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A study of natural durability of selected coniferous wood species from north Asia affected by the fungus *Coniophora puteana* (Schumach.) P. Karst.

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Abstract: *The aim of prestened study was to determine the natural durability of selected coniferous wood species from Asia to the effect of Coniophora puteana (Schumach.) P. Karst., which causes brown rot. The species tested were: Larix gmellini (Rupr.) Kuzen., Larix sibirica Ledeb. and Pinus sibirica Du Tour.. The test was conducted on the basis of PN-EN 350:2016-10 and PN-EN 113:2000. As a result of the research durability classes were determined. Wood durability of tested Asian species was compared with the domestic wood species such as Pinus sylvestris L. and Larix decidua Mill.. The most durable of the tested wood species was Larix sibirica Ledeb., while the European larch showed comparable durability. The wood of Larix gmellini (Rupr.) Kuzen. showed the lowest persistence among the tested species.*

Keywords: natural durability of wood, wood durability class, *Larix dahurica, Larix gmellini, Larix sibirica, Pinus sibirica*

INTRODUCTION

The use of wood in construction has a long tradition and the demand for the material is constant. With the increase of our knowledge about the material, its structure and characteristics have become better recognized. Additionally, knowledge about ways of protecting wood against numerous biotic and abiotic factors has grown as well. Apart from looking for new solutions aimed at increasing the natural resistance of domestic wood, a search was undertaken for wood with more favourable technical properties than the ones we find in domestic species. The biggest interest of importing wood is dealing with tropical wood species. Usually it is wood characterizing with intense colour of heartwood, high density and mechanical properties such as hardness. Those wood species are mainly hardwoods. But apart of that also coniferous wood species are derived and imported to middle part of Europe, such as to Poland. Those coniferous wood species came from North and East Asia. The most popular is Siberian larch and Siberian yellow pine.

The wood present in trade in Poland, called as Siberian larch, comes from two species of trees: *Larix sibirica* Ledeb. and *Larix gmelinii* (Rupr.) Kuzen. The term larch called "Siberian" is associated with the origin of wood. The matter of naming the larch wood was not completely ordered. In the PN-EN 13556:2005 standard concerning the naming of wood present in trade in Europe, the term Siberian larch in Polish does not appear. According to the information in the standard, *L. gmelinii* (syn. *Larix dahurica* Turcz.) wood, is wood with the Polish name Dahurian larch. While *L. sibirica* wood is the subject of many research works [Venäläinen et al. 2006], characteristics of Dahurian larch *L. gmelinii* still requires additions. On the domestic market of wood raw materials, Siberian yellow pine wood (*Pinus sibirica* Du Tour.) is increasingly appearing in merchant offers. However, the knowledge of the technical characteristics of the *P. sibirica* wood is insufficient and is based primarily on data and experiences from abroad, often from the literature of the former USSR.

Information on the durability of wood is given in the standard PN-EN 350:2016-10. According to the information provided, the durability of the heartwood of the *Larix* genus is moderately durable (class 3 in the 5-class system). It means a service life of at least 15 years. However, the growing conditions of Siberian larch make it more durable than its European variant. Due to the differences in structure and properties (such as wood density), it can be presumed that wood from far Siberia will have higher parameters than wood from local supplies. The assumption is based on the higher density of Far Eastern wood.

The aim of the present paper was to study the influence of fungi on the natural durability of selected coniferous wood species from north Asia wood such as: *Larix gmellini* (Rupr.) Kuzen. and *Larix sibirica* Ledeb. and *Pinus sibirica* Du Tour. The resistance to decay caused by *Coniophora puteana* (Schum., Fr.) Karst. (causing brown rot) was tested. The knowledge that has been gained is indispensable for rational wood management, which is particularly essential from both the ecological and economical points of view.

MATERIALS AND METHODS

In presented study, wood species were used: *L. dahurica*, *L. sibirica*, *P. sibirica* as well as *P. sylvestris* and *L. decidua*. All specimens were manufactured from commercial products. The wood intended for testing was free of defects such as cracks or knots. The wood was seasoned under normal climate conditions (air temperature close to 20 °C and relative humidity 50-55%) for a period of approximately six months. The moisture content of research material was about 10.8 %. For our study we have used the heartwood part. In the case of the tested wood species, the heartwood clearly differs from the sapwood due to the difference in colour. Standard samples for conducted determinations were made from the wood prepared in this way. In accordance with the PN-EN 113:2000 standard, size of the samples was 50 × 25 × 15 mm. The samples were prepared preserving the main anatomical characteristics. 30 samples of each wood species have been used for the study. Additionally, 10 samples of each species were obtained in order to calculate the correction factor. This made it possible to determine the change in mass of the samples due to factors other than the fungus (thermal sterilization of samples, etc.) and to correct the weight loss of the samples exposed to the attack by the calculated value of the correction factor.

To examine the pace of decay of the fungus *C. puteana* domestic Scots pine wood *P. sylvestris* was used. Pure cultures of the fungus *C. puteana* strains EB97 were taken from the collection of the Department of Wood Science and Wood Protection. The grafting lasted 16 weeks. After 16 weeks, the samples were removed from the flasks, thoroughly cleaned of the mycelium and dried at 103 °C for 48 hours, then weighed to determine the final weight of individual samples at 0 % moisture. The resistance factor was calculated based on the standard for the natural durability determination (PN-EN 350:2016-10).

The equilibrium moisture content of samples was determined according to PN-D-04100:1977. The wood density of samples was determined according to PN-D-04101:1977.

RESULTS AND DISCUSSION

The results of determining the density of the tested wood are summarized in Table 1.

Results of testing the changes in wood mass after 16 weeks of action of the fungus are given in table 2. The highest corrected weight loss (average value) was found in Dahurian larch wood samples (36.75 %), while the lowest result was achieved by samples of Siberian larch (16.51 %). It should be noted, however, that the average corrected weight loss of European larch (17.89%) was only slightly different from the best result achieved by Siberian larch. The loss of weight achieved by the standard samples of Scots pine sapwood (42.61%) is also significant, as it is a result higher than the minimum value, indicating a slightly higher

degradative activity of the test fungus. The PN-EN 113: 2000 standard specifies the minimum value of 38.2% of the weight loss of reference samples.

Table. 1. Density of the tested wood species

Wood name	Average density [kg/m^3]	Standard deviation [kg/m^3]
Larix dahurica	579	18
Larix sibirica	610	21
Larix decidua	510	25
Pinus sibirica	380	12
Pinus sylvestris (sapwood)	470	32
Pinus sylvestris (heartwood)	472	33

The calculated value of the correction factor proved that tested wood of Siberian yellow pine showed the highest resistance to factors unrelated to the destructive effect of the fungus. On the other hand, Dahurian larch wood showed the lowest resistance to the mentioned factors influencing the weight loss of samples not exposed to the fungus. Hence, it should be assumed that thermal sterilization of samples could reduce the resin content in that wood. This made it more susceptible to wood degrading factors.

Table 2. Change in wood mass after 16 weeks of action of the fungus*

Wood name	Average wood mass at MC=0% [g]		Loss of wood mass [g]			Average corrected loss of mass [%]	SD [g]	CV [%]
	initial	*final*	*min.*	*av.*	*max.*			
Larix dahurica	10.70	6.78	1.55	3.92	6.48	36.75	1.20	17.69
Larix sibirica	13.67	11.45	1.01	2.23	4.34	16.51	0.87	7.63
Larix decidue	11.42	9.59	0.51	1.82	3.82	17.89	1.10	11.51
Pinus sibirica	7.62	5.79	0.11	1.83	3.66	24.33	1.56	26.94
Pinus sylvestris (sapwood)	8.71	4.99	1.29	3.72	5.13	42.61	0.63	12.56
Pinus sylvestris (heartwood)	9.37	7.35	0.24	2.02	4.16	22.41	1.37	18.72

* *min.* – minimal value, *av.* – average value, *max.* – maximal value, **SD** – standard deviation, **CV** – coefficient of variation.

Table 3. Classes of natural durability of the tested wood species

Wood name	Average corrected loss of mass [%]	Average corrected loss of mass of reference samples [%]	Value „*X*" (for Scots pine sapwood)	Value „*X*" (for Scots pine heartwood)	Class of natural durability in relation to Scots pine sapwood	Class of natural durability in relation to Scots pine heartwood
Larix dahurica	36.75	-	0.84	1.71	**4**	5
Larix sibirica	16.51	-	0.38	0.77	**3**	4
Larix decidua	17.89	-	0.41	0.83	**3**	4
Pinus sibirica	24.33	-	0.56	1.13	**3**	5
Pinus sylvestris (sapwood)	-	43.84	-	-	-	-
Pinus sylvestris (heartwood)	-	21.48	-	-	-	-

The difference between the initial mass and the final mass of the samples in comparison with the mass loss of the reference samples made it possible to calculate the natural wood durability of the tested wood species. The PN-EN 113:2000 standard recommends using the sapwood of Scots pine as a reference for calculations. However, the study also used samples obtained from

Scots pine heartwood. This allowed for the calculation of two variants of the natural durability classes of wood of the studied species based on the distribution of standard samples of sapwood and Scots pine heartwood (Tab. 3).

The presented research results require caution in formulating the claim that Siberian larch wood is more durable. For confirmation, research in this area should be continued and supplemented with chemical analysis. Due to the variability of wood properties, this research should be considered as a pilot.

CONCLUSIONS

Based on the results obtained in the study of the natural durability of wood of selected coniferous species, the following conclusions were made. The wood of European larch (*L. decidua*) showed comparable durability to that of Siberian larch (*L. sibirica*). The most durable of the studied wood species is Siberian larch (*L. sibirica*). The wood of Dahurian larch (*L. dahurica*) showed the lowest durability among the examined wood species. The weight loss of Siberian pine (*P. sibirica*) is comparable to the weight loss of the heartwood of the Scots pine (*P. sylvestris*).

As such, wood shows a wide variety of properties. Hence, the presented results should be treated as pilot ones. Research in the presented scope should be continued. It is also recommended to continue the research due to the variability of the wood as such as well as the huge area of harvest.

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Streszczenie: *Badanie naturalnej trwałości wybranych drewna iglastego gatunków z Azji Północnej poddanych działaniu grzyba Coniophora puteana* (Schumach.) P. Karst. Praca dotyczy określenia naturalnej trwałości drewna wybranych gatunków iglastych pochodzących z Azji wobec działania grzyba *C. puteana*, powodującego brunatny rozkład drewna. Zakresem badań objeto drewno twardzieli drewna *Larix gmellini* (Rupr.) Kuzen., *Larix sibirica* Ledeb. and *Pinus sibirica* Du Tour.. Badanie zostało przeprowadzone w oparciu o normy PN-EN 350:2016-10 i PN-EN 113:2000. W wyniku badania określono klasy trwałości oraz porównano trwałość z drewnem krajowym sosny zwyczajnej (*Pinus sylvestris* L.) i modrzewia europejskiego (*Larix decidua* Mill.). Badania wykazały, iż najtrwalszym z pośród badanych gatunków drewna jest *L. sibirica*, przy czym *L. decidua* wykazał porównywalną trwałość. Najniższą trwałość z pośród badanych gatunków odnotowano dla drewna *L. gmellini*.

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