F O L I A F O R E S T A L I A P O L O N I C A

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CHEMICAL WOOD PROTECTION AGAINST MOULD

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SYNOPSIS. The limit fungicidal value against moulds (*Aspergillus niger* van Tieghem, *Chaetomium globusom* Kunze, *Penicillium cyclopium* Westling, *Penicillium funiculosum* Thom, *Paeciliomyces varioti* Bainer, *Trichoderma viride* Pers. ex. S.F. Gray aggr) and *C. puteana* were determined. The 11 preservatives containing the following fungicides: 2-Octyl-3-2H-Isothiazolone, 5-Chloro-2-Methyl-2H-Isothiazol-3-one, 5-Chloro-2-Methyl--4-Isothiazol-3-one, 2-Methyl-4-Isothiazol-3-one, 2-Octyl-3-2H-Isothiazolone, 2-N-Octyl--4-Isothiazolin-3-on, IPBC, Benzalkonium Chloride, Methylene-Dithiocianate, Tetrakis hydroxymethyl phosphonium sulphate, Carbendazim, 2-Methyl-Thio-4-Tertbutylamino--6-Cyklopropyloamino-S-triazin, 1,2-Benzisothiazolin-3-one, Didecyldimethylammonium chloride, 2-Methyl-3-2H-Isothiazolone. The most effective fungicides were IPBC and the mixture of Methylene-Dithiocianate and Benzalkonium Chloride.

KEY WORDS: mould, fungicides

INTRODUCTION

One of the most important properties of wood preservatives is the limit fungicidal value against fungi from the basidiomycetes subgroup (*Basidiomycotina*). The information on the value can be found in the literature or can be obtained from producers of the preservatives. The qualitative evaluation of the preservatives usually omits the preservatives effectiveness against moulds. It is very often observed that mould develops on previously impregnated wood which was stored in unfavorable conditions. Such wood loses its aesthetical properties and the economical demand on such wood significantly drops down. Wood infected with moulds is also dangerous for the natural environment because of the pathogenic mycotoxins emitted by the microorganisms. One of the probable reasons of the appearance of sac fungi (*Ascomycotina*) and imperfect fungi (*Deuteromycotina*) on the impregnated wood is the high adaptability of the fungi to different ecological conditions. As compared to the typical fungi causing wood rot, moulds can develop in broader extend of temperature and pH. The fungi also have lower demand on oxygen (Sharp and Eggins 1970). The differences are also found in the different

resistance on fungicides. Ważny (1970) showed different effectiveness of five biocides against *Coniophora cerebella* as well as against the natural microflora of soil. Hedley et al. (1979) made extensive investigations of 49 chemical compounds getting different results for *C. puteana* as well as microfungi applied in the investigations. Therefore, it seems that the presence of mould fungi on the impregnated wood may be caused by the too low effectiveness of fungicides contained in wood preservatives. The preliminary investigations were performed in order to determine the effectiveness of free-metallic fungicides against moulds as well as to select the most effective fungicides which might be applied in previously mentioned wood preservatives.

MATERIALS AND METHODS

The investigations were performed with the use of different commercial mixtures of free-metallic fungicides. The percentage content of the individual fungicides contained in the tested preservatives is presented in Table 1. The limit fungicidal value against moulds was determined according to the method proposed by Ważny et al. (1989). The mycological tests were performed for the following microfungi: *Aspergillus niger* van Tieghem, *Chaetomium globusom* Kunze, *Penicillium cyclopium* Westling , *Penicillium funiculosum* Thom, *Paeciliomyces varioti* Bainer, *Trichoderma viride* Pers. ex. S.F. Gray aggr. The investigations were performed for samples of dimensions of 40 × 4 × 40 mm (the last dimension along the grain) made of Scots pine sapwood (*Pinus sylvestris* L.). In each variant of investigations consisted of 6 repetitions. The samples were impregnated according to the standard EN-PN 113. In order to determine the concentration causing inhibition of mycelium development, visual assessment was used. There were distinguished 5 categories of sprouting of material impregnated with the investigated preservative. The categories were graded every 2 and the mean values from all measurements were calculated (Ważny 1974).

- 10 – no growth of mycelium on a sample: between a sample and mycelium exists zone of breaking
- 8 – no growth of mycelium on a sample; there is no breaking zone between a sample and mycelium
- 6 – mycelium from nutrient growths on a sample and stops at an edge
- 4 – weak growth of clusters of mycelium on the whole surface of a sample
- 2 – weak growth of mycelium on the whole surface of a sample
- 0 – strong growth of mycelium on the whole surface of a sample.

The concentration at which a sample impregnated with preservative obtained index 8 was regarded as the concentration ensuring effective preservation of wood against the mould attack. The paper presents only fungicides concentrations which effectively preserved impregnated samples against attack of the tested fungi.

Table 1. Percentage content of fungicides in tested preservatives

Symbol	Active substance		Solvent
	Component	Content in preservative [%]	
A	2-Octyl-3-2H-Isothiazolone 5-Chloro-2-Methyl-2H-Isothiazol-3-one 2-Methyl-3-2H-Isothiazolone	5-10 0.1 < 0.1	water
B	5-Chloro-2-Methyl-4-Isothiazol-3-one 2-Methyl-4-Isothiazol-3-one	14	water
C	2-Octyl-3-2H-Isothiazolone	5-10	water
D	2-N-Octyl-4-Isothiazoli-3-on	45	water
E	3-Iodo-2-Propynylbutylcarbamate	100	water:ethyl alcohol (1:1)
F	3-Iodo-2-Propynylbutylcarbamate	20	water
G	Benzalkonium Chloride Methylene-Dithiocianate	30 10	water
H	Tetrakis hydroxymethyl phosphonium sulphate	70-80	water
I	Carbendazim 2-Methyl-Thio-4-Tertbutylamino-6--Cyklopropyloamino-S-triazin	8-12 4-6	water
J	1,2-Benzisothiazolinone-3-one	20	water
DDAC	Didecyldimethylammonium chloride	50	water

RESULTS AND DISCUSSION

The obtained results for sac fungi and imperfect fungi are presented in Table 2. The highest effectiveness of preservatives against *A. niger* attack was found for IPBC. The result is in accordance with the investigations made by Clausen and Yang (2003). They showed that wood immersed in 0.1% solution of iodoorganic derivative for 15 s was resistant to microfungi attack. The preservative containing isothiazole derivative as well as impregnants based on benzothiazolinone and DDAC were less effective against *A. niger*. The results presented in Table 2 show low effectiveness of benzothiazolinone derivatives against the other tested microfungi. The results presented in the paper confirm observations of Hedley et al. (1979) on low biological activity of benzothiazolinone. On the basis of our results high dispersion of fungicidal values was found for isothiazole preservatives. The values varied from 0.51 to over 2.60 kg/m^3. The preservative coded as B (isothiazole derivative) was not effective for the value of ca. 2.5 kg/m^3 for almost all moulds used in the tests.

Table 2. Limit fungicidal value against microfungi

Preservative	Test fungus					
	P. varoti	*P. cyclopium*	*P. funiculosum*	*T. viride*	*Ch. globosum*	*A. niger*
	[kg/m^3]					
A	1.17	0.53	1.08	0.43	0.51	0.48
B	< 2.41	2.31	< 2.21	< 2.61	< 2.41	< 2.38
C	2.92	0.57	1.40	1.42	1.37	0.53
D	0.92	0.78	0.71	0.80	0.84	0.79
E	NT	NT	NT	NT	NT	0.03
F	NT	NT	NT	NT	NT	0.03
G	NT	NT	NT	NT	NT	0.25
H	NT	NT	NT	NT	NT	4.81
I	1.12	0.61	< 11.24	0.57	2.47	1.05
J	< 6.51	6.45	< 6.39	< 6.19	< 6.37	6.48
DDAC	11.91	8.67	8.32	12.38	17.21	12.62

Among the tested isothiazole derivatives the preservative coded as A and containing the mixture of 2-Octyl-3-2H-Isothiazolone, 5-Chloro-2-Methyl-2H-Isothiazol-3-one and 2-Methyl-3-2H-Isothiazolone was the most effective. The results of the investigations of the fungicidal value showed that among 6 tested microfungi the most sensitive on fungicides based on isothiazole was *P. cyclopium* while the most resistant was *P. varioti*.

The obtained results show the high usefulness of IPBC and Methylene-Dithiocianate for wood preservations against moulds. In the case of the investigations with *A. niger* the activity of IPBC and Methylene-Dithiocianate was much higher as compared to DDAC. The obtained results let to determine the sequence of the tested fungicides taking into account their effectiveness. The sequence is presented in Figure 1.

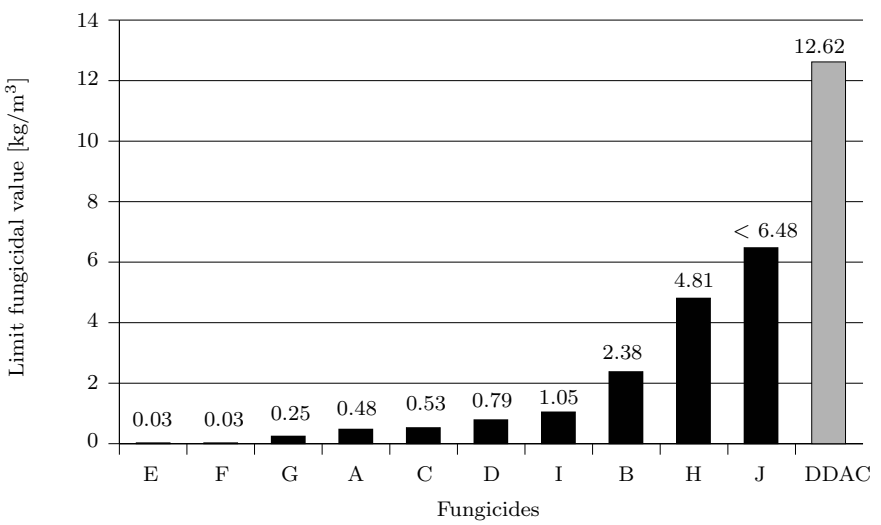

Fig. 1. Effectiveness against *A. niger*

Similar results were obtained by Baileys et al. (2003) during testing 3 preservatives containing IPBC and used for preservation of wood based composites. They found the best efficiency of the preservatives against microfungi as compared to fungi causing wood rot. The impregnant containing 2-N-octyl-4-isothiazolin-3--on (coded as D) as well as the preservative based on Benzalkonium Chloride and Methylene-Dithiocianate (coded as G) were characterized by similar fungicidal value against all fungi used in the mycological test. Williams and Lewis (1989) analysed susceptibility to natural infection of wood preserved with isothiazole derivative. They isolated Penicillium spp. and Coniophora sp. showing the comparable effectiveness of isothiazole against *Penicillium* as a representative of moulds and *Coniophora* sp. being the fungus causing the brown rot.

CONCLUSIONS

1. The investigations revealed that the most effective preservatives against all tested fungi were IPBC and the mixture of Methylene-Dithiocianate and Benzalkonium Chloride.
2. The preservatives containing 2-N-Octyl-4-Isothiazolin 3 on and the mixture of Methylene-Dithiocianate and Benzalkonium Chloride were characterized by the similar fungicidal values against all tested organisms.
3. Because of the diversified biological activity of fungicides it was necessary to determine the limit fungicidal value also against microfungi in order to avoid mould development on wood.

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