DECAY RESISTANCE OF ACETYLATED BEECH WOOD AGAINST WHITE ROT FUNGUS (TRAMETES VERSICOLOR)

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Rezistența la degradare a lemnului de fag acetilat împotriva ciupercilor de putregai alb (Trametes versicolor)

Rezumat

Acest studiu s-a realizat pentru a investiga biodisponibilitatea reziduurilor biodegradabile ale speciilor de fag iranian (Fagus orientalis) la acțiune ciupercii putregaiului alb (Trametes versicolor)După 12 ore de imersie în nhidridă acetică, lemnul de fag a fost încălzit timp de 30, 90 și 240 de minute la 120°C în etuvă pentru a atinge 3 niveluri de creștere în greutate de 5, 9 și 16%. Măsurarea rezistenței biologice a probelor de mai sus a fost efectuată în conformitate cu standardul EN113. Examinarea efectului intensității acetilării asupra rezistenței biologice a arătat că, pe măsură ce intensitatea tratamentului a crescut, rezistența specimenelor la putregaiul alb a crescut. De fapt, odată cu creșterea acetilării de la zero la 16%, scăderea masei probei împotriva putregaiului alb a scăzut de la 21,8% la 0,97% după 12 săptămâni și de la 36,3% la 16,78% după 16 săptămâni.

Cuvinte cheie: *Lemn de fag, acetilare, creștere procentuală în greutate, ciupercă albă.*
Key words: *Beech wood, acetylation, weight percentage gain, white rot fungus.*

Introduction

Chemical modification of wood is the chemical reaction between some active parts of the components of wood (cellulose, hemicellulose and lignin) with a simple chemical that ultimately leads to the bonding between wood and the chemical. In other words, wood chemical modification of the substitution reaction of some of the wood hydroxyl groups with a chemical with less hydrophilic groups. Thus, the chemical structure of some of the cells that make up the cell wall changes, which in turn can increase important features such as dimensional stability, hardness, biological resistance, and resistance to ultraviolet radiation (Larsson, 1998).

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Acetylation is one of the most common methods of chemical modification, which is a type of esterification reaction based on the replacement of hydroxyl groups by cell wall constructors by steel groups (Mohebby, 2003).

Hydroxyl groups are not only sources of water absorption, but also a site for most enzymatic reactions. Fungi, termites, and bacteria have special enzyme systems that are able to convert cell wall deposits into absorbable units. Therefore, if the soil material of these enzymes changes chemically, these enzymes cannot affect that material (Takahashi, 1996). By measuring the reduction in the mass of wood attacked by brown rot fungi, it was found that the acetylation rate of 10% is effective in reducing the degradation of brown rot fungi (Ohkoshi et al, 1999). Research on destructive marine life has also shown a good effect on acetylation on wood. In such a way that the woods, which were sterilized with 22% acetic anhydride, are classified as resistant to destructive marine organisms in the class of good durability with partial degradation (Rowell, 1997). Also, after 8 years of proximity, the destruction caused by marine diggers on 22% acetylated pine wood has been very small (Brelid & Westin, 2007). Compared with the increase in the amount of relatively non-polar groups and the hydrophobicity of acetate in the domed wood, the adhesion decreases (Tarkow et al., 1950). Also, due to the treatment of acetylation, the rupture modulus, elastic modulus and internal adhesion of the particle board are reduced and this decrease is proportional to the percentage of weight gain(WPG) (Khosravani, 2006).

One of the most important and significant effects of sterilization is swelling and increasing the volume of the material. After the wood reacts and replaces the steel groups, the cell walls face an increase in volume. The rate of increase is directly related to the severity of the treatment. The higher the reaction, the larger the cell wall (Sander et al, 2003). It should also be noted that the reduction in accessibility to places for the formation of hydrogen bonds leads to an increase in the stability of the dimensions of the acetylated wood samples (Rowell, 1983). In the case of 18% weight gain, less than 10% of the weighted boards were adjusted. This suggests that lowering the hydrophilic groups of lignocellulosic materials leads to lower moisture absorption (Imamura et al., 1989). The positive effect of sterilization on some wood properties has been established. Since most of the research has been done on coniferous species, this study was conducted to investigate the biological resistance of domesticated wood of a native Iranian broadleaf *(Fagus orientalis)* species to white rot fungi.

Materials and methods

Completely radial tangential samples of beech (Fagus orientalis) wood were prepared. The moisture content of the prepared wood was about 30%, which was dried using a rotary dryer at a speed of 3 rpm at a temperature of 120 ˚C and their moisture content was reduced to 1%. After emptying, the wood chips were packed in durable bags and moisture insulators.

Chemical modification

Wood samples were treated without the presence of catalysts and solvents and only by temperature with 99% pure anhydride and 120 ˚C welding temperature. Based

on the results of the pre-treatment, the samples were placed in an oven at 120. C for 30, 90 and 240 minutes.

At the end of the reaction time, the specimens were removed from the iron and the bags containing the stained wood were immersed in ordinary water for 24 hours in order to remove the acetic acid and eliminate the unpleasant odor, and then for 24 hours in the iron and under. Dry temperatures of 103 degrees Celsius. After the chemical processing operation and complete drying, the percentage of wood weight gain (WPG) was calculated (table 1).

Table 1. acetylation reaction conditions

Time of reaction (min)	Temperatures (˚C)	Wood weight gain (%)
30	120	5
90	120	9
240	120	16

Preparing the culture medium and propagating the fungus

First, 48 grams of agar agate malt in an Erlenmeyer flask was poured into a capacity of 1000 cc containing distilled water and delivered to a capacity of 1 liter. Erlenmeyer was then placed on a magnetic heater, and by stirring, a smooth, uniform solution was obtained. Sterilization was performed for 20 minutes inside the autoclave at 120˚C and at a pressure of 1.5 kg/cm^2. Transfer of fungal samples to the culture medium was performed under a sterile hood equipped with a UV lamp and ventilator. During 2 weeks, the white rot fungus covered the surface of the culture medium inside the Kolle and at this stage was ready to transfer the wood samples.

Adjacent to pure fungus with specimens

First, the samples were wrapped in aluminum foil and dried at 100˚C for 24 hours in a sterile oven to zero percent moisture. Under the sterile hood, next to the alcohol lamp, two glass pacifiers were placed inside each container, the surface of which was completely covered with pure mushroom, and then the samples were placed on the glass packs. Kolle glasses containing samples and fungi were transferred to an incubator to control relative humidity and temperature.

To control the relative humidity, a water container was placed inside the incubator to provide the required relative humidity with its gradual evaporation. Thus, according to EN113 standard, the samples were exposed to 22˚C and relative humidity of 65±5% for 16 weeks. In order to investigate the destruction process, weighing was performed at 12 weeks. Relative humidity and incubator temperature were monitored daily.

After 16 weeks, all samples were removed from the incubator.

Determining the effect of fungi on samples

After removing the Kolle glass containers containing samples from the incubator, the samples were removed from the glass containers in order to check the durability of the samples against white rot and fungi. To determine the dry weight, the samples were placed in an iron for 24 hours at 100˚C. After this time, the samples were weighed. Due to the dry weight of the specimens before proximity to the fungus (primary) and their

dry weight after proximity to the fungus (secondary), the percentage of reduction of the mass of each specimen was calculated according to the following equation.

$$Reduce\ the\ mass\ of\ samples = \frac{dry\ weight\ (primary) - dry\ weight\ (secondary)}{dry\ weight\ (primary)} \times 100$$

Results

Examining the results of this experiment, the resistance of the acetylated wood to the white rot fungus showed that the stabilization had a significant effect on this feature and that the difference was significant at the level of more than 99% of the statistical confidence (Table 2). Comparison of the meanings obtained from each treatment showed that during 12 weeks, there was no significant difference in biological resistance between control and domesticated samples at 5% (Table 2).

After 16 weeks, virtually no acetylated specimens were severely damaged. The effect of increasing treatment severity on weight loss due to white rot fungal attack after 12 and 16 weeks has been shown in Figure 1 so that in both cases, weight loss is greatly reduced. The appearance of the specimens after 12 and 16 weeks of proximity to the fungus showed that the untreated specimens and even the 5% sterilized specimens were affected by the fungus and that the specimens had a white coating of fungal fibers. However, this coverage is much lower in more severely sterilized samples. The decrease in yarn coverage indicates the inability of the fungus to provide the nutrients it needs and to grow. Overall, the results showed that by increasing the intensity of the acetylation, the resistance to this fungus increases well, and the more severely acetylated wood samples have suffered the least weight loss (table 3).

Table 2. Analysis of variance the effect of acetylation treatment on the biological resistance of wood against white rot *(Trametes versicolor)* fungus

Destruction time	Sources of change	degree of release	sum of squares	average of squares	F value	P number
12 weeks	Percentage of acetylation	3	2048.577	682.859	124.843	0.000
	Test error	27	147.683	5.470		
	Total	30	2196.259			
16 weeks	Percentage of acetylation	3	6601.807	2200.602	176.882	0.000
	Test error	35	435.437	12.441		
	Total	38	7037.244			

Table 3. Comparison of the effect of different acetylation intensities on weight loss due to degeneration of white rot fungus in wood by Duncan method

Weight Gain (%)	weight loss (%) after	
	12 weeks	16 weeks
0	21.858[a]	36.3189[a]
5	20.9944[a]	26.6290[b]
9	9.235[b]	16.2722[c]
16	0.970[c]	1.7800[d]

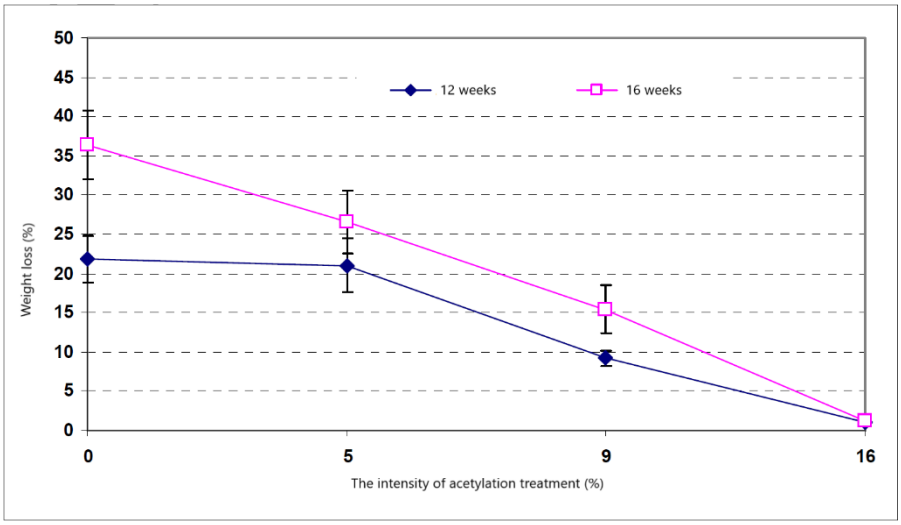

Fig. 1. The resistance of acetylated wood to white rot *(Trametes versicolor)* fungus

According to the obtained results, it was observed that with increasing the intensity of acetylation, the biological resistance of wood specimens increases significantly. These results indicate a positive effect of acetylation. The results showed that after 16 weeks of proximity, the destruction of white rot fungi in improved specimens with an intensity of 16% compared with control specimens was significantly reduced by 95.3%. White rot fungi have a much more limited ability to destroy modified specimens and are better controlled.

Studies show an increase in the biological resistance of wood composite products such as wood chips (Okino et al., 1998), chipboard (Youngquist et al., 1986) and wood (Mohebby, 2003) against white rot fungi due to acetylation. The reason for the increase in biological resistance to white rot fungi can be attributed to its degradation mechanism. Since white rot fungi have large hydrophobic enzymes that require hospitalization of water layers to be able to access destructive sites (Morrell & Zabel, 1992; Eriksson et al., 1990). Due to the acetylation and the occurrence of the phenomenon of bulking of wood particles (Sander et al. 2003) and the closing of the pores through which these enzymes could pass, the access of these enzymes is

practically encountered. On the other hand, by increasing the severity of the acetylation treatment and replacing the steel hydrophobic groups instead of hydroxyl hydrophilic groups, the cell walls have less moisture. This reduces the amount of water in the wall and limits the transport of enzymes. Therefore, the fungus that causes white rot with large enzymes faces two major problems: lack of moisture to transport the enzyme and access to cell wall polymers, and on the other hand, narrowing the passageways for its large enzymes. This phenomenon is exacerbated by increasing the severity of the treatment and further reduces the activity of the fungus. If the enzymes have access to cell wall polymers, they must be identified for degradation. As a result of acetylation, the chemical nature of cell walls changes, and as a result of this phenomenon, fungal enzymes lose their ability to detect degradation sites (Takahashi, 1996). Therefore, it can be stated that acetylation changes the chemical nature of cell walls, and as a result, reduces the moisture in the wall, shrinks the pores of the cell walls and makes the polymers attacked by the fungus more unknown. White rot increases.

Conclusion

In general, it can be said that acetylation has a significant effect on the biological resistance of wood samples, so that the severity of the treatment of 16% of fungal activity almost stops white rot.

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