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LABORATORY INVESTIGATIONS ON THE DURABILITY OF ASPEN (*POPULUS TREMULA L.*) WOOD ON THE FUNGI ACTION*

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Under laboratory conditions aspen wood (*Populus tremula L.*) was subject to the action of selected fungi causing brown, white, soft rot and mould growth. Fungus action lasted 4, 8, 12 and 16 weeks, wood samples were take 5, 10 m high from the butt end. Sample mass decrement was taken as the basic criterion for the assessment of wood rot degree. The dynamics of wood destruction under the action of brown and white rot fungi was also determined.

INTRODUCTION

Basic literature shows that the wood of fast growing trees, especially in the early stage of development is usually characterized by the low degree of resistance to biotic factors. Among others, poplar wood (*Populus sp.*) and aspen wood (*Populus tremula L.*) [11, 15] belong to that kind. One of more interesting properties of poplar wood (*Populus sp.*) is its resistance to the *Lyctus* sp. larva feeding [11]. Aspen trees grow all over Europe, having the widest range amongst poplars and appearing as the addition in pine and spruce forest. It requires loamy soil. In specialists' opinion it is of great importance for land reclamation e.g. for afforestation of dumps and excavations [2]. The wood of this species as not a heart-wood, can be used for different purposes. It can stand for raw material for the pulp and paper industry, mill-board industry, construction wood-work and some other applications in the building industry [3, 5, 7, 9, 10, 12, 14, 20, 21, 25, 28]. This paper presents the results of laboratory

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investigations carried out on aspen wood resistance to the action of various settling and rotting fungi.

MATERIALS

The materials for research was aspen wood (*Populus tremula L.*) obtained in the later half of summer from the land after agricultural cultivation, located 30 km north of Poznań. For research purposes, three trees were felled, having 40 cm in diameter at a hight of 1.25 m. The trees were about 30 years old. From the wooden logs two rollers were cut out, each 1.0 m long, at a height of 5.0 and 10.0 m from the butt end. From the log parts near the circumference square timber of about 5x5 cm cross-section was cut out. Square timber was subject to natural drying in the open air, under the roof, for about six months.

RESEARCH METHODS

DETERMINATION OF WOOD DENSITY

The density of wood under investigation was determined by means of stereometric method [15]. The mean value was calculated from 12 measurements.

DETERMINATION OF WOOD RESISTANCE TO FUNGI ACTION

The square timber described in the chapter 2, was used to make strips of 30x30 mm cross-section, later used for the preparation of l0 mm long samples for mycological tests. Nominal sample size was equal to 30x30x10 mm. Samples, properly marked and dried to the solid substance at a temp. 50-60°C and about 100 hPa air pressure were weighed with the accuracy of 0.001 g and left in the laboratory room, loosely arranged on the polyamide net.

The resistance of samples to the fungi action was determined in the relation to the following species:

– *Coniophora puteana* (Schum. ex. Fr.) Karst. - Ebersw. 15 graft, brown rot fungus;

– *Coriolus versicolor* (L. ex. Fr.) Quel. (= *Trametes versicolor* L. ex. Fr. Pilat) - Ebersw. 214 graft, white rot fungus;

– *Aspergillus niger* van Tieghem - fungus causing mould growth on wood and any other materials;

– *Chaetomium globosum* Kunze - soft-rot fungus;

– *Paecilomyces varioti* Bainier - soft rot fungus.

Pure cultures of the brown- and white rot fungi came from the Pure Culture Collection of the Wood Protection Department of the Agriculture University in Warsaw and were obtained through the kindness of its head, professor

J. Ważny and by courtesy of W. Kotowska, M.sc. The soft rot and mould fungi were delivered from the Institute of Fermentation Technology and Microbiology of the Engineering College of Łódź. Nutrient medium for the brown- and white rot fungi was agar water solution with the addition of malt extract whereas the soft rot and mould fungi have perlite substrate with the addition of mineral salt water solution acc. to Czapek-Dox. After double sterilization in the water steam jet, thus prepared samples were placed in the Kolle flask on proper nutrient media provided with previously cultured mycelium of appropriate test fungus. Samples were placed in flasks in groups of four, on spacers prepared from 2 mm diameter glass rod. The flasks with samples were stored in the following conditions: the brown and white rot fungi were kept in a room at a controlled temperature of 22 ± 1°C and air relative humidity of 75 ± 5%; the soft rot and mould fungi were kept in incubators at a temp. 28 ± 1°C and air humidity of 90 • 95%. Time of keeping flasks with samples under such conditions was equal to 4, 8 and 12 weeks, whereas the *Chaetomium globosum* and *Aspergillus niger* were kept for 16 weeks. After that time samples were removed from the flasks, cleaned, weighed, predried in the open air for 48 hours, dried to the solid substance at a temperature of 50 • 60 °C and air pressure of about 100 hPa, and weighed once again with the accuracy up to 0.001 g. There were 12 samples per each group. Humidity and mass decrements were determined, depending on the place of sampling, species and action time of the test fungus.

RESULTS

WOOD DENSITY

Results shown in Table 1 indicate that wood density of aspen being tested, was equal to 470 and 495 kg/m^3 depending on the sampling place.

Table 1
Tabela 1

Aspen wood density in dependense upon height of sampling
Gęstość drewna osiki w zależności od wysokości od poziomu gruntu

Height from the ground level Wysokość od poziomu gruntu	Density Gęstość	Standard deviation Odchylenie standardowe	Variation coefficient Współczynnik zmienności
4,5 – 5,5 m	470 kg/m^3	± 31 kg/m^3	7 %
9,5 – 10,5 m	490 kg/m^3	± 21 kg/m^3	4 %

Index of refferences significance md = 2, difference unsignificant
Wskaźnik istotności różnic md = 2, różnica nieistotna

Statistical analysis did not show significant differences with coefficient of variation lower than 7%. According to the literature, average density of poplar wood is within the range of 430-520 kg/m^3 [11, 13, 15]. The results obtained do not differ from most common values.

RESISTANCE TO FUNGUS ACTION

The brown- and white rot fungi

On the basis of mass changes under action of brown and white rot fungi (Table 2), aspen wood subjected to tests has to be numbered among short-life woods. This confirms the basic opinion about that property of Populus wood [2, 3, 11, 13]. The white rot fungus, *Coriolus versicolor* was more active species. This is a fungus, growing extremely well on the wood of decinous trees [22]. Among ten various test fungi, *Coriolus versicolor* proved to be the most active during tests of natural durability of *Mesua nagassarium* (Burm. f.) Kosterm wood, recognized in India as very resistant to fungus action [1]. *Coniophora puteana,* as species specialized in the rot of softwood [24], was not so conductive to the rot of tested aspen wood.

Table 2
Tabela 2

Effect of brown- and white rot fungi on moisture content and mass changes of aspen wood in dependence upon place of sampling and time of exposition to the fungus activity
Wpływ grzybów rozkładu brunatnego i białego na wilgotność i zmiany masy drewna osiki w zależności od wysokości od poziomu gruntu i czasu działania grzybów

Test fungus Grzyb testowy	Height from the gruond level Wysokość od poziomu gruntu	Time of exposition to the fungus activity Czas działania grzyba	Wood moisture content Wilgotność drewna	Mass lost Ubytek wagi			Rate of wood decay Szybkość rozkładu
				Mean Średnia	Standard deviation Odchylenie standardowe	Variation coefficient Współczynnik zmienności	
	m	week tyg.	%				%/day %/dz.
Conio-phora puteana	5	4	61,5	14,7	1,1	7,0	0,525
		8	70,6	19,9	2,0	10,0	0,355
		12	93,2	21,2	2,1	10,0	0,252
	10	4	60,9	16,6	1,7	10,0	0,592
		8	75,2	19,1	1,6	8,0	0,341
		12	94,7	20,9	2,0	10,0	0,248
Coriolus versicolor	5	4	38,9	3,0	1,6	53,0	0,107
		8	43,8	17,6	5,4	31,0	0,314
		12	65,5	33,4	3,5	10,0	0,397
	10	4	41,6	4,8	2,7	56,0	0,200
		8	46,3	21,2	8,8	42,0	0,318
		12	85,6	39,1	13,1	34,0	0,465

The test brown- and white rot fungi used in investigations, distinctly differed in the rate of aspen wood rot with the passing of time. That rate in case of brown rot fungus (*Coniophora puteana*) was big in first four weeks of testing, then it greatly diminished, just like it was found in case of spruce wood exposed to the action of the same fungus [19]. The opposite effect was observed in case of white rot fungus (*Coriolus versicolor*). The rate of wood rot for that species calculated for the whole 12-week period was almost four times bigger from the rate established in the first 4-week period.

The soft rot and mould-fungi

Among soft rot fungi, *Chaetomium globosum* was extremely active, causing over 14% rot of aspen wood within 16 weeks. Those quantitative changes are similar to those, found by Seifert [23] in his research on the influence of that fungus upon changes in chemical constitution of beech wood (*Fagus silvatica L.*)

Table 3
Tabela 3

Effect of soft rot fungi upon moisture content and mass changes of aspen wood in dependence of place sampling and time of exposition to the fungus activity
Wpływ grzybów rozkładu szarego na wilgotność i zmiany masy drewna osiki w zależności od wysokości od poziomu gruntu i czasu działania grzybów

Test fungus Grzyb testowy	Height from the gruond level Wysokość od poziomu gruntu	Time of exposition to the fungus Czas działania grzyba	Wood moisture content Wilgotność drewna	Mass lost Ubytek wagi		
				Mean Średnia	Standard deviation Odchylenie standardowe	Variation coefficient Współczynnik zmienności
	m	week tyg.	%			
Chaetomium globosum	5	4	211,7	10,9	3,2	29
		8	219,8	11,9	0,9	8
		12	196,1	12,8	3,2	25
		16	143,1	13,8	2,1	15
	10	4	234,1	12,4	2,1	17
		8	230,5	12,6	2,0	16
		12	190,7	12,9	3,8	29
		16	177,2	14,3	1,3	9,4
Peacilomyces varioti	5	4	139,0	0,9	0,6	67
		8	187,5	0,6	0,6	22
		12	173,0	0,9	0,9	15
	10	4	205,1	0,6	0,6	60
		8	205,7	0,7	0,7	37
		12	145,4	0,6	0,6	24

During tests *Aspergillus niger*, a fungus recognized as species of small cellulolytic activity [8, 26], showed its wood rotting ability. After 12 weeks of its action mass decrements in aspen wood samples exceeded 8%. It can confirm the previous observation, that *Aspergillus niger*, under favourable conditions, can cause qualitative and quantitative changes in any other species. The lowest activity in aspen wood rotting was found in case of *Paecilomyces varioti* fungus. According to some authors [4, 16, 17, 18] the *Paecilomyces* sp. fungi belong to the group of soft rot perpetrators, i.e. to the species which restrainedly decay the wood substance. Here it is worthy to mention the observation of Wolf and Liese [26] that different species of the *Asco-* and *Deuteromycetes* can cause different effects, depending on the external conditions. Some of those fungi, responsible for the effect of mould, under favourable conditions, can cause slight, surface rot of the wood and its deep colouring, or even symptoms similar to those of soft rot. It is difficult to define the border line separating soft-rot fungi from species causing mould. Ważny [27] is of similar opinion.

It should be underlined that all test fungi of the *Asco-* and *Deuteromycetes* very quickly covered the tested samples of aspen wood, and *Aspergillus niger* was particularly active. That species totally covered the whole surface of samples within 3 days from the test beginning.

Table 4
Tabela 4

Effect *Aspergillus niger* and *Trichoderma viride* fungi upon moisture content and mass changes of aspen wood in dependence of place sampling and time of exposition to the fungus activity
Wpływ grzybów *Aspergillus niger* i *Trichoderma viride* na wilgotność i zmiany masy drewna osiki w zależności od wysokości od poziomu gruntu i czasu działania grzybów

Test fungus Grzyb testowy	Height from the gruond level Wysokość od poziomu gruntu	Time of exposition to the fungus Czas działania grzyba	Wood moisture content Wilgotność drewna	Mass lost Ubytek wagi		
				Mean Średnia	Standard deviation Odchylenie standardowe	Variation coefficient Współczynnik zmienności
	m	week tyg.	%			
Aspergillus niger	5	4	151,2	0,2	0,4	200
		8	173,8	1,15	1,9	164
		12	146,7	4,2	1,0	24,7
		16	163,5	8,0	1,3	16,6
	10	4	176,2	0,3	0,9	300
		8	183,5	0,3	0,3	113
		12	181,6	3,6	1,2	32,5
		16	153,0	8,4	1,6	18,6
Trichoderma viride	5	4	139,0	0,2	0,7	350
		8	99,9	2,6	2,7	106
		12	16,3	2,6	1,7	65
	10	4	194,3	1,2	3,1	258
		8	97,3	2,6	2,5	95
		12	56,3	5,7	4,1	72

REASSUMPTION

Aspen wood (*Populus tremula L.*), the species characterized by its fast growth, is easily susceptible to the action of fungi causing different types of rot. Dynamics of destruction by the *Coniophora puteana*, the brown rot fungus, is decreasing from 0.5% mass decrement a day within the first month, up to 0.25% a day within the following three months. The rate of rot of this wood under the action of *Coriolus versicolor*, a white rot fungus, distinctly grows as the time passes. The aspen wood is also susceptible to the decay caused by soft-rot fungi; it also easily and quickly suffers overgrowth by *Aspergillus niger*, with simultaneous symptoms of wood substance decay caused by that fungus.

Statistical analysis of results obtained shows that there are no significant differences in susceptibility to the action of fungi of the wood taken 5 and 10 m high from the butt end. Thus observed low resistance of aspen wood to the fungus action indicates the necessity of its improving by use of chemical

fungicides, especially when that wood is to be used at even small risk of activity of biological destructive factors.

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LABORATORYJNE BADANIA NAD ODPORNOŚCIĄ DREWNA OSIKI (*POPULUS TREMULA L.*) NA DZIAŁANIE GRZYBÓW.

Streszczenie

Próbki drewna osiki (*Populus tremula L.*) w wieku 30 lat pozyskanej z gruntów porolnych położonych w odległości około 30 km na północ od Poznania, poddano działaniu 6 różnych gatunków grzybów powodujących rozkład drewna typu brunatnego, białego i szarego (pleśniowego). Próbki wycięto z wysokości 5 i 10 m od odziomka, czas działania grzybów wynosił 4, 8, 12 i 16 tygodni. Na podstawie ubytków masy stwierdzono szczególnie wysoką podatność drewna osiki na działanie grzyba *Coriolus versicolor*, gatunku bedącego sprawcą białego rozkładu drewna. Grzyb ten wyróżnił się także rosnącą szybkością rozkładu drewna. Drewno osiki okazało sie także bardzo podatne na działanie grzybów rozkładu szarego, w tym również grzyba *Aspergillus niger,* uchodzącego jako gatunek o niskiej aktywności celulolitycznej. Nie stwierdzono istotnych różnic w podatności na działanie grzybów drewna pochodzącego z różnych wysokości od odziomka.

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