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LABORATORY RESEARCH ON THE COMMON BIRCH WOOD (*BETULA PENDULA* ROTH.) RESISTANCE TO THE FUNGAL ATTACK*

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Common birch wood (*Betula pendula* Roth.) was subjected to laboratory tests for its resistance to the action of brown, white, soft rot fungi as well as fungi causing mould growth. Mass decrements were determinated after 4, 8, 12 and 16 weeks of action of 7 fungi species.

Key words: Birch wood, durability, wood decay, fungi, brown rot, white rot, soft rot, mould

INTRODUCTION

Diminishing resources of wood comming from traditional Polish trees as pine (*Pinus sylvestris* L.) and spruce (*Picea excelsa* (Lam.)Link), as well as the need for afforestation of former arable lands made the grounds for scientific research on the possibilities of using wood comming from other trees, especially those fast-growing and easy to reforest. Birches (*Betula* spp.) belong to trees of this group, growing all over the country. They cover 5.6% of Polish forest area, taking one of leading places among broadleaved trees in respect of their prevalence (Marszałek 1992). *Betula pendula* Roth. and *Betula pubescens* Ehrh. are the most common from among 7 species of this group growing in Poland. The former is found more often as the addition to other trees or forms small forests, sometimes planted by man, whereas the latter grows on marshy areas, often with alder. Both of these species grow together on drier grounds. They are distinguished by the ecologically pioneer characteristics of first generation trees of particularly high degree of tolerance for industrial pollution

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(Białobok 1979). The common birch is also considered to be suitable for the afforestation of former agricultural lands and also for plantation purposes (Bernacki 1990, Bernacki and Kowalski 1983). Observations performed in 1992-1994 on areas which suffered from forest fires showed that just after such a calamity birch trees produced bigger amounts of seeds than usually, thus seizing the whole land.

According to Białobok (1979) the wood of European white birch and pubescent birch does not differ essentially in its physical, mechanical properties and chemical construction. Opinions about their biological resistance, particularly to the action of fungi, are not univocal. In professional literature, dealing with these problems, different subject-matters can be distinguished. One of them, prevailing to the end of the seventies, described macro- and microscopic effect of various fungi on the birch wood (Cobert 1965, Greaves and Levy 1965, Kirk et al. 1975). At the beginning of the eighties, research centres basing on their earlier investigations, paid attention to the effect of white rot fungi upon the birch wood (Blanchete 1984, Otjen et al. 1987). Until now this problem is being analyzed by researchers making the use of more and more refined methods of instrumental chemistry (Otjen and Blanchette 1988, Davis et al. 1994).

Effect of brown rot fungi on dynamic of changes going on in pine, spruce, beech and oak wood was investigated by Ważny (1959).

In spite of such a vast literature on that subject, no detailed numerical data can be found regarding birch wood resistance to the action of different fungi. Wood susceptibility to biotic factors is one of major utility features, determining its application. Therefore, the authors undertook research to fill partially this gap and determine the resistance of birch wood to the action of various fungi, decaying and colonizing the wood under different conditions.

EXPERIMENTS

Materials

For research three specimens of 28-year-old common-birch (*Betula pendula* Roth.) of 16-20 cm breast height diameter were chosen. They grew on former arable land of the Zielonka Forest Experimental (LZD Murowana Goślina), located about 30 km north of Poznań. Trees were hewed at the beginning of June, 6 weeks after they started to vegetate. From each tree two 1 m long logs were cut out at the height of 2-3 m and 7-8 m. From the part adjoining the periphery of the billet beyond the juvenile zone (Helińska-Raczkowska and Fabisiak 1995), 40 x 40 mm squared logs were made.

Thus obtained material was piled under the roof for about 6 months for predrying.

METHODS OF RESEARCH

Wood density

Wood density was determined using stereometric method (Krzysik 1974). The average value was calculated by making 15 measurements of samples obtained from the height of 2-3 m and 7-8 m above the ground.

Wood resistance to fungal attack

Those tests were carried out using methods described in detail in the paper on the resistance of aspen wood to the fungal attack (Lutomski 1995).
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;

– *Poria placenta* (Fr. Cke. sensu Eriksson) (= *Poria monticola* Murr.) – Ebersw. 125 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;

– *Trichoderma viride* (Pers. ex Fr.) – fungus causing mould growth on wood.

Pure cultures of the brown – and white rot fungi came from the Pure Culture Collection of the Wood Protection Department of the Agricultural University in Warsaw. The soft rot and mould fungi were delivered from the Institute of Fermentation Technology and Microbiology of the Engineering College of Łódź.

RESULTS

Wood density

Density of common birch wood comming from the former arable land located in the Zielonka Experimental Forest was equal to 570 and 580 kg/cu.m, depending on the place of sampling. According to literature values of average density of the birch wood vary from 510 to 830 kg/cu.m.

Results of the tests are within density limits given by different sources (Krzysik 1974, Białobok 1979, Kolmann 1951). The statistical analysis did not show considerable difference in density of wood comming from different levels above to the ground.

RESISTANCE TO THE FUNGAL ATTACK

Brown and white rot fungi

The humidity of wood subjected to the attack of test fungi was found to be above the point of fibre saturation, showing the growing tendency as the time of fungal attack was prolonged. It proves that the wood decay conditions of the test were favourable. Higher humidity of samples in the final stage of the test can by explained by the process of wood substance decomposition, resulting in formation of considerable amounts of free water table 1).

Table 1
Tabela 1

Birch wood density depending on the place of sampling
Gęstość drewna brzozy w zależności od miejsca pobrania próbek

Height from the ground level Wysokość od poziomu gruntu	Density Gęstość	Standard deviation Ochylenie standardowe	Variation coefficient Współczynnik zmienności
[m]	[kg/m^3]	[kg/m^3]	[%]
2.0 - 3.0	570	± 18	3.21
7.0 - 8.0	580	± 23	2.38

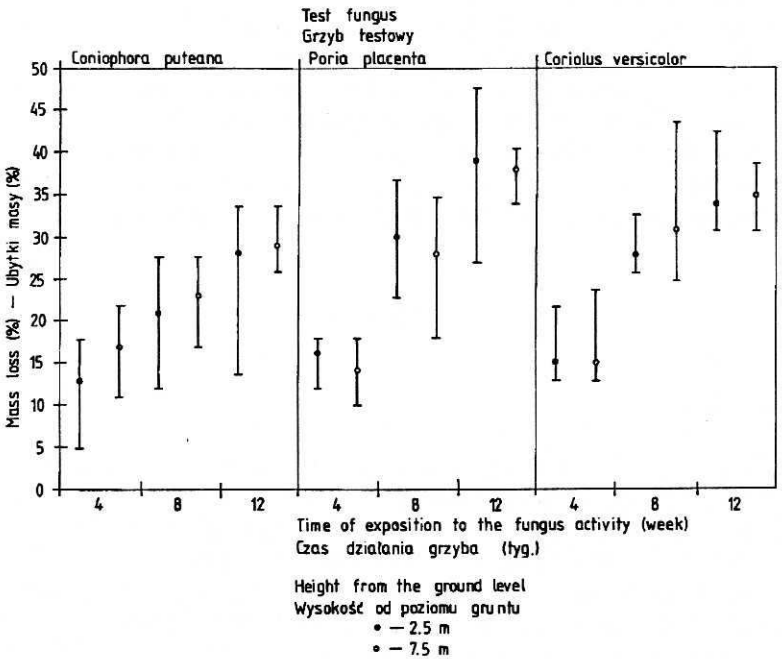

Fig. 1. Birch wood mass decrements caused by the *Basidiomycetes* fungi depending on the time of their attack and place of sampling
Rys. 1. Ubytki masy drewna brzozy pod wpływem grzybów *Basidiomycetes* w zależności od czasu ich działania i miejsca pobrania próbek

Among brown rot fungi used for tests, *Poria placenta* showed higher activity manifested by mass decrements (fig. 1). After 12 weeks the amount of wood substance rotted by this fungus was much higher than in case of *Coniophora puteana* attack. Mass decrements caused by *P. placenta* are comparable with figures obtained by Erikson et al. (1990) for the *Betula papirifera* wood. *Coriolus versicolor*, a white rot fungus, takes a middle place between the both brown rot fungi with its birch wood decaying activity. The results obtained differ from values of mass decrements published by Erikson et al. (1990), Blanchette and Abad (1988), or Nilson, Kirk and Obst (1989). Most probably it can be explained by different virulence of strains of the test fungi used. However, in Hesse's opinion (1990), different values of mass decrements can be obtained depending on the season of the year when mycological test was performed. He demonstrated, that wood decaying fungi in late summer and autumn showed higher activity. It is of interest, as standard strains of fungi used in laboratory, for mycological tests, were isolated from natural materials many years ago and then cultivated under artificial conditions, at the constant temperature and humidity of the air and bed. And still for such a long time they did not lose their biological rythm coded in their cells.

The characteristics of the wood decaying fungi can be the dynamics of the decay process. It can be estimated by the comparison of the daily percentage of mass decrements. The diagram (fig. 2) shows this dependence. *P. placenta* was distinguished by the slightly growing rate of wood decay within the period of 8 weeks. Two other species were characterized by the higher initial rate of decay, lowered at later time.

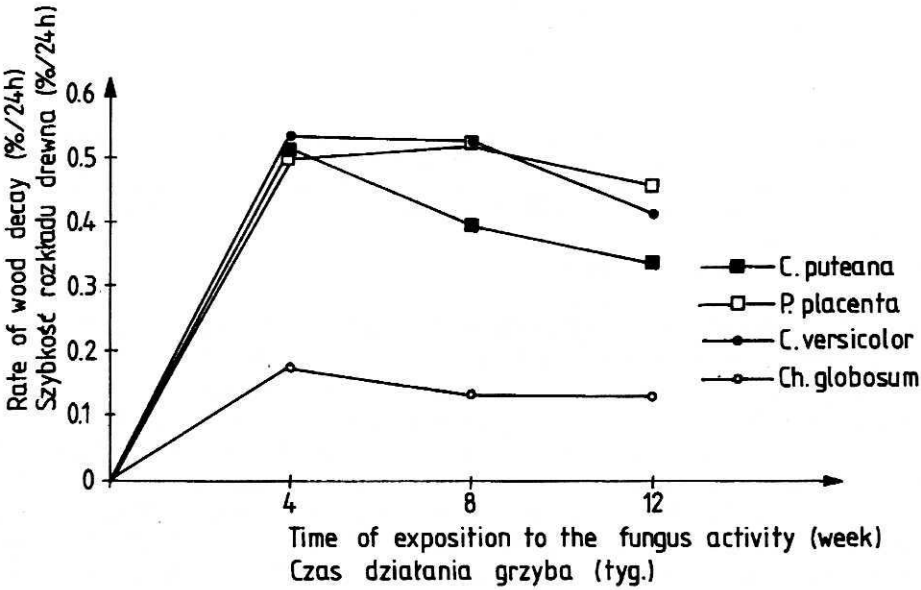

Fig. 2. Rate of birch wood decay caused by fungi
Rys. 2. Szybkość rozkładu drewna brzozy pod wpływem grzybów

The statistical analysis of mass decrements did not show significant differences in resistance of wood, cut at the various height from the butt, to the attack of brown and white rot fungi.

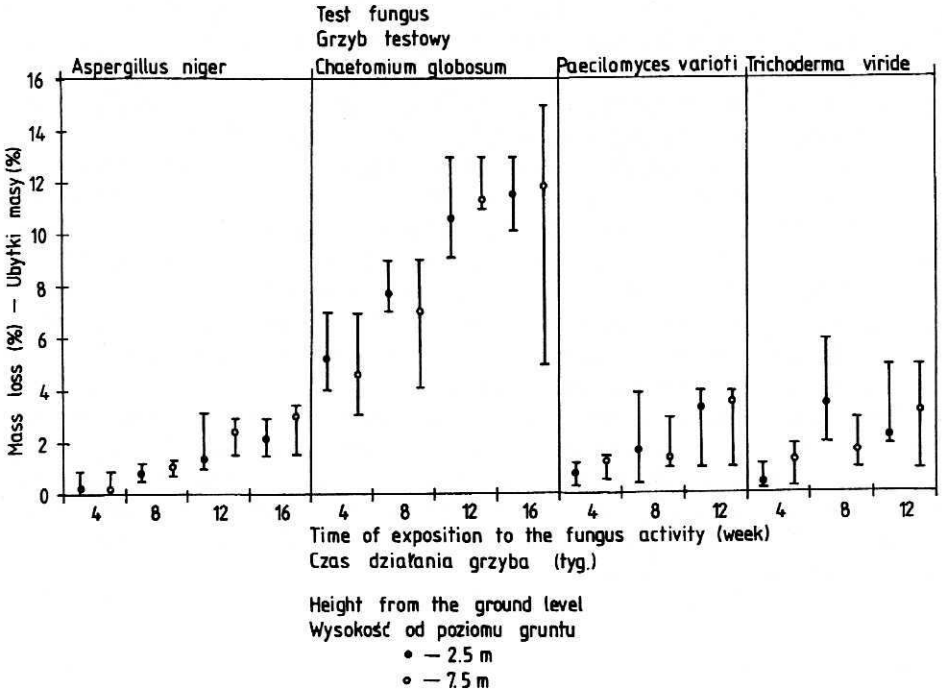

Fig. 3. Birch wood mass decrements caused by the soft rot and mould fungi depending on the time of their attack and place of sampling
Rys. 3. Ubytki masy drewna brzozy pod wpływem grzybów rozkładu szarego i grzybów pleśniowych w zależności od czasu ich działania i miejsca pobrania próbek

Soft rot and moulds-fungi

The rate of birch sample overgrowing with moulds- and soft-rot fungi was big, and *Aspergillus niger* was especially active, covering samples within 5-7 days. Test fungi caused the 40-80% increase of humidity in all wood samples. Among species being tested, *Chaetomium globosum* was found very active, causing almost 12% mass decrement in the birch wood within 16 weeks of the test duration. So big decay of the beech wood (*Fagus silvatica* L.) was found by Seifert (1966) only after 25 weeks. In case of aspen wood, in 16 weeks *Ch. globosum* caused mass decrements exceeding 14% (Lutomski 1993). Changes in the mass of aspen and birch wood after 16 weeks' attack of this fungus are therefore comparable. In tests with *Ch. globosum*, it was found that the maximum rate of birch wood decay took place in the first month and it decreased by about 50% at the end of investigation.

Table 2
Tabela 2

Birch wood moisture content depending on the place of sampling and time of exposition to the fungus activity
Wilgotność drewna brzozy w zależności od miejsca pobrania próbek i czasu działania grzybów

Test fungus Grzyb testowy	Height from the ground level Wysokość od poziomu gruntu	Time of exposition to the fungus activity Czas działania grzyba	Moisture content Wilgotność
	[m]	week, tyg.	[%]
Coniophora puteana	2.0 - 3.0	4	37.11
		8	46.92
		12	44.39
	7.0 - 8.0	4	38.14
		8	47.36
		12	47.25
Poria placenta	2.0 - 3.0	4	41.62
		8	57.31
		12	65.36
	7.0 - 8.0	4	35.71
		8	53.90
		12	61.34
Coriolus versicolor	2.0 - 3.0	4	31.78
		8	37.30
		12	37.85
	7.0 - 8.0	4	30.10
		8	38.49
		12	43.93
Aspergillus niger	2.0 - 3.0	4	53.81
		8	44.62
		12	49.62
		16	50.19
	7.0 - 8.0	4	55.44
		8	41.09
		12	54.26
		16	80.08

Table 3
Tabela 3

Rate of birch wood overgroving with fungi
Szybkość porastania drewna brzozy przez grzyby

Test fungus Grzyb testowy	Time of total sample covering with mycelium Czas całkowitego porośnięcia próbek przez grzybnię
	days, dni
Coniophora puteana	7 - 10
Poria placenta	7 - 10
Coriolus versicolor	7 - 10
Aspergillus niger	3 - 5
Chaetomium globosum	7 - 10
Paecilomyces varioti	7 - 10
Trichoderma viride	7 - 10

The statistical analysis with Student's t-test for average mass decrements under the influence of *Paecilomyces varioti* and *Trichoderma viride* did not show significant differences in activity of these species; small mass decrements

in the birch wood, found during tests with the use of these fungi and *T. viride* were most probably caused by changes in the content of cells, and the differences found were insignificant from the point of view of statistics. Among test fungi, the lowest activity resulting in mass decrements showed *A. niger*. It confirms the well-known low rate of cellulolytic activity of this species.

CONCLUSIONS

1. Common birch wood (*Betula pendula* Roth.) is characterized by the low, similar to aspenwood, resistance to the wood decaying fungal attack, with no regard to the sampling height from the butt end.

2. Among decaying fungi, the brown rot fungus, *Poria placenta* was found specially active in birch wood decaying.

3. Under favourable conditions, the birch wood easily decays under the action of mildew and soft rot fungi. It is more susceptible to the attack of *Chaetomium globosum* than beech wood.

4. The birch wood used under conditions favourable to fungi growth should be chemically preserved from decay caused both by the *Basidiomycetes*, moulds- and soft-rot fungi (*Deuteromycetes, Ascomycetes*).

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LABORATORYJNE BADANIA NAD ODPORNOŚCIĄ DREWNA BRZOZY BRODAWKOWATEJ (*BETULA PENDULA* ROTH.) NA DZIAŁANIE GRZYBÓW

Streszczenie

Drewno brzozy brodawkowatej (*Betula pendula* Roth.) poddano, w warunkach laboratoryjnych, badaniom odporności na działanie grzybów rozkładu brunatnego, białego oraz szarego i powodujących pleśnienie drewna. Określono ubytki masy i wilgotności drewna po 4, 8, 12 i 16 tygodniach działania 7 gatunków grzybów. Stwierdzono, że drewno brzozy charakteryzuje się niską, zbliżoną do drewna osiki, odpornością na działanie grzybów rozkładających, jest również szybko parastane przez grzyby pleśniowe. Wśród gatunków rozkładających substancję drzewną, szczególną aktywnością wyróżnił się grzyb domowy biały (*Poria placenta*). Drewno brzozy jest bardziej podatne na działanie grzyba rozkładu szarego (*Chaetomium globosum*) niż drewno buka.

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