Decay Resistance of Four Wood Species Treated to Destroy Thiamine

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Accepted for publication 15 June 1970.

ABSTRACT

Alkaline treatment of wood at elevated temp to destroy thiamine content rendered the wood resistant to two thiamine-requiring brown-rot fungi, *Poria monticola* and *Lentinus lepideus*. Treated wood was not resistant, however, to attack by two thiamine-requiring white-rot fungi, *Polyporus versicolor* and *P. anceps*. Putting thiamine back into treated pine blocks failed to overcome the resistance of the blocks to the brown-rot fungus *Poria monticola*. This result plus the variation in the decay resistance of the treated woods to the other test fungi suggests that the thiamine relationship to decay resistance could be more elusive than anticipated, and that further investigations are needed to ascertain precisely the changes produced by alkaline treating of wood. Phytopathology 60:1660-1661.

Thiamine, a naturally occurring minor constituent of wood, is essential to the metabolism of most wood-decaying Basidiomycetes. Therefore, wood treated to destroy its thiamine content should be resistant so long as outside sources of thiamine are excluded. Presumed thiamine destruction was reported by Baechler (1) in laboratory experiments employing small southern pine (*Pinus* sp.) blocks subjected to an alkaline treatment at elevated temp. The results were inconclusive, but pine was generally resistant to *Lenzites trabea* when assayed over a low-thiamine medium. In later tests, subjecting ammonia-treated southern pine panels to elevated temp provided markedly good protection in field experiments if wood was kept off the ground (2). Alkaline treatment without heating the hardwood (beech) facilitated hydrolysis by fungal enzymes (4). In digestibility experiments, alkaline treatment of hardwoods was reported to aid enzymic breakdown by microorganisms (5); the treatment of softwoods, however, had no effect (5). Thus, it is possible that basic treatment of hardwoods and subsequent heating may not provide the protection obtained in pine. Therefore, the objective here was to evaluate the capacity of four thiamine-requiring wood-rotting fungi to attack both hardwoods and softwoods treated with alkaline solutions and gas.

MATERIALS AND METHODS.—Test blocks, ½ × 1 × ⅜ inch (grain direction), were cut from the sapwood of sweetgum (*Liquidambar styraciflua* L.), southern pine (*Pinus* sp.), Douglas fir (*Pseudotsuga menziesii* [Mirb.] Franco var. *menziesii*), and from the heartwood of birch (*Betula* sp.). The blocks were then treated under vacuum with either 1.0% aq ammonia or sodium hydroxide. Ammonia gas was also used to treat blocks; in this treatment, blocks were exposed to ammonia vapors for 1 hr in a closed container. All the treated blocks with the exception of a few southern pine were heated by placing the blocks in large test tubes; the tubes were stoppered and steamed for 1 hr at 100 C. Before exposure to fungi, sodium hydroxide-treated blocks were leached in distilled water on a shaker until the leach water was near neutrality. Leaching was not necessary to lower the pH of ammonia-treated wood, because it assumed an almost normal pH on exposure to air. This condition was determined by suspending pine sawdust in water and measuring the pH with a pH meter. The pH of untreated pine sawdust was 4.7; that of wood treated with ammonia was 6.1. Most wood-decaying fungi have a pH opt of about 6.0; thus, increased pH probably would not be a factor contributing to decay resistance.

Two brown-rot fungi, *Lentinus lepideus* (Fr.) (Madison 534) and *Poria monticola* (Murr.) (Madison 698), and two white-rot fungi, *Polyporus versicolor* (L. ex Fr.) (Madison 697) and *P. anceps* (Pk.) (F784-S), were used as the test fungi.

The test to evaluate the decay resistance of alkaline-treated wood was designed to provide the nutrients within wood suitable for fungus growth yet exclude any extraneous nutrient, such as thiamine. Treated and untreated control blocks were conditioned to equilibrium moisture content at 27 C (80 F) and 70% relative humidity, weighed, infiltrated with distilled water to refusal under vacuum, and sterilized at 100 C for 20 min. Eight-oz French-square bottles were used for the decay chambers. Twenty-five ml of 2% agar (w/v) were placed on one of the horizontal sides of the bottles. After the agar solidified, the bottles were inverted, and each test block was placed on the other horizontal side of the bottle, opposite and below the agar.

Inoculum was grown on Whatman No. 1 filter paper placed over a low-thiamine medium prepared from the following: 15 g Nobles special agar; 10 g glucose; 2 g vitamin-free casein amino acids; 1.5 g KH_2PO_4; 0.5 g $MgSO_4 \cdot 7H_2O$; 1 ml minor elements (3); and 1,000 ml distilled water.

Five-mm-square pieces of filter paper with the fungus culture attached were placed aseptically on the sterilized test blocks in the decay-chamber bottles. Six weeks later, all blocks were removed from the bottles, dried to equilibrium moisture content at 27 C and 70% relative humidity, and weighed. The loss in wt of each block indicated the extent of fungus damage.

RESULTS AND DISCUSSION.—The results from the wood blocks treated with two basic solutions and with ammonia gas did not vary significantly; therefore, only the results of the blocks treated with 1.0% aq am-

TABLE 1. Weight losses produced in 6 weeks by four wood-rotting fungi in ammonia-treated woods

Fungus[a]	Wt loss							
	Sweetgum		Birch		Southern pine		Douglas fir	
	1% Ammonia plus heat[b]	Control	1% Ammonia plus heat[b]	Control	1% Ammonia plus heat[b]	Control	1% Ammonia plus heat[b]	Control
	%	%	%	%	%	%	%	%
Polyporus versicolor (WR)	34	26	20	12	9[c]	12[c]	0	0
Polyporus anceps (WR)	18	16	17	12	8	12	11	13
Poria monticola (BR)	0	17	0	12	0	20	0	19
Lentinus lepideus (BR)	0	7	0	2	0	14	0	12

[a] WR = white-rot fungus; BR = brown-rot fungus.
[b] Heated for 1 hr at 100 C.
[c] Eight-week incubation.

monia are presented in Table 1. The two brown-rot fungi were unable to cause decay on any of the treated woods. The two white-rot fungi, however, were able to cause decay; in the birch and sweetgum, the treatment seemed to enhance fungus attack. To determine if a higher concn of ammonia might be required to impart resistance to the white-rot fungi, sweetgum was treated with 2.5-10% of ammonia. Even with the highest concn (10%), however, the treated wood was more susceptible to attack by *P. versicolor* than was the untreated wood after 6 weeks.

Heat is considered necessary to render alkaline-treated southern pine resistant to fungus attack (1, 2). In this work, southern pine blocks treated with a 1% solution of base and not heated appeared to have a marginal type of resistance to *Poria monticola*. Some blocks remained free from attack, and others were attacked as severely as the untreated controls. By employing higher concn of base, particularly with sodium hydroxide, more consistent freedom from attack by *P. monticola* was obtained in unheated southern pine blocks.

It has been assumed that decay resistance imparted to wood by alkaline treatment is brought about by destruction of trace amt of thiamine necessary for fungus growth. Southern pine blocks that were initially treated to destroy the naturally occurring thiamine and that had the thiamine put back into them, however, still had no wt losses when exposed to attack by *Poria monticola*. Furthermore, the variation among the test fungi in their ability to attack alkaline-treated wood suggests that the source of decay resistance could be more elusive than anticipated. Perhaps alkaline treatment alters simple carbohydrates necessary for the establishment of certain fungi, or the cellulose substrate itself may be so modified that enzymes of the attacking fungus are inhibited. Formation of toxic compounds, particularly in wood treated with ammonia, is another possibility that could account for resistance. Further studies are underway to ascertain precisely what changes in wood have been affected by alkaline treatment.

LITERATURE CITED

1. BAECHLER, R. H. 1959. Improving wood's durability through chemical modification. Forest Prod. J. 9:166-171.
2. GJOVIK, L. R., & R. H. BAECHLER. 1968. Field tests on wood dethiaminized for protection against decay. Forest Prod. J. 18:25-27.
3. HOAGLAND, D. R., & D. I. ARNON. 1938. The water-culture method of growing plants without soil. Calif. Agr. Exp. Sta. Circ. 347:1-39.
4. JURASEK, L., & J. VÁRADI. 1968. The effect of various treatments on enzymic digestion of beech wood. Drevársky Výskum 1:11-16.
5. SCOTT, R. W., M. A. MILLETT, & G. J. HAJNY. 1969. Wood wastes for animal feeding. Forest Prod. J. 19:14-18.