Final REPORT

Durability of thermally modified Loblolly pine (*Pinus taeda*) against wood-destroying basidiomycetes

<u>Done:</u>

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1 Test material

Thermally modified Loblolly pine (*Pinus taeda*) sections (in the following: Taeda TMT) were provided by Swero GmbH & CO. KG (Wangen i. A., Germany) in autumn 2023. According to the supplier, the material had been treated in a steam-heat process to produce 30 planks with dimensions approx. 95 (width) x 25 (thickness) x 600 (length) mm.

2 Natural durability against basidiomycetes (CEN/TS 15083-1, 2005)

<u>Material:</u> The specimens were 25 × 15 × 50 (long.) mm and had an annual ring orientation of approx. 45°. The specimens were taken one each from the 30 planks. Virulence control specimens for the brown rot fungus were made from Scots pine sapwood (*Pinus sylvestris*) and from European beech (*Fagus sylvatica*).

<u>Leaching:</u> All test specimens were leached according to EN 84 (1997). The specimens were impregnated with distilled water. Subsequently, they were submerged in distilled water, which was changed every second day over a period of 14 days. Finally, the specimens were subsequently dried at 40, 60, 80 and 103°C for 24 h, weighed to the nearest 0.001 g, and conditioned at 20 °C and 65 % RH until constant weight.

<u>Testing:</u> After leaching and conditioning, the specimens were used to perform a durability test according to CEN/TS 15083-1 (2005) using the following test fungi:

Brown rot fungi:

- *Coniophora puteana* = (Schum.:Fr.) P. Karsten BAM Ebw. 15 (*C.p.*)
- *Rhodonia placenta = (Fr.) Niemelä, K.H. Larsson & Schigel (R.p.)*

The specimens were placed in culture vessels (i.e. Kolle flasks) which contained sterilized malt extract agar nutrient medium, which was inoculated with one of the fungal species. All culture vessels were placed in a culture room (22 °C/70 % RH) for a period of 16 weeks. After incubation, the specimens were removed from the culture vessels, cleaned and weighed to the nearest 0.001 g directly after harvesting and after drying at 103 °C for 24 h. The mass loss (ML) of each individual specimen due to fungal decay was calculated based on its oven-dry mass before and after incubation, while the moisture content (MC) of the specimens was calculated based on the mass after harvesting and after oven-drying (see equations 1 and 2).

$$ML = \frac{m_{i,0} - m_{f,0}}{m_{i,0}} \cdot 100 \qquad (1)$$

ML *mass loss [%]*

$m_{i,0}$ *oven-dry mass before incubation [g]*

$m_{f,0}$ *oven-dry mass after incubation [g]*

$$MC = \frac{m_f - m_{f,0}}{m_{f,0}} \cdot 100 \qquad (2)$$

MC *wood moisture content [%]*

m_f *wet mass after incubation [g]*

$m_{f,0}$ *oven-dry mass after incubation [g]*

The durability of the tested wood was classified according to CEN/TS 15083-1 (2005) as summarized in Table 1.

Table 1: Durability classification according to CEN/TS 15083-1 (2005).

Durability class	Description	Median mass loss [%]
1	Very durable	≤ 5
2	Durable	> 5 to ≤ 10
3	Moderately durable	10 to ≥ 15
4	Slightly durable	15 to ≥ 30
5	Not durable	> 30

<u>Results:</u> Mass loss and MC after incubation are summarized in Table 2 and Table 3, Figure 1, and Figure 2. Required minimum ML of 20% was achieved by the virulence controls, however the average ML for *R. placenta* was just below 20%.

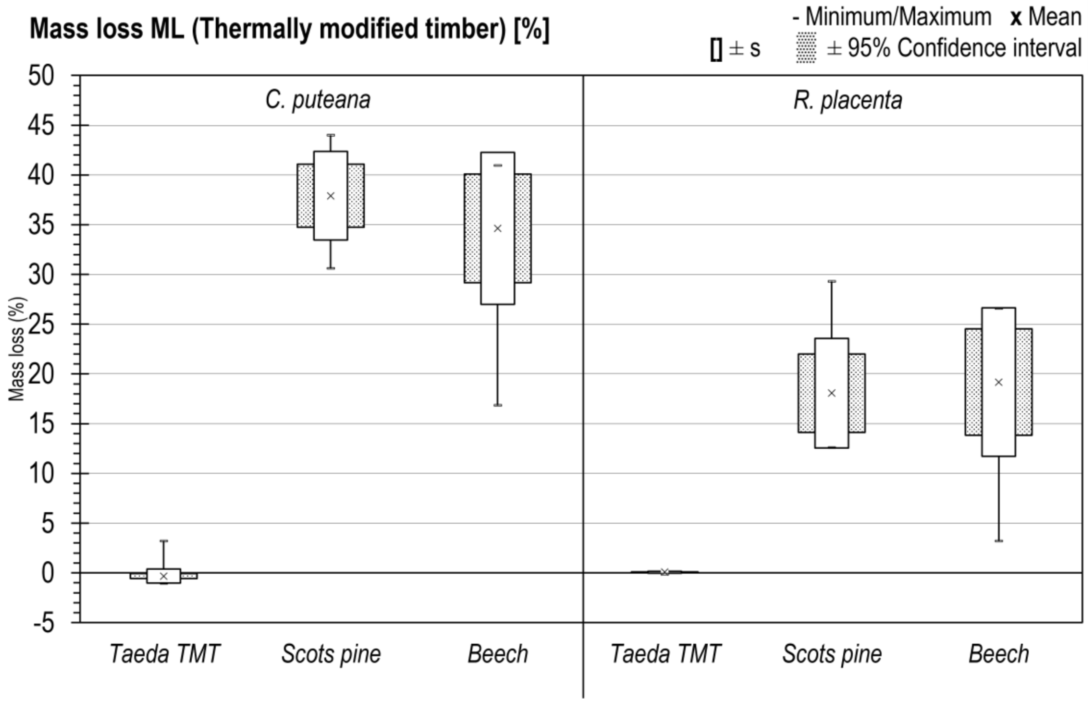

Figure 1: Mass loss of thermally modified *P. taeda* (Taeda TMT) and virulence species after 16 weeks of incubation.

Table 2: Mass loss (ML) and wood moisture content (MC) of thermally modified *P. taeda* (Taeda TMT) and virulence control specimens after incubation with the brown rot fungus *Coniophora puteana.*

Material	**Number of replicates**	**Median ML [%]**	**Mean ML [%]**	**SD ML [%]**	**Mean final MC [%]**	**DC**
Taeda TMT	30	-0.630	-0.325	0.69	46.22	1
Scots pine sap-wood	10	38.72	37.91	4.21	73.14	5
Beech	10	38.16	34.62	7.25	67.63	5

Table 3: Mass loss (ML) and wood moisture content (MC) of thermally modified *P. taeda* (Taeda TMT) and virulence control specimens after incubation with the brown rot fungus *Rhodonia placenta.*

Material	**Number of replicates**	**Median ML [%]**	**Mean ML [%]**	**SD ML [%]**	**Mean final MC [%]**	**DC**
Taeda TMT	27	0.061	0.072	0.09	23.32	1
Scots pine sap-wood	10	16.92	18.06	5.22	71.01	4
Beech	10	22.76	19.18	7.08	63.67	4

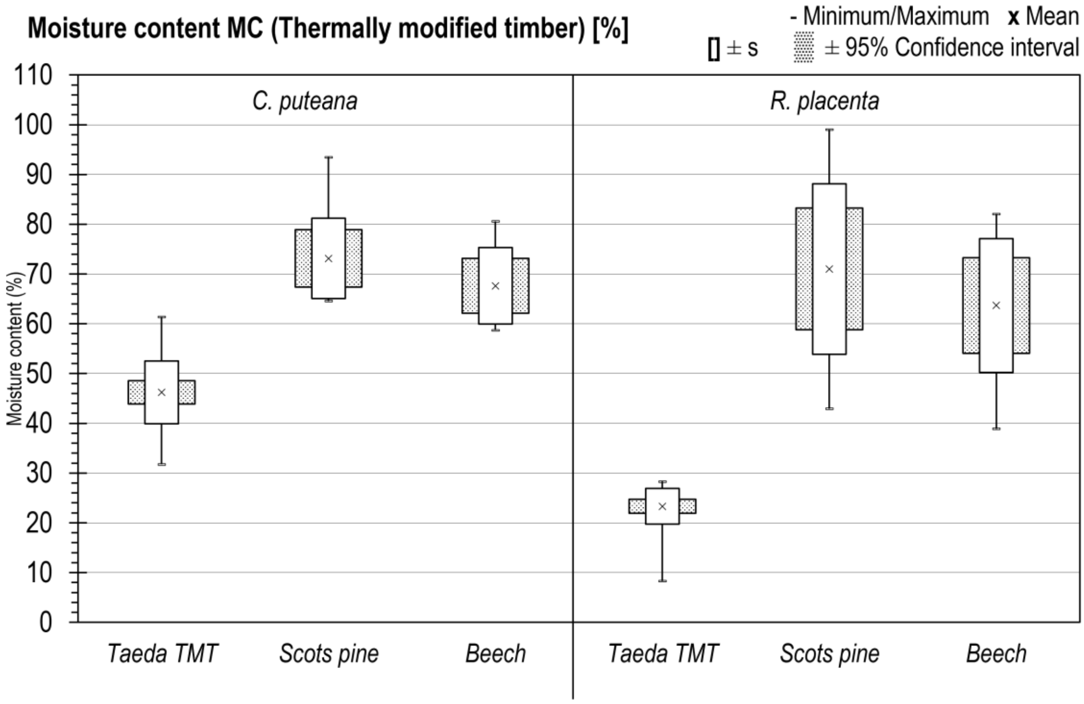

Figure 2: Wood moisture content (MC) of thermally modified *P. taeda* (Taeda TMT) and virulence species after 16 weeks of incubation.

3 Summary

Thermally modified *P. taeda* (Taeda TMT) was assigned to DC1 for the brown rot species *C. puteana* and *R. placenta*.

Literature

CEN/TS 15083-1 (2005) Durability of wood and wood-based products - Determination of the natural durability of solid wood against wood-destroying fungi, test methods - Part 1: Basidiomycetes. European Committee for Standardization (CEN), Brussels, Belgium.

EN 84 (1997) Wood preservatives - Accelerated ageing of treated wood prior to biological testing - Leaching procedure. European Committee for Standardization (CEN), Brussels, Belgium.

Appendix

Appendix A: Individual data for durability tests

Table A1: Individual data for mass loss (ML), moisture content (MC) and durability class (DC) in durability tests against *Coniophora puteana* – Taeda TMT.

ID	Oven-dry mass before incubation [g]	Wet mass after incubation [g]	Oven-dry mass after incubation [g]	ML [%]	MC [%]	DC
T1	8,405	12,176	8,424	-0,23	44,54	1
T2	8,182	12	8,211	-0,35	49,04	1
T3	8,11	11,726	8,146	-0,44	43,95	1
T4	7,955	11,366	7,979	-0,30	42,45	1
T5	7,82	10,758	7,837	-0,22	37,27	1
T6	7,546	12,305	7,625	-1,05	61,38	1
T7	7,836	11,755	7,886	-0,64	49,06	1
T8	9,571	12,646	9,598	-0,28	31,76	1
T9	8,814	12,645	8,539	3,12	48,09	1
T10	8,812	12,466	8,854	-0,48	40,80	1
T11	8,71	12,45	8,748	-0,44	42,32	1
T12	8,875	13,573	8,927	-0,59	52,04	1
T13	7,772	11,426	7,818	-0,59	46,15	1
T14	7,295	11,583	7,354	-0,81	57,51	1
T15	8,119	12,316	8,166	-0,58	50,82	1
T16	7,965	12,447	8,008	-0,54	55,43	1
T17	7,249	11,473	7,31	-0,84	56,95	1
T18	8,974	12,426	9.00	-0,29	38,07	1
T19	7,379	10,717	7,405	-0,35	44,73	1
T20	9,846	14,683	9,898	-0,53	48,34	1
T21	8,084	11,819	8,12	-0,45	45,55	1
T22	7,994	11,986	8,039	-0,56	49,10	1
T23	8,435	11,914	8,466	-0,37	40,73	1
T24	8,708	12,729	8,737	-0,33	45,69	1
T25	7,742	11,047	7,765	-0,30	42,27	1
T26	8,142	11,827	8,169	-0,33	44,78	1
T27	8,48	12,303	8,508	-0,33	44,61	1
T28	9,81	14,178	9,834	-0,24	44,17	1
T29	8,493	12,65	8,523	-0,35	48,42	1
T30	8,356	11,763	8,374	-0,22	40,47	1

Table A2: Individual data for mass loss (ML), moisture content (MC) and durability class (DC) in durability tests against *Rhodonia placenta* – Taeda TMT.

ID	Oven-dry mass before incubation [g]	Wet mass after incubation [g]	Oven-dry mass after incubation [g]	ML [%]	MC [%]	DC
T1	8,220	10,211	8,222	-0,02	24,19	1
T2	8,193	10,466	8,192	0,01	27,76	1
T3	8,090	10,044	8,099	-0,11	24,02	1
T4	8,083	10,019	8,084	-0,01	23,94	1
T5	7,799	9,625	7,788	0,14	23,59	1
T6	7,455	9,561	7,452	0,04	28,30	1
T7	7,647	9,478	7,645	0,03	23,98	1
T8	9,880	12,125	9,873	0,07	22,81	1
T9	8,443	10,282	8,44	0,04	21,82	1
T10	8,482	10,34	8,478	0,05	21,96	1
T11	8,641	10,702	8,627	0,16	24,05	1
T12	9,101	11,599	9,09	0,12	27,60	1
T13	8,009	9,978	8,009	0,00	24,58	1
T14	7,590	9,447	7,596	-0,08	24,37	1
T15	8,137	9,982	8,142	-0,06	22,60	1
T16	7,864	9,726	7,846	0,23	23,96	1
T17	7,242	8,924	7,228	0,19	23,46	1
T18						
T19	8,131	9,874	8,117	0,17	21,65	1
T20	7,844*	12,277*	9,983*	-27,27*	22,98*	1*
T21	7,841	9,596	7,836	0,06	22,46	1
T22	8,347	10,462	8,332	0,18	25,56	1
T23	8,354	10,529	8,339	0,18	26,26	1
T24	8,989	9,736	8,991	-0,02	8,29	1
T25	7,874	9,71	7,873	0,01	23,33	1
T26	8,208	9,994	8,203	0,06	21,83	1
T27	8,601	10,735	8,594	0,08	24,91	1
T28	9,778	11,769	9,759	0,19	20,60	1
T29	8,652	10,512	8,633	0,22	21,77	1
T30						

*Excluded from calculations and durability classification

Table A3: Individual data for mass loss (ML), moisture content (MC) and durability class (DC) in durability tests against *Coniophora puteana* – Scots pine sapwood.

ID	Oven-dry mass before incubation [g]	Wet mass after incubation [g]	Oven-dry mass after incubation [g]	ML [%]	MC [%]	DC
SP 1	8,496	8,974	5,292	37,712	69,577	5
SP 2	8,135	8,533	4,976	38,832	71,483	5
SP 3	8,554	9,768	5,935	30,617	64,583	5
SP 4	8,44	8,718	5,182	38,602	68,236	5
SP 5	8,716	10,084	6,002	31,138	68,011	5
SP 6	8,054	8,103	4,72	41,396	71,674	5
SP 7	8,206	9,137	5,337	34,962	71,201	5
SP 8	8,159	8,483	4,755	41,721	78,402	5
SP 9	9,002	9,753	5,041	44,001	93,474	5
SP 10	8,412	8,81	5,041	40,074	74,767	5

Table A4: Individual data for mass loss (ML), moisture content (MC) and durability class (DC) in durability tests against *Rhodonia placenta* – Scots pine sapwood.

ID	Oven-dry mass before incubation [g]	Wet mass after incubation [g]	Oven-dry mass after incubation [g]	ML [%]	MC [%]	DC
SP 11	8,6	10,742	7,516	12,605	42,922	3
SP 12	8,613	11,426	7,163	16,835	59,514	4
SP 13	7,92	10,281	6,864	13,333	49,781	3
SP 14	7,449	12,198	6,129	17,720	99,021	4
SP 15	7,298	11,2	6,184	15,264	81,113	4
SP 16	8,068	12,992	6,873	14,812	89,030	3
SP 17	8,314	10,553	6,105	26,570	72,858	4
SP 18	7,577	10,493	6,275	17,184	67,219	3
SP 19	7,79	11,43	6,465	17,009	76,798	3
SP 20	8,415	10,221	5,949	29,305	71,810	4

Table A5: Individual data for mass loss (ML), moisture content (MC) and durability class (DC) in durability tests against *Coniophora puteana* – Beech.

ID	Oven-dry mass before incubation [g]	Wet mass after incubation [g]	Oven-dry mass after incubation [g]	ML [%]	MC [%]	DC
B 1	12,51	12,088	7,616	39,121	58,718	5
B 2	12,436	12,346	7,616	38,758	62,106	5
B 3	12,405	12,53	7,514	39,428	66,755	5
B 4	12,446	14,382	8,827	29,078	62,932	4
B 5	12,317	11,687	7,273	40,952	60,690	5
B 6	11,849	12,22	7,212	39,134	69,440	5
B 7	11,763	16,653	9,78	16,858	70,276	4
B 8	11,26	12,688	7,03	37,567	80,484	5
B 9	13,179	14,944	8,275	37,211	80,592	5
B 10	12,302	14,539	8,847	28,085	64,338	4

Table A6: Individual data for mass loss (ML), moisture content (MC) and durability class (DC) in durability tests against *Rhodonia placenta* – Beech.

ID	Oven-dry mass before incubation [g]	Wet mass after incubation [g]	Oven-dry mass after incubation [g]	ML [%]	MC [%]	DC
B 11	12,646	15,569	10,823	14,416	43,851	3
B 12	12,877	17,723	9,735	24,400	82,054	4
B 13	12,67	15,028	9,508	24,957	58,056	4
B 14	12,181	16,377	11,79	3,210	38,906	1
B 15	12,713	15,857	9,332	26,595	69,921	4
B 16	12,593	18,925	10,958	12,983	72,705	3
B 17	12,661	16,597	9,84	22,281	68,669	4
B 18	12,68	15,716	9,734	23,233	61,455	4
B 19	11,952	17,05	10,129	15,253	68,329	4
B 20	12,556	16,382	9,482	24,482	72,769	4