Advances in Microbial Remediation of Organic Contaminated Soil

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Abstract. With the growth of population and the rapid development of economy, the discharge of "three wastes" from industry keeps increasing, and the soil organic pollution keeps aggravating, which poses a great threat to human health and the safety of ecological environment. Now for typical organic pollutants, the main use of low cost, no secondary pollution and easy operation of bioremediation method, including composting, bioreactors, etc., and the main body of the repair technology are microbes, due to the microorganism has stronger adaptability to the environment, variability, in the process of survival differentiate into a variety of metabolic type, and can better adapt to the environment. With the development of genetic, genomic, proteomics and metabolomics technologies, knowledge about physiology, ecology, biochemistry and the regulation mechanism of microbial metabolic pathways has been greatly enriched. Therefore, in the future, we can study the degradation ability of the dominant degrading bacteria and their adaptation mechanism to pollutants through experiments, and study the composition of soil microbial community, community function and metabolic pathway through macro gene sequencing, so as to improve the degradation efficiency of bacteria to petroleum hydrocarbons, polycyclic aromatic hydrocarbons and halogenated hydrocarbons. It provides data support and theoretical basis for degradation of compound organic pollutants in natural environment.

1. Introduction

Soil is the basic natural resources for human survival and the basis for plant growth and reproduction. The state of soil environment is closely related to the survival and reproduction of human society. Soil pollution is refers to the pollutants produced by human activity into the soil through various channels, the number and speed than the soil environmental capacity and the self-purification ability, accumulation of pollutants in the advantage gradually, lead to soil natural function disorder, soil quality to drop, affect crop growth and development [1], the phenomenon of ultimately endanger human body health.
Soil composite pollution refers to the phenomenon that two or more pollutants with different properties act together in the soil environment, and the concentration of each pollutant exceeds the standard of soil concentration, resulting in a significant decline in soil quality and function. According to the characteristics of pollutants, soil composite pollution is divided into organic composite pollution, inorganic composite pollution and inorganic-organic composite pollution. According to the sources of pollutants in the soil, soil composite pollution can be divided into homologous composite pollution and heterogeneous composite pollution. Compared with water and soil pollution, soil pollution is invisible and lagging, so it is called "invisible pollution". Soil is a source and sink of pollutants, and 90% of all pollution, including air pollution and water pollution, eventually enters the soil. Therefore, soil pollution is a microcosm of ecological deterioration. At the same time, the pollutants in the polluted soil can enter the surface water or underground water through rain erosion under a certain environment and pollute the water environment. Or through plant growth into the food chain, harm the safety of organisms and even humans.

2. Organic pollution of soil

With the growth of the population and the rapid development of economy, the industrial "three wastes" (waste gas, waste water and waste residue) emissions continue to increase, at the same time under the influence of the long-term unreasonable wastewater irrigation, in the process of the modern agricultural production and excessive use of fertilizers, pesticides, agricultural films, such as chemical pollution, caused by a variety of new and old pollutants in soil environment medium superimposition and accumulation, its exist in the state of compound pollution, soil pollution are diversified [2], the characteristics of composite soil pollution problem more and more prominent in our country [3]. In 2014, the ministry of environmental protection and the ministry of land and resources jointly issued the national soil pollution investigation bulletin, which pointed out that the overall situation of the national soil environment was not optimistic, and the quality of cultivated land soil environment was worrying. The total rate of exceeding pollutants in the national soil was 16.1%, among which the rate of exceeding cultivated land soil point was 19.4%[4]. Soil pollution has great harm. On the one hand, soil pollution affects the quality of agricultural products and aggravates the contradiction between more people and less land. On the other hand, soil pollution directly leads to excessive residual pollutants in agricultural products and the decline in the quality of agricultural products, affecting the export trade of agricultural products, and even the enrichment of pollutants through the food chain endangers human health and ecological security. Soil pollution has become one of the major environmental problems restricting sustainable development and affecting the national economy and people's livelihood [5].

At present, the common forms of soil compound pollution include heavy metal compound pollution, organic pollutant compound pollution and heavy metal-organic pollutant compound pollution. Among them, soil organic compound pollution is mainly related to the production and use of organic pesticides and the discharge of "three wastes" from industry. The most common pollutants are organochlorine pesticides (OCPs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and petroleum hydrocarbons (TPHs). According to statistics, at least 36 million hectares of soil in China are polluted by pesticides, petroleum hydrocarbons, polycyclic aromatic hydrocarbons and other organic compounds [6]. Compared with heavy metal combined pollution, soil organic combined pollution is more extensive, more complex and the results are more difficult to predict. At present, soil organic compound pollution has expanded from local to regional, from cities to suburbs and villages, resulting in the coexistence of point source and non-point source pollution, the superposition of domestic pollution, agricultural pollution and industrial pollution, and the combination or mixture of old and new pollution and secondary pollution [7].
3. Technology of microbial remediation of organic contaminated soil

3.1. Bioremediation

Petroleum hydrocarbons (TPH) are composed of complex non-aqueous and hydrophobic mixtures, such as n-alkanes, aromatic hydrocarbons, etc. These chemicals are transported and accumulated through the food chain, showing long-term toxicity, and have more or less influence on the overall environment of the earth. Polycyclic aromatic hydrocarbons (PAHs) is a widely distributed in the air, soil and water, the persistent organic pollutants (pops), teratogenic, carcinogenic, respectively, and the biological enrichment of polycyclic aromatic hydrocarbons, high rate, low biological availability, for human health and ecological environment poses a great threat to the safety of the focus of persistent organic pollutants in soil environment, is listed as priority control of toxic organic pollutants [8-10]. Halogenated hydrocarbon (VCHs) substances have acute or chronic, direct or indirect pathogenic effects on the human body, some of which accumulate in the body tissue, will change the cell DNA structure, causing human tissues to produce carcinogenic changes, teratogenic changes and mutations. Common degradation methods include physical remediation, chemical degradation, bioremediation and chemical-biological combined remediation, among which bioremediation has been considered as the preferred method to degrade organic pollutants due to its advantages of low cost, no secondary pollution and easy operation.

3.2. Microbial repair technology

Early bioremediation mainly refers to microbial restoration, which is also the earliest, most in-depth and most widely applied bioremediation method. A series of bioremediation technologies including on-site treatment, on-site treatment, composting and bioreactor have been developed. The main body of these remediation technologies is microorganism, and the application of these technologies to treat soil polluted by organic pollutants has been widely studied. Studies have shown [11] that microbial degradation is one of the main ways to remove organic pollutants, and other bioremediation technologies are also inseparable from the role of microorganisms. Due to the strong adaptability and variability of microorganisms to the environment, they differentiate into a variety of metabolic types in the survival process and can strongly adapt to the survival environment. In the soil polluted by organic pollutants, through natural domestication, a variety of microbial species or strains capable of degrading organic pollutants have been gradually formed. Different microbial types and degraded objects may lead to different degradation pathways for organic pollutants in the environment.

3.3. Prospect

At present, with the research and development of genetic, genomic, proteomics and metabolomics technologies and their application in the field of bioremediation of organic pollutants, knowledge about physiology, ecology, biochemistry and the regulation mechanism of microbial metabolic pathways has been greatly enriched. In particular, 16S rRNA and 18S rRNA genes can predict the evolutionary characteristics of microbial populations in a given environment. The degradation ability of the dominant degrading bacteria and their adaptation mechanism to pollutants were studied through experiments, so as to improve the degradation efficiency of the bacteria on petroleum hydrocarbons, polycyclic aromatic hydrocarbons and halocarbons, and to clarify the impact of environmental factors on the biological characteristics of microorganisms in organic soil. At the same time, macrogene sequencing was used to study soil microbial community composition, community function and metabolic pathways. It provides data support and theoretical basis for degradation of compound organic pollutants in natural environment.

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