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Effect of aerobic composting on antibiotics and microbial community in livestock manure

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Abstract

The livestock and poultry breeding industry often uses heavy metals and antibiotics as the main feed additives to reduce the incidence of diseases and improve feed utilization. Due to the limited intestinal absorption of livestock and poultry, a large amount of heavy metals and antibiotics and their metabolites remain in the feces of livestock and poultry. Aerobic composting is one of the main means to realize the recycling and harmless utilization of agricultural waste, and it has a significant effect on the content of antibiotics and the form of heavy metals in livestock and poultry manure. In addition, the aerobic composting process is to achieve the degradation and utilization of complex organic substances with the participation of multiple microorganisms (such as bacteria and nitrogen cycle function microorganisms). The microorganisms that play a dominant role in different stages are quite different, and the different raw materials will also affect The community structure of microorganisms, therefore, this article describes the impact of aerobic composting on the harmless treatment of livestock and poultry manure, and proposes that the future research direction should focus on microorganisms.

Keywords

Microbial community, antibiotics, livestock manure.

1. Antibiotics and heavy metals in livestock and poultry manure

Animal husbandry is an integral part of our country's agriculture and an important industry for developing rural economy and increasing farmers' income. Intensification and large-scale aquaculture are important means for its rapid development, which has caused a large amount of livestock and poultry manure to become the environment. According to the data in 2019, my country's livestock and poultry manure waste has reached 3.19 billion tons in one year [1]. The reasonable disposal of these large amounts of agricultural waste is a problem that we need to solve as soon as possible. problem. At the same time, by adding a large amount of targeted heavy metals and antibiotics to feed to reduce the prevalence of livestock in the breeding process and speed up growth, it is a common method in modern breeding industry. For example, adding Cu can improve the utilization efficiency of feed, adding Zn can alleviate the symptoms of piglet diarrhea, adding chlortetracycline, oxytetracycline, sulfamethazine and other antibiotics, for some common infectious diseases in the breeding process, etc. Have a better preventive effect.

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The amount of antibiotics added to the feed of farms is also huge. Data in 2006 showed that the use of antibiotics in the aquaculture industry accounted for 54% of the total amount of antibiotics used throughout the year, reaching 97,000 tons. Like heavy metals, these antibiotics will also be excreted from animals with feces, including the original antibiotics and their metabolites. The survey results of antibiotics in the feces of livestock and poultry in Tianjin City and Liaoning Province in my country show that the maximum residues of three different types of antibiotics, chlortetracycline, sulfamethazine, and ciprofloxacin, in feces are 124.6, 9.4 and 10.1, respectively. mg/kg, nationally, the average content of oxytetracycline, tetracycline and chlortetracycline in pig manure is 9.1, 5.2 and 3.6 mg/kg, respectively, and the average content of oxytetracycline, tetracycline and chlortetracycline in chicken manure They are 6.0, 2.6 and 1.4 mg/kg respectively.

2. The effect of aerobic composting on antibiotics and heavy metals

Aerobic composting is the main way for the harmless treatment and resource utilization of livestock manure. High concentrations of antibiotics will inhibit the activity and quantity of microbes in the pile, and the compost product will have residual antibiotics, which is not conducive to the harmless treatment and resource utilization of livestock manure. use. Aerobic composting is a possible way to eliminate antibiotic contamination in livestock and poultry manure. Guo Mengting (2012) and Wang Guizhen (2013) have shown that oxytetracycline reduces the temperature rise rate of the pile and shortens the high temperature period of composting[2-3]. Li Weihua (2013) research shows that antibiotics can inhibit the metabolism rate of lignin, cellulose, hemicellulose and other substances by microorganisms[4]. The study by Pan Xun et al. (2013) showed that changes in the temperature of the pile have a greater impact on the removal of antibiotics, and the removal efficiency of antibiotics also increases as the temperature rises and the time of the high-temperature greenhouse increases[5]. The study found that the degradation rate of tetracycline after composting is 70%, and its degradation products mainly include ETC and ATC. Shen Dongsheng (2013) obtained oxytetracycline degradation bacteria TJ-1 through screening, and inoculation with TJ-1 can significantly increase the degradation rate of oxytetracycline from 62.7% to 82.0%[6].

In the process of aerobic composting, the form and proportion of heavy metals are closely related to the reduction of organic matter and the production of humus and other high-molecular substances. Some scholars have shown that the total amount of heavy metals in pig manure has increased after 122 days of composting, and found that the increase is mainly concentrated in the initial stage of composting, which is related to the rapid decomposition of organic matter. The total amount of heavy metals (Cu, Mn, Zn) in the decomposed compost product has increased by about 3 times. The analysis may be due to the decrease in the water content of the pile during the composting process, the rapid degradation of organic substances, and some volatile substances Loss, which causes the total mass of the stack to decrease, thereby increasing the concentration of heavy metals to a relative extent. So far, most scholars have focused on the changes of heavy metals in the composting process. The acid extraction state of Cu after pig manure composting is reduced by 9.2%, the reducible state is reduced by 17.2%, and the acid extraction state of Zn is reduced by 17.4 %, the reducible state is reduced by 29.1%, and the residue state and oxidizable state are significantly increased. The four movable forms of Cu, Zn, and Pb in the sludge composting process are all reduced to varying degrees, and yes, their toxicity in the compost product is also significantly reduced. The above research results can prove that aerobic composting can effectively reduce the toxicity of heavy metals in composting raw materials, and the product safety is guaranteed to a certain extent.

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3. The main types of bacteria in aerobic composting

Bacteria play an important role in the degradation of organic substances such as protein, cellulose and toxic compounds in livestock and poultry manure during the composting process. Studies have shown by scholars that when the temperature of the aerobic composting body is continuously higher than 40℃ When the temperature is between 50-60℃, some organic substances will undergo high-efficiency and high-speed biological oxidation processes in the stack. The degradation efficiency of the organic substances in the stack is the highest when the temperature is between 50-60°C. In the heating phase of composting, the types of bacterial communities are the most abundant, and there is no obvious dominant bacteria category. In the high temperature phase, there will be obvious dominant bacteria, which are the microorganisms that play a major role in the high temperature period. When the temperature reaches the cooling phase, the bacteria The overall community structure has basically reached a stable state, which indicates that the temperature during the aerobic composting process has a significant influence and selectivity on the succession of the bacterial community structure in the pile.

The main predominant flora of the pile in the high temperature stage is thermophilic anaerobic cellulose degrading bacteria, most of which belong to the genus Bacillus and Clostridium. The optimum growth temperature for Bacillus is 50 ℃-74 ℃, It can strengthen the degradability of hard-to-degrade organic substances in the pile in the high temperature stage, and improve the efficiency of aerobic composting. In recent years, with the popularization of detection methods, high-throughput sequencing technology has gradually been applied to the analysis of aerobic composting microbial community structure. Some research results have shown that Bacteroidetes and Proteobacteria are composts. Among the most abundant bacteria in each stage, Actinobacteria only plays a leading role in the high temperature stage of composting. Other scholars have found that Proteobacteria can be significantly enriched in compost samples with a pile temperature of ≤50 ℃, Bacillales, Actinomycetales, Thermobifida and Clostridium Clostridia was significantly enriched in compost samples ≥55 ℃. Based on high-throughput sequencing analysis of the changes in bacterial communities at different stages of composting, the results showed that there were significant differences in the composition of bacterial communities between the warming stage and the maturity stage of composting.

4. Conclusion

Aerobic composting is an important way of harmless treatment and resource utilization of livestock manure with the participation of a variety of microorganisms (such as bacteria and nitrogen cycle function microorganisms). Aerobic composting can remove more than 70% of antibiotics in feces, and the removal rate can reach more than 90% through some additives or prolonging the high temperature period.

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