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Research progress of mixed fermentation of medicinal residue and cultured compost of artificial soil algal crust

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Abstract

The expansion of market demand makes the waste such as Chinese medicine residue increasing day by day. In this paper, a soil conditioner based on mixed fermentation of medicinal residue and artificial soil algal crust was summarized in order to improve soil quality, improve soil ecological environment, increase crop yield and protect land resources. The use of waste medicine residue as a substrate production of conditioner, in the reduction of resource consumption at the same time to treat saline-alkali soil, to protect the survival of the earth.

Keywords

Drug residue; Fermentation; Soil algal crust; compost.

1. Introduction

With the increase of support for traditional Chinese medicine, the public's trust in the efficacy of traditional Chinese medicine in health care and chronic diseases has been significantly improved, and the traditional Chinese medicine industry has ushered in unprecedented development opportunities. At the same time, the expansion of market demand has led to the rapid expansion of traditional Chinese medicine and its related industries, and the waste from the processing and production of traditional Chinese medicine raw materials, traditional Chinese medicine pieces and light chemical products containing traditional Chinese medicine ingredients has increased, and the annual discharge of Chinese medicine residue in the country has reached 30 million tons.

Traditional Chinese medicine residue is an important biomass resource, but because of the immature technology, the use of traditional Chinese medicine residue can not be realized or unreasonable situation. Its incineration, stacking and burial treatment will cause the waste of resources and occupy a lot of land. It is easy for the medicinal residue in high humidity to breed microorganisms and cause mildew and deterioration, emit foul odor, and at the same time, stacking and burying the leachate will cause secondary pollution to the groundwater or the surrounding environment, resulting in potential ecological environment safety risks. Drying and incineration produce atmospheric pollution and increase the cost of environmental protection treatment, which seriously restricts the sustainable development of traditional Chinese medicine industry.

The research prospect of Chinese medicine residue is very broad. This direction is not only to eliminate or reduce the pollution of Chinese medicine residue to the environment, but more importantly to make it become a resource and get full use.

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2. Mixed fermentation of residue

2.1. Research progress of composting of pharmaceutical residues

2.1.1. Study on the composition of Chinese medicinal residue

Chinese medicine residue refers to the waste in the process of Chinese medicine processing, which is mainly produced by the processing of Chinese medicine slices or other Chinese medicine related products. In the production and processing of traditional Chinese medicine, single medicinal ingredients are extracted, and the medicinal residues still contain organic nutrients and trace elements such as sugar and cellulose, and some incomplete medicinal ingredients still remain in the medicinal residues, resulting in a great waste of resources.

2.1.1.1 Plant pharmaceutical residue ingredients

According to the statistics of the national survey of traditional Chinese medicine resources, plant drugs account for the largest proportion, accounting for about 87% of the total number, so plant drug residues are the main source of drug residues [1] .Its main components are cellulose, hemicellulose, sugar, organic matter, lignin and trace elements. Many scholars have explored the organic components of plant medicinal residues such as licorice, notoginseng, schisandra schisandra and salviorrhiza. For example, Huangin et al. [2] pointed out that the main components of Astragalus medicinal residues are cellulose, hemicellulose, protein, soluble reducing sugar, and flavonoids, saponins, amino acids and other compounds are the main effective components.

2.1.1.2 Ingredients of animal and mineral drug residues

Animal and mineral drug residues account for a relatively small proportion, of which animal drug residues are mostly animal residues after animal drug processing, the main components are protein, monosaccharides, calcium carbonate, etc., most of which also contain fat. Microorganisms can be used as soil cementing agent after decomposing animal organs and muscle tissues in the residue[1]. The composition of mineral drug residues is similar to that of the drugs themselves, and the vast majority of them are solid inorganic compounds and their elemental elements.

At present, there are few researches on mineral and animal drug residues, most of which are aimed at plant drug residues, but there are also problems such as lack of basic research and lack of systematic research on the composition of drug residues.

2.1.2. Research on composting of Chinese medicinal residue

As a resource with reuse value, Chinese medicinal residue is rich in nutrients, has a large number of highly active chemical components, and can improve the permeability of soil, and can be used as a high-quality organic fertilizer in planting industry. For Chinese medicine residue with large output, composting treatment has less side effects on medicine residue, fast fermentation speed and more convenient operation, so composting treatment of Chinese medicine residue is more and more respected by people. Xu Kaige et al[3] . carried out compost fermentation treatment on medicinal residues of different medicinal parts, such as leaf Perilla, whole grass mint, stem wood mulberry branch, etc. The test results showed that the total nutrient contents of medicinal residues of different medicinal parts after fermentation were in line with Chinese agricultural industry standards. Dai Jing[4]studied the medicinal residue of the stems and leaves of Fritillaria fritillaria and found that its organic matter content was as high as 88.23%, much higher than the 30% stipulated in the organic fertilizer standard. The reasonableness and effectiveness of the reuse of composting by fermentation of traditional Chinese medicine residue were proved.

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2.1.2.1 Compost microorganism

Microbial fermentation is the main process of composting of Chinese medicine residue, and the fermentation effect is different with different strains added, so selecting the right strains is the key in the composting process of Chinese medicine residue. Yin Chenqian et al. [5]conducted composting experiments of herb residues in Bacillus subtilis, Trichoderma corningensis, EM bacteria and non-added bacteria groups. By comparing the changes in physical and chemical properties such as temperature, PH and EC during the composting process, they concluded that the addition of bacteria strains could accelerate the growth and propagation of microorganisms and promote the temperature rise and maturation of the pile.

2.1.2.2 Composting parameters of pharmaceutical residues

Microorganisms play a key role in the composting process, so creating an environment suitable for microbial growth and metabolism can improve composting efficiency and composting quality. Ren Lili[6]proposed that the optimum fermentation efficiency of composting Chinese medicinal residue was achieved when the water content was 55%, the carbon to nitrogen ratio was 30:1, and the turning frequency and water replenishment frequency were 7d/ time.Based on the single factor experiment, Feng Long[7] investigated the interaction between various factors and determined that 65% water content, 30:1 carbon to nitrogen ratio, pile turning frequency 4d/ time, and 3.5‰ strain inoculation amount were the best technological parameters of residue fermentation.

2.2. Development direction, existing problems and solutions

Although the drug residue has a wide range of application fields, it mostly belongs to the extensive and low value resource mode at present. We should change the thinking and improve the technology, so that the utilization value or potential utilization value of pharmaceutical residue fermentation can be effectively excavated and fully utilized, and rise to the transformation and efficiency enhancement resource mode, or even the fine high value resource mode. Firstly, Mixed fermentation composting technology enables anaerobic fermentation. Xi[8] et al. studied the effects of different Chinese medicine residue additives on fermentation biogas, and the addition of 10% Panax notoginseng increased the yield of biogas and methane by 28% and 37%, respectively, showing that the addition of Chinese medicine residue had a positive effect on anaerobic co-digestion and reduced the pollution of organic matter. Secondly, the organic fertilizer produced by the mixed fermentation compost of pharmaceutical residues is rich in nutrients, which can provide nutrients required for plant growth and improve soil fertility. This helps to improve the soil structure, increase the soil's ability to retain water and fertilizer, and improve the yield and quality of crops. For example, Zhou Yuping et al. [9]added different concentrations of fermented Chinese medicinal residue (1%, 5% and 10%) into the soil of wheat seedlings, and found that the emergence rate, plant height, dry and wet weight were significantly improved compared with blank soil. Fermented Chinese medicinal residue as an organic fertilizer could significantly promote the growth of wheat seedlings. In addition, the mixed fermentation composting technology of pharmaceutical residues can also promote the sustainable development of agriculture. Through rational utilization of pharmaceutical residue resources, the dependence on chemical fertilizers and pesticides in agricultural production process is reduced, and the cost of agricultural production is reduced. At the same time, the use of organic fertilizers also reduces the risk of pollution to groundwater and water bodies, and protects the health of the ecological environment.

At present, the research on the application of Chinese medicine residue shows that it has great utilization potential. The fermentation technology can improve the nutritional and medicinal components of Chinese medicine residue to a certain extent, and reduce the anti-nutritional components, which provides a useful reference for the resource utilization of Chinese medicine residue in the future. However, at present, the fermentation technology of Chinese medicine

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residue is still in the initial stage, and there are still many problems to be solved. First of all, although the relatively large amount of Chinese medicine residue produced by large-scale pharmaceutical factories has the potential of resource utilization; However, due to the characteristics of TCM compounds, most of the raw materials are mixed decoctions, resulting in complex composition of Chinese medicine residue. Even the same medicinal material in compatibility will vary greatly in the content of components due to different places of origin. The composition and characteristics of Chinese medicine residue produced by different proprietary Chinese medicine production are different. Secondly, the control of fermentation process is the key issue. For example, Liu Qian et al. [10]found that fermentation days affected the quality of pharmaceutical residues in fermentation; Xu Kaige et al. [3]found that there were obvious differences in the temperature variation characteristics of different residues of mulberry branch, Perilla leaves, peppermint and composite residues during the fermentation process. When the mechanism of active substances in Chinese herbal residues is not clear, it is necessary to ensure suitable conditions such as fermentation temperature, humidity and ventilation to promote the growth and metabolic activities of microorganisms, so as to promote the degradation and transformation of organic matter.

In order to solve the above problems, it is necessary to carry out from the following two aspects, on the one hand, improve the recycling system, improve the local incentive policy on the recycling classification of organic solid waste such as Chinese medicine residue. On the other hand, it relies on the research results of universities and scientific research institutions to optimize and improve key technology processes, strengthen the research on the active ingredients of pharmaceutical residue fermentation, and relevant scientific research departments and large pharmaceutical enterprises to carry out joint fixed-point experiments, and determine reasonable resource utilization methods according to the physical and chemical properties of Chinese pharmaceutical residue, such as non-toxic and nutrient-rich Chinese pharmaceutical residue as feed or fertilizer. The solution of the above related problems will promote the industrialization development and utilization of fermented pharmaceutical residues.

3. Cultivation of algae crust in Artificial soil

3.1. Introduction to algae crust in artificial soil

Soil algae are an important part of the soil microbial community. The application of active microalgae as biofertilizers in soil can promote soil nutrient cycling. As primary producers, soil algae play an important role in soil ecosystem. The growth and development of soil algae can increase the solubility of phosphate, promote mineral release, continuously improve soil fertility, and help rebuild microbial communities[11].

Biological soil crust is a surface stable complex formed by crypto-plants such as algae, lichens, moss, and microorganisms in soil such as bacteria and fungi cementing with soil surface particles through mycelium, rhizoid, and secretions. It is a common community structure in desert ecosystems, and has many important ecological functions such as wind prevention and sand fixation, hydrological regulation, and soil nutrient increase[12].

However, the natural succession of biological crusts to advanced stages can take decades or even thousands of years. The important reason for the difficult formation of crust is that the biological components of early crust lack stable carrier attachment. Biological soil crust needs to undergo cumulative rain impact to form a physical crust with high clay and silt content on the sand surface, and then bacteria, fungi, actinomyces and cyanobacteria can colonize and form algal crust[13].

Compared with biological soil crust, the formation time of artificial soil algae crust was greatly shortened. Artificial soil algae crust using artificial biological algae crust technology, to promote

the maintenance and survival of soil algae, accelerate the formation of surface biological crust, improve the solubility of phosphate, improve soil fertility, is an effective treatment of salinized land new technology.

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With the rapid development of artificial soil algal crust technology, the research and development continue to deepen, the application range is more extensive, and the mode of action tends to be diversified. In terms of application scope, artificial soil algal crust technology can promote the restoration of salinized land and complete the construction of sandy surface soil. In terms of mode of action, artificial soil algal crust technology can delay the evaporation of soil surface water and prevent the accumulation of salt on the surface along with the upward migration of pore water. Salt content can also be reduced by producing extracellular polymers to chelate salt ions in soil.

The scope and mechanism of action of artificial soil algal crust are constantly enriched, but there are also shortcomings in the development, which need to be improved constantly. The research scope of artificial soil algae needs to be further expanded, the research on lichen and moss is vacant, and the comprehensive impact of artificial soil algae crust on soil microorganisms and various physical and chemical properties has not been studied in detail. Seasonal detection of artificial soil algae crust will also help to better promote the recovery of soil function.

3.2. Application and prospect of artificial soil algal crust

3.2.1. Application of artificial soil algal crust technology

Desertification is one of the main types of desertification, which refers to the land degradation mainly marked by wind-sand activities in arid, semi-arid and partly sub-humid areas caused by the incongruous relationship between man and land[14] . Our country is one of the most serious countries affected by desertification in the world, the rate of land desertification development is speeding up. For a long time, afforestation and grass planting are the main ways of desert management in our country, and some results have been achieved in the long-term practice. However, afforestation and other traditional methods for desertification control are sometimes difficult to achieve the desired effects and objectives. Through field investigation, it is found that there are abundant algae species resources in desert areas in China. Moreover, the related research results of biological crust provide a new idea for desertification control - artificial soil algae crust technology came into being. The researchers isolated and purified the unique filamentous cyanobacteria from the biological soil crust in desert areas, and cultivated them in large quantities through engineering measures, and then sprayed and inoculated them on the surface of mobile dune (ground) to form artificial biological soil crust. The technology of artificial soil algae crust provides a new way of low cost and high benefit for the control of desertification in desertification areas, which plays the role of "sand fixation, dust suppression, soil formation, fertilizer and ecological restoration". Researchers have carried out experiments in different types of sandy lands and deserts in Inner Mongolia, Qinghai, Xinjiang and other places, and have implemented nearly 60,000 mu [15]. After the application of this technology in

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Kubuqi Desert in Dalat Banner, Inner Mongolia Autonomous Region, the landscape of the sparsely forested grassland was restored[15].

This technology makes up for the lack of understanding that the role of lower plants is neglected in the current desertification control in China, and is the first technology at home and abroad to restore desertification land. The panel suggested that the application of the technology be included in China's strategic planning for desertification control, ecological civilization construction and sustainable development.

3.2.2. Prospects and Prospects of Artificial soil algae crust

As a new means of desertification prevention and control, artificial soil algae crust technology needs to be further developed and improved through scientific research and production practice in the process of desertification control, and it also needs to be continuously optimized and innovated in some key links. For example: ①How to break through the technical bottleneck, quickly cultivate biological soil crust inoculation organisms, explore the best method of field colonization, and finally realize the large-scale application of biological soil algae crust technology. ②How to select and breed fine algae seeds and what proportion of algae seeds is better for desertification control. ③How to realize the innovation of vaccination technology. ④How to maximize the efficiency of artificial soil algal crust technology.

According to statistics, 176,000 square kilometers of land has been desertified in China, and 158,000 square kilometers of land is potentially at risk of desertification. According to the data of Lanzhou Institute of Desert Research of Chinese Academy of Sciences, from 1950s to 1970s, the desertification rate of land increased by 1560 square kilometers per year; From the 1970s to the 1980s, the rate of increase has been 2100 square kilometers per year; It is now expanding to 2,460 square kilometers per year. At present, about 60 million mu of farmland in China is under threat of desertification. Although some local areas of land desertification has been effectively curbed or improved, but in general, China's land desertification is still accelerating the expansion and spread. When combined with deserts and the Gobi, it is 1.533 million square kilometers, almost 16% of the country's land area . It can be seen that the task of desertification prevention and control is very urgent in the utilization and remediation of land. In the desertification control system, China combines the artificial soil algal crust technology with the traditional biological sand control technologies such as sealing, flying, afforestation and biological sand barrier, forming a multi-level and multi-directional artificial vegetation coverage of algal, grass, irrigation and grass, which is conducive to strengthening the overall stability of the protection system and improving the effect of sand fixation and resisting wind erosion and sandstorms. The technology of artificial soil algae crust in desert has enriched the technical theory of desertification control in China, and improved the technical level and ecological benefits of comprehensive desertification control. With the development and innovation of artificial soil algae crust technology, it will have a broader application prospect in desertification control in China and even in the world.

4. Conclusion

Using traditional Chinese medicine waste residue as the main raw material, the organic fertilizer prepared by mixing and fermentation has the advantages of promoting crop yield, improving crop quality, enhancing crop disease resistance and stress resistance, and improving the economic benefit of soil. The full utilization of medicine residue is conducive to reducing garbage removal, landfill, saving waste disposal costs, and reducing the cost of treatment of traditional Chinese medicine waste residue in hospitals, pharmaceutical enterprises and pharmacies. The medicine residue mixed composting technology described in this paper to restore saline-alkali land to improve the ecological environment as the core, to build an industrial chain as the starting point, to share co-governance operating mechanism as the

guidance, will walk out of a new path of ecological governance, ecological, economic and social benefits to win a new situation, will become a saline-alkali desert beach green water and green water and green mountains into a vivid practice.

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