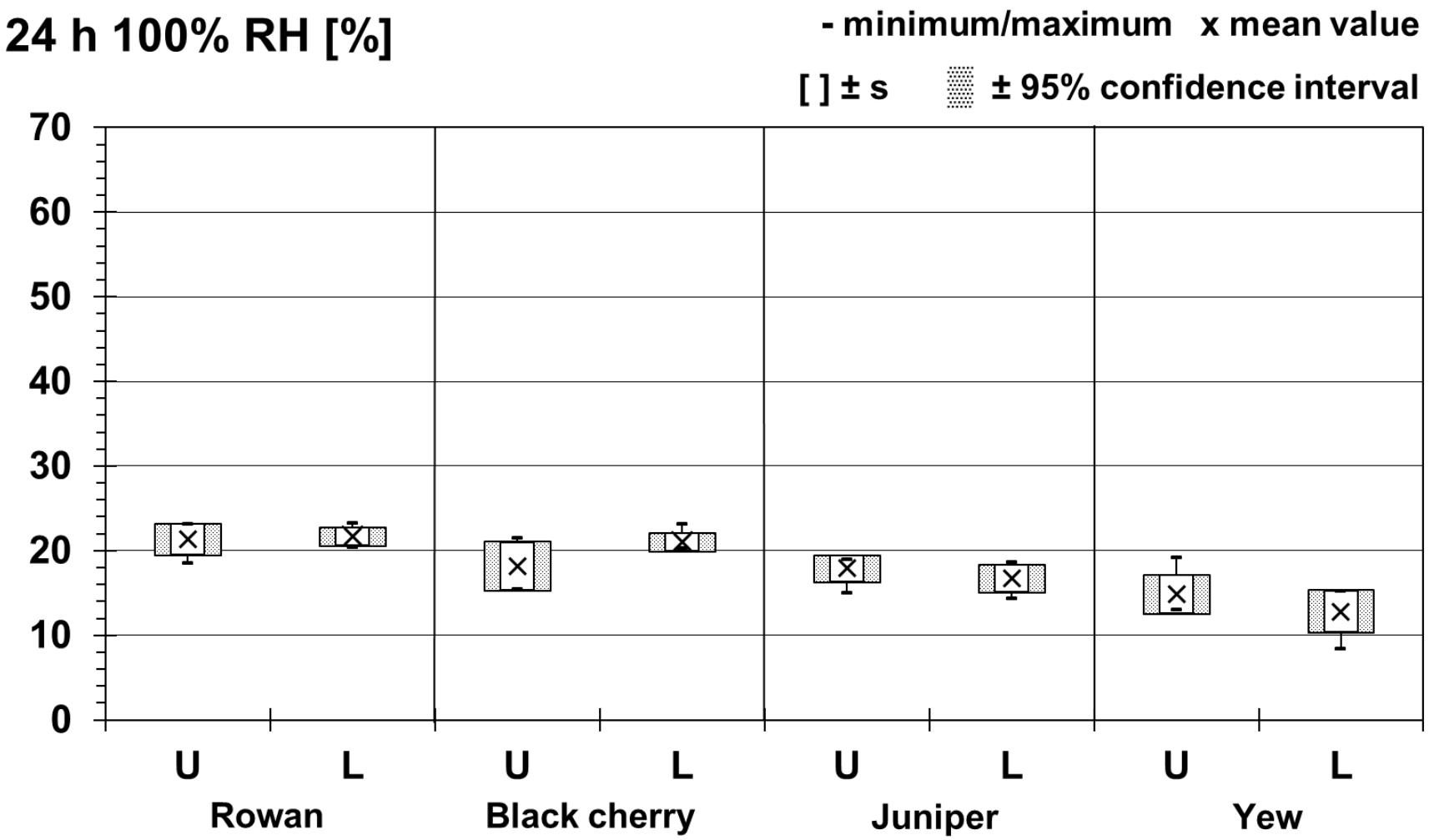
Capillary water uptake



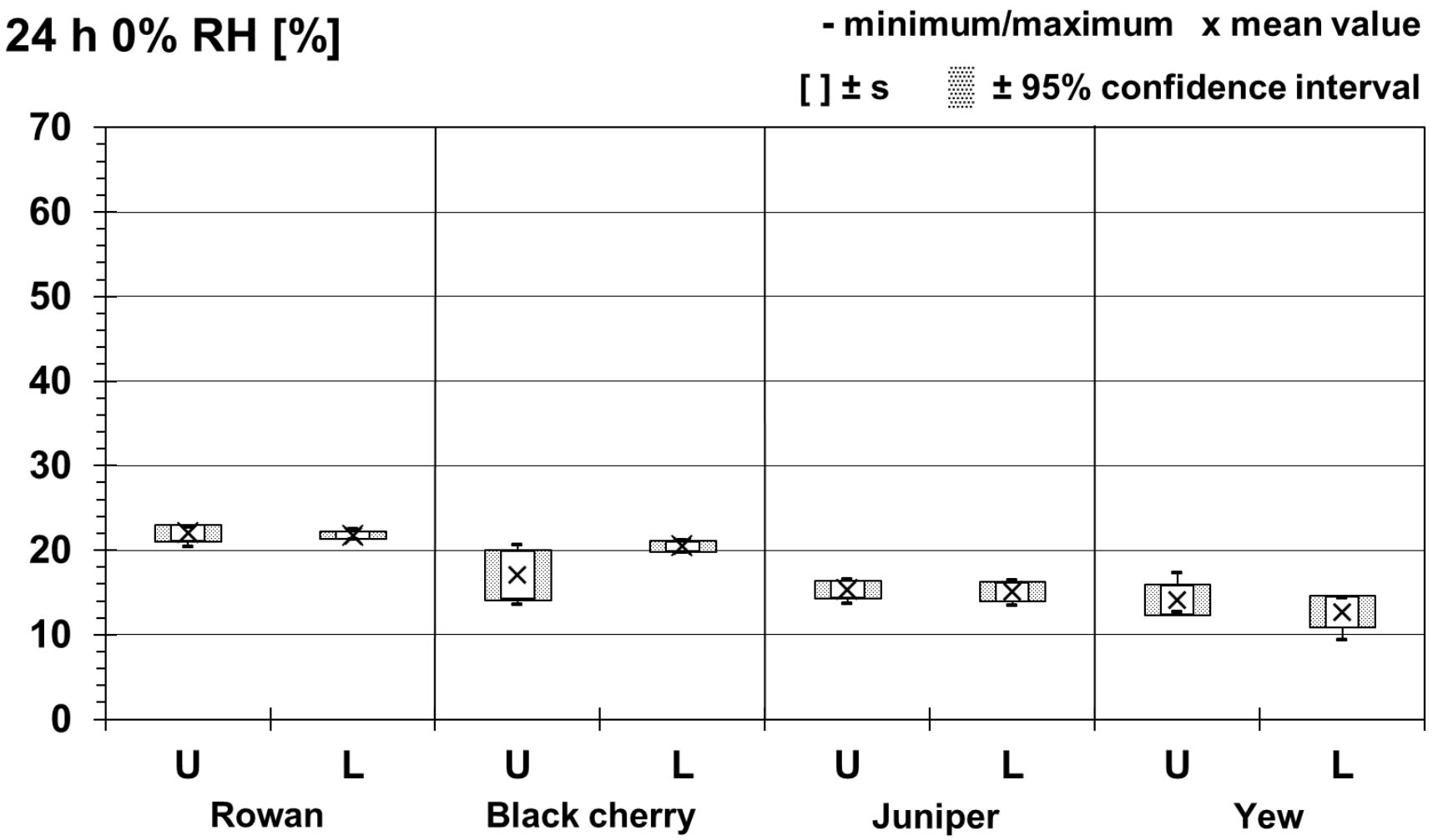
W24 - submersion



W24 – 100 % RH


24 h 100% RH [%]
- minimum/maximum x mean value
[ ] ± s
± 95% confidence interval
70
60
50
40
30
20
10
0
U
L
U
L
U
L
U
L
Rowan
Black cherry
Juniper
Yew

W24 - desorption



Factor approach

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Design principle:

Exposure (D_{Ed}) ≤ Resistance (D_{Rd})

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Exposure (D_{Ed}) ≤ Resistance (D_{Rd})

Resistance dose D_{Rd}:

$$D_{Rd} = D_{crit} \times k_{wa} \times k_{inh} \; [d]$$

D_{crit} = critical dose corresponding to decay rating 1 according to EN 252 (2015) [d]

k_{wa} = factor accounting for the wetting ability of the material

k_{inh} = factor accounting for the inherent protective properties of the material against decay

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D_{Rd} (Norway spruce) = 325

Factor approach

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Resistance dose D_{Rd}:

$D_{Rd} = D_{crit} \times k_{wa} \times k_{inh}$ [d]

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k_{wa} = factor accounting for the wetting abi

k_{inh} = factor accounting for the inherent protec

In words:

325 days with optimum conditions for fungal growth are needed to obtain "slight attack"

D_{Rd} (Norway spruce) = 325

Resistance dose

- k_{wa} and k_{inh} calculated on the base of Norway spruce

	k_{wa}			k_{inh}	
	CWU	W24		Brown/ white rot	TMC
		H_2O	100% RH	0% RH	
Rowan	0.50	0.98	0.83	0.73	1.65	1.41
Black cherry	0.37	1.08	0.91	0.85	3.28	2.03
Juniper	0.43	1.52	1.03	1.05	5.00	5.00
Yew	0.67	1.51	1.29	1.19	5.00	5.00
Spruce						
Pine sapwood						
Eur. larch						
Oak						

Resistance dose

- k_{wa} and k_{inh} calculated on the base of Norway spruce

	k_{wa}				k_{inh}		D_{Rd}	D_{Rd}
	CWU	W24			Brown/ white rot	TMC		relative to spruce
		H_2O	100% RH	0% RH				
Rowan	0.50	0.98	0.83	0.73	1.65	1.41	348	1.07
Black cherry	0.37	1.08	0.91	0.85	3.28	2.03	528	1.60
Juniper	0.43	1.52	1.03	1.05	5.00	5.00	1641	5.05
Yew	0.67	1.51	1.29	1.19	5.00	5.00	1885	5.80
Spruce								
Pine sapwood								
Eur. larch								
Oak								

Resistance dose

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	k_{wa}				k_{inh}		D_{Rd}	D_{Rd} relative to spruce
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Yew	0.67	1.51	1.29	1.19	5.00	5.00	1885	5.80
Spruce							**325**	**1.00**
Pine sapwood							173	0.53
Eur. larch							1090	3.35
Oak							941	2.89

Conclusions

- **Durability characteristics completed with different indicators for wetting ability**
- **Combined effect of wetting ability and inherent material resistance considered for design planning**
- **Potential for implementing wetting ability data into performance classification as requested for the revision of EN 460**

Thank you…

Leibniz Universität Hannover

… for listening

…and COST FP 1303 for granting Carola

a STSM to Ljubljana

Performance modelling