

# Promoting Effect of Dissolved Organic Matter on the Degradation of Persistent Organic Pollutants by White Rot Fungi

Li LIN, Qunxiang He, Shaojun Yu

Kunming University, Kunming, Yunnan 650214, China

llysj4809@163.com

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**Abstract:** The effect of dissolved organic matter on the degradation of white rot fungi plays a certain role from the existing research. It can mainly accelerate the degradation ability of white rot fungi, play a role as a carrier for the transport of pollutants in soil and water, significantly affect the concentration of soil persistent organic pollutants, and restrict their migration, transformation degradation and other chemical and biological processes. White rot fungi have a significant effect on filamentous fungi that degrade lignin. Due to their low specificity of degrading enzyme system, they can show a certain effect on a variety of refractory organic pollutants, and the fusion of dissolved organic matter and white rot fungi can play a better role and effect. It has high value in bioremediation and application in refractory organic pollutants.

## 1. Introduction

Dissolved organic matter (DOM) refers to the general name of organic matter in soil and water, which is composed of a series of molecules with different sizes and structures, can pass through the filter membrane within 0.5 micrometers and can be better dissolved in water<sup>[1]</sup>. Although it accounts for a small part of soil organic matter, it can be found in soil and water environment. It is a more active material in the earth's ecosystem, and can play a stable carrier role in the movement and transformation of pollutants in soil and water. White rot fungi are the general name of a kind of fungi with better degradation of lignocellulose. According to its properties, it is basidiomycetes, which named for their white decay on rotten wood. Among the matters that can degrade POPs persistent organic pollutants, white rot fungi are the most representative fungi with the strongest ability to degrade lignin. It is also a research hotspot in dealing with POPs in recent years<sup>[2]</sup>.

## 2. Overview of POPs

Persistent organic pollutants (POPs) are persistent in the environment and exist in different fields. Their characteristic is long half-life period, and they can accumulate quickly through the food web. They will also exist in environmental media, such as atmosphere, water, organisms, etc. According to the Stockholm Convention, there are 12 kinds (categories) of POPs included in the Convention control in the first batch. They are organic chemicals that have many effects on human health and the environment. This trait has "five characteristics", namely long-term residue, bioaccumulation, semi-volatility and high toxicity. It includes not only natural substances that can seriously endanger human health, but also some synthetic organic pollutants. Therefore, the existence of POPs is also extensive.

## 3. Mechanism and Influencing Factors of DOM Promoting the Degradation of Soil POPs by White Rot Fungi

White rot fungi can not only degrade lignin, but also have strong decomposition ability to xenobiotic. White rot fungi have high research value. Therefore, the study of its action mechanism has become a focus. The mechanism and influencing factors of DOM promoting the degradation of

soil POPs by white rot fungi still need to be further proved.

### **3.1 Advantages of Dissolved Organic Matter in Promoting the Degradation of White Rot Fungi**

With the participation of DOM, the degradation ability of white rot fungi has been greatly improved and becomes more “non-directional”, that is, it can degrade a large number of different kinds of chemicals, not limited to a certain kind of substances, so it has a wide range of uses<sup>[3]</sup>. In addition, in terms of kinetics, the addition of DOM becomes more advantageous. White rot fungi realize transformation through free radical process. With the help of DOM, the kinetics of chemical degradation is stronger and reversible, which is very conducive to, for example, the formation of some oxidation products. The degradation of pollutants by white rot fungi assisted by DOM is significant and complete. Meanwhile, with the help of DOM, the degradation of pollutants by white rot fungi, whether in the process or after the reaction, will not cause significant impact and harm to the existing environment. Other advantages include low cost. Dissolved organic matter and the original strain of white rot fungi are easy to obtain, do not need valuable raw materials and some special environment, and in the culture process, white rot fungi can grow rapidly in both solid medium and liquid medium, which are relatively easy. In addition, the requirements for nutrients are not high, and sawdust can be used as raw materials for mass culture.

### **3.2 Action Mechanism of Dissolved Organic Matter on Degradation of Organic Pollutants by White Rot Fungi**

DOM is mainly composed of carbohydrates. White rot fungi use nutrients in DOM with different molecular weights to make their mycelium multiply in large numbers, and the amount that can be effectively adsorbed to POPs will also increase. Then the components in soil will change, in which carbon and nitrogen will be limited to a certain extent, and they can stimulate the white rot fungus to start the systematic expression of lignin degrading enzymes, while the degradation ability of white rot fungus in dissolved organic matter environment has been brought into full play, and the dissolved and adsorbed states of POPs are obvious. Meanwhile, due to the addition of dissolved organic matter, the temperature, humidity and pH value change to a certain extent in the complex soil environment, which will also have a certain impact on the degradation of POPs.

The degradation of white rot fungi occurs in the secondary metabolic stage. The enzymes related to degradation are formed only when some nutrients, such as nitrogen, carbon and sulfur, are limited, which is the starting condition of white rot fungi degradation. This nutritional limitation of enzyme production is called lignin degradation condition. In response to nutritional response, white rot fungi form an enzyme system. The degradation main body of white rot fungi is composed of peroxidase with  $H_2O_2$ , oxidase with  $H_2O_2$ , reductase, laccase, methylase, protease and other enzymes. Peroxidase is the initiator of the reaction. The degradation of refractory organic pollutants by white rot fungi can be divided into intracellular and extracellular processes. In cells, the main function of white rot fungi is synthase, which mainly produces lignin oxidase system, mainly including lignin peroxidase, manganese peroxidase and laccase. Then, catalase can reduce oxygen, activate laccase and catalyze free radical chain<sup>[4]</sup>. Outside the cell, the separated enzymes such as lignin peroxidase oxidize the chemical substance RH (such as petroleum, dye secretion and other refractory organics) into free radical R. Under the catalysis of peroxidase, RH can quickly produce many different free radicals in the form of chain reaction to oxidize the refractory organics, so as to degrade various refractory organic pollutants.

## **4. Promotion and Treatment Value of Dissolved Organic Matter on the Degradation of POPs by White Rot Fungi**

DOM can increase the solubility of POPs and promote the growth of white rot fungi. DOM is mainly composed of carbohydrates with less aromatic substances, less alkyl chain hydrocarbons and short branched chains. It contains active functional groups such as carboxyl, hydroxyl, carbonyl and methoxy groups. It can have a series of reactions with POPs in soil, such as ion exchange,

adsorption, complexation, chelation, flocculation and redox. DOM itself and its metabolites have no toxic and side effects on the environment, so it is an excellent co-metabolic substrate for the bioremediation of high-ring POPs.

#### **4.1 Effect of DOM on the Growth and Key Enzyme Secretion of White Rot Fungi**

From previous quantitative studies, the dynamic change of adsorption and desorption of POPs by DOM on white rot fungi was found, and the effect of low molecular weight DOM as carbon source on the process of promoting white rot fungi was analyzed. Through dissolved white rot fungi on POPs, it was found that the binding and solubilization process of DOM to POPs was obvious. Through quantitative detection of peroxidase (Lip), manganese peroxidase (Mnp) and Laccase, it was found that the effect of dissolved organic matter on the degradation of white rot fungi and POPs was strengthened.

#### **4.2 Effect of Dissolved Organic Matter on Degradation Rate of White Rot Fungi**

The participation of dissolved organic matter has a certain impact on the pH value and temperature of soil environment, which has a significant impact on the degradation of white rot fungi. PH value and temperature have a certain influence on the degradation process of white rot fungi, so the participation of dissolved organic matter can play its greatest effect on white rot fungi. In the process of dissolved organic matter assisting white rot fungi to degrade some persistent pollutants, pH and temperature have a great impact on the reaction. Temperature and pH value can change the enzyme activity. At the same time, with the change of pH and temperature, the physical and chemical properties of persistent pollutants will also change significantly.

#### **4.3 Role of DOM in Promoting the Degradation of Soil POPs by White Rot Fungi**

The role of DOM in promoting the degradation of soil POPs by white rot fungi is that the soil has a better adsorption, mycelial adsorption and analysis process, while DOM with small molecular weight can better promote mycelial growth, significantly solubilize the binding effect of DOM with large molecular weight, and the enzyme metabolic degradation ability has been fully improved. With the concentration of POPs, it has changed to a certain extent. In this sense, DOM needs to be continuously solubilized under complex soil conditions to expand the effective degradation of POPs by white rot fungi and promote mycelial growth. Therefore, DOM has significant value in promoting the degradation of soil POPs by white rot fungi.

### **5. Conclusion**

DOM has good application value in promoting the degradation of soil POPs by white rot fungi. Because white rot fungi can degrade a wide range of pollutants, it can better meet the participation of enzyme metabolism of white rot fungi under the action of dissolved organic matter, so as to achieve better and efficient degradation of white rot fungi.

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