THE BIOPROTECTION SOME SYSTEMS BASED ON NATURAL AROMATIC COMPOUNDS AND THEIR COPPER COMPLEXES

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OVERVIEW

Purpose: This paper presents the results regarding the biological stability of the birch veneer in the presence of some natural aromatic compounds (unmodified or modified by hydroxylation) having different levels of chemical modification and their copper complexes compounds (copper chloride and copperammonia solution).

Methods: The biostability tests have been performed by burying of the test pieces treated with the mentioned products in soil for 6 months. The influence of applied treatments was followed by mass losses and wetting angle. The obtained results have been correlated with the characteristics of the products and their complex forming capacity.

INTRODUCTION

It is known that in the initial phase, some of the wood compounds soluble in water (extractable substances, mineral salts) diffuse outside, thus forming the first nutritive elements for microorganisms (Ungrueanu and collab., in press). The high humidity content as well as favorable temperature conditions will allow the access of the enzymes produced by microorganisms to the woody substrate.

According to their structure, the wood chemical compounds will be degraded in the following order: hemichelluloses, cellulose. In the end there will remain the lignin in a more or less modified form, depending on the conditions and the microorganisms that invade the wooden tissue (Pollacco et al., 2002; Lazzeri et al., 1994; Popa and collab., 1993).

Nowadays, in order to protect wood, the products that are toxic for microorganisms and insects are used, but most of them are incompatible with the environment. Some of the products extensively used have in their composition the toxic copper ions. The studies performed till now have pointed out that they penetrate just the areas less ordered of the cellulose and hemichelluloses. When the copper ions enter the composition along with ammonia, this compound is considered to evaporate totally or just partially, which results in the precipitation of the insoluble copper hydroxide. Also, a part of the copper ions are bound to the wood substrate by means of the hydroxy or carboxyl groups from the wood, which are in ionized state under pH conditions.

In such a situation, the interaction of the copperammonia complexes with individual components of the wood is manifested in the following order: lignin, hemichelluloses and cellulose, and the pH increasing intensifying the interaction with lignin.

Having in view the resistance of lignin to the biological attack and the toxicity of the copper ions, in the present study, the way in which birch wood biostability is approached using systems created from by-products (the chemically modified/unmodified lignins), (Malutan and collab., 2003, 2007), in the absence or presence of the copper ions.

EXPERIMENTAL

In this study there have been used lignins provided by Grant Company (L1 from Wheat straw), and straw lignin modified through hydroxymethylation (Casaciu and collab., 2005; copper chloride, tetraammonium copper hydroxide (copperammonia) ammonia solution 0.1N, Cuap, agar culture medium. Using the veneer samples and the mentioned products dissolved in ammonia solution 0.1N, at a concentration of 5%, the following treatments have been applied: a) the immersion of the samples in solutions for 5 minutes followed by their drying; b) the immersion of the samples in solutions of the copper compounds, drying them and then treating with ammonia solutions of lignin and its derivatives followed by drying.

The samples treated in this way have been previously weighed, in order to determine the quantity of retained substances and total mass of the samples. Then the samples have been buried in garden soil and have been maintained under laboratory conditions for a period of six months. The specific humidity of the soil has been kept through periodic moistening.

The level of biodegradability has been estimated by determining the mass losses and the wetting angle. The latter has been estimated using the goniometer Kraus, model FM40 Easy Drop. The samples that displayed on their surface the visible effects of microorganisms have been used for their identification. For this purpose the microorganisms have been removed under sterile conditions on a filter paper support, and after that they have been inoculated into a Czapek agar medium.

RESULTS AND DISCUSSION

Figures 1-3 present the results regarding the mass losses for the veneer samples treated with various products. It can be seen that lignin products inhibit the process of biodegradation, in an order which is influenced by their nature, type of applied reaction and by the degree of complex forming with the copper ions. Thus, unmodified straw lignin (L1) inhibits biodegradation process and the effect is positively influenced by complexation with copper ions: The unmodified commercial product (Pb 1000) is more sensible to the soil microorganisms attack and as following mass losses is increased. The same behavior is characteristic to hydroxymethylation derivatives of lignin products. The functions introduced in lignins (both in initial and in commercial product) determines a good interaction of them with soil microorganisms. On the other hand, the increasing their functionalities by the two applied reactions has a favorable effect in the complex forming. As a consequence, the complexes formed via successive treatments of wooden substrates with solutions of copper ions and lignin derivatives increase the biological stability of veneer samples.

The copperammonia solution has an improved capacity to protect the wooden tissue and in this way the biological stability is better after this treatment. At the same time the nature of copper compounds influence the complex forming capacity with lignin or its derivatives. It seems that copper chloride presents a better interaction capacity between wood substance and lignin derivative. In the case of copper ammonia solution, due to its penetration in wooden tissue, the accessibility of copper ions to participate in complex forming is more reduced. Thus the biostability may be correlated with accessibility of functional groups from wooden substrate and lignin to form complexes which assure a good resistance to soil microorganisms attack.

The effects of biostabilization determined by complexes of lignin derivatives are also evidenced by wetting angle, which has the lowest value in all cases. A strong resistance is observed in the case of utilization of modified products. They didn’t assure an efficient protection from mass losses point of view, but the values of wetting angles are high. This situation may be explained by biodegradation of polysaccharides from wood tissue and increasing of lignin content which is characterized by hdrophobicity.

After their burial in soil, some samples present visible microorganisms developed on the surface. These samples were selected to identify the microorganisms which are resistant against to used treatments.

CONCLUSIONS

The efficiency of the treatment of birch veneer samples with unmodified and modified lignins by hydroxymethylation, their copper complexes along with copper compounds was studied, from the view point of biostabilization. The effects of the treatments were followed by the burial of the samples in soil and maintained them in laboratory conditions for 6 months. After this period the mass losses and wetting angle were determined. The obtained results confirm the toxic role of lignin and copper ions. The lignin derivatives with an increased functionality have the capacity to form complexes which can assure bioprotection of wooden tissue against attack o microorganisms.

The wetting angle values, as a measure of surface hydrophobicity can be used to characterize the effects of treatments and of the transformation produced during burial in soil of the woody substrates. Despite of the applied treatments some of soil microorganisms attack the woody substrate and a method to identify them was developed.

The preliminary results, which will be further developed could be considered as a possibility to obtain new biodegradable systems based on synergistic action of natural products unmodified or modified along with their complexes with copper ions.

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