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SHORT NOTE

Resistance of *Pinus leucodermis* heartwood and sapwood against the brown-rot fungus *Coniophora puteana*

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Abstract
This study assessed the decay resistance of *Pinus leucodermis* wood to the brown-rot fungus *Coniophora puteana*. Based upon the median weight losses of 30.65% for heartwood and of 34.68% for sapwood obtained in the biological tests, both the heartwood and sapwood material examined was classified as not durable (durability class 5) according to the CEN/TS 15083-1 classification. Total extractives were low, 3.93% in heartwood and 1.00% in sapwood, while lignin content was 22.60% and 25.41% in heartwood and sapwood, respectively. It is highly recommended to use protective treatments before using *P. leucodermis* wood in outdoor conditions.

Keywords: Pinus leucodermis, *wood, decay resistance, brown-rot,* Coniophora puteana.

Introduction

Pinus leucodermis is a widespread forest species in the Balkan Peninsula growing from 900 up to 2500 m altitude (Jalas and Suominen 1973, Farjon 2005). The Greek populations of this species are located at high elevations in the northern part of the country, experiencing a long-lasting anthropo-zoogenic pressure. Traditional uses of *P. leucodermis* wood include building poles, fences and wine barrels (Tsoumis 1991), while value-added wood products (e.g. construction, window frames, furniture manufacturing) are less common. To enhance its uses, a previous study provided useful information on the physical and mechanical properties of *P. leucodermis* wood (Mantanis *et al.* 2010). This study was undertaken to further advance our knowledge on the quality of *P. leucodermis* wood by investigating its decay resistance to brown-rot.

Materials and methods

Wood blocks, each measuring $50 \times 25 \times 15$ mm, were machined from mature heartwood and sapwood material of *P. leucodermis* originating from a high altitude forest area of Pindos mountain in north-west Greece. The wood decay test followed the procedures described in the CEN/TS 15083-1 (2005). The wood blocks were oven-dried at 103°C, weighed, sterilised and placed in Kolleflasks with a malt-agar culture medium inoculated with the brown-rot fungus *Coniophora puteana* (BAM Ebw. 15). Sapwood blocks of *Pinus sylvestris* were included as virulence controls. After 16 weeks of incubation at 22°C, adhering mycelia were carefully removed and the blocks were weighed again after oven drying at 103°C to calculate the weight loss.

Extractive and lignin contents of *P. leucodermis* were determined using wood powder from the same

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Table I. Chemical composition, weight loss and durability class of *Pinus leucodermis* heartwood and sapwood.

	Pinus leucodermis		
Property	Heartwood	Sapwood	*Pinus sylvestris* sapwood (control)
Total extractives[a] (%)	3.93	1.00	3.10[e]
Lignin[b] (%)	22.60 (35.15)	25.41 (38.82)	26.30[e]
Holocelluse[c] (%)	77.40 (64.85)	74.59 (61.18)	74.30[e]
Weight loss (%)	30.65	34.68	38.86
Durability class[d]	5 = not durable	5 = not durable	5 = not durable

[a]Acetone–water (9:1), mean values of three replicate measurements.
[b]Mean values of two replicate measurements, data in brackets express content of decayed wood.
[c]Calculated data in brackets express content of decayed wood.
[d]According to CEN/TS 15083-1 (2005).
[e]Literature values given by Fengel and Wegener (1984).

heartwood and sapwood material. An accelerated solvent extraction (ASE 200, *Dionex*) was used for a gradual extraction as follows: solvent acetone–water (9:1): temperature 60°C, pressure 100 bar, heating time 5 min; static time 10 min; flush volume 100%; purge time 120 s; static cycles: 1. The extracts were concentrated in vacuo at 40°C, purged with nitrogen and dried over phosphorus pentoxyde. The dry extracts were weighted and the total content of extractives was expressed as percentage dry mass of the original sample. The resulting extractive free wood powder was used to determine the Klason's lignin content according to the ASTM D 1106-96 standard (ASTM 2005). Klason lignin was also determined for the decayed wood. Holocellulose content was obtained by the difference.

Results and discussion

Median weight losses for *P. leucodermis* heartwood and sapwood exposed to *C. puteana* were 30.65% and 34.68%, respectively, illustrating a very poor decay resistance of the species (Table I). These results place *P. leucodermis* in class 5 (not durable) of the provisional durability rating scale provided in the technical specification CEN/TS 15083-1 (2005). However, unlike sapwood, some heartwood blocks exhibited weight loss values lower than 30% implying a natural durability class 4 (slightly durable). This variation may reflect the natural range of decay resistance of heartwood of the species most probably due to differences in extractive content. A better natural durability is indicated in EN 350-2 (1994) for the heartwood of other native commercial conifer species in Greece, *P. sylvestris* (class 3–4) and *Pinus nigra* (class 4). Table I also shows information on the chemical composition of the wood material used in the study. Besides their low presence in both heartwood (3.93%) and sapwood (1.00%) of *P. leucodermis*, extractives seem to have a minimal biocide action. As reported in the literature for brown-rot decay (e.g. Enoki *et al.* 1998), *C. puteana* selectively decayed structural carbohydrates resulting in an increase of Klason lignin content and a decrease of holocellulose content in wood (Table I). Specifically, lignin content increased from 22.60% and 25.41% in the reference heartwood and sapwood material to the respective values of 35.15% and of 38.82% in the decayed wood.

The susceptibility of *P. leucodermis* wood to the brown-rot fungal attack should be considered by processors and end-users of this timber. For using *P. leucodermis* wood in exterior applications, both with and without ground contact (use class 3, EN 335-1 situations), an improvement of its biological resistance by the employment of various protective measures (wood preservation using biocides, non-biocidal protection strategies) is highly recommended. This should also be the practice for interior applications of the timber where humidity (e.g. basements) is high enough to sustain fungal growth.

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