Journal of Earth Sciences and Geotechnical Engineering, vol. 4, no. 3, 2014, 131-136
ISSN: 1792-9040 (print), 1792-9660 (online)
Scienpress Ltd, 2014

Comparing of Aerobic and Anaerobic Composition of Water Spinach Residual from Floating Plantation

Yu Xiao-Mei[1], Li Zhaohua[1], Chen Hongbing[1], Kang Qun[1], Li Yanqiang[1], Ye Jing[1], Zhao Sha[1], Miao Jifa[1], Wang Simeng[1] and Yi Chenghao[1]

Abstract

This study was conducted to find out a new way to treat plant residuals from flotation bed plantation. Compost comparison tests were given to water spinach from floating beds with three different conditions in terms of aerobic condition, anaerobic condition and semi-aerobic condition. After four months of composting, results are as follows: the process of composting in aerobiotic group was the fastest, but moisture content in aerobiotic group was the lowest. The composting weren't happened in semi-aerobic condition. The concentration of N, P, K in aerobiotic condition were 0.77%, 0.58%, 0.87%, respectively. The concentration of N, P, K were 1.16%, 0.86%, 1.13% in anaerobic condition. While the concentration of N, P, K were 1.11%, 1.33%, 0.64%. Results show that the aerobiotic group has the highest nutrition loss. The suitable oxygen control and time control can result a better effectiveness in composting.

Keywords: Water Spinach from Floating Beds Composting Nitrogen Phosphorus Potassium

1 Introduction

Floating-beds system is an ecological remediation technology developed during the last century. Plants are fastened to the floating carriers. By the assimilation of plants and microbial around the roots, water can be purified. And the N, P, K in eutrophic water were absorbed and used by plants[1]. Annual herbaceous were the most common plants in floating-beds system. This kind of plant can grow fast and have a good effect of purifying at the same time. While the problem is that the plants should be harvested or removed in time, otherwise the N, P, K in plants would return into the water by the fallen leaves. It will cause a second pollution.

The harvested plants can be eaten as food or used as raw material of feed. While they

[1]Correspondence Author, School of Resources and Environmental Science, Hubei University, Wuhan 430062This research was supported by "Chinese National Program of Science and Technology for Human Livelihood (No. S2013GMD100042)".

were usually discarded as rubbish. Therefore this study was conducted to search a better way for the harvested plants from floating beds. Composting the harvested plants instead of discarding can harmlessly treat the plants and enrich the soil at the same time.

2 Materials and Methods

2.1 Materials

As the most used plants in floating beds, water spinach was chosen in this composting experiment. Physical and chemical properties of the water spinach had been tested before starting the experiment (result in table 1).

Table 1: Physical and chemical properties of experimental materials

	moisture content%	N%	P%	K%`
Concentration	89.9%	2.02%	1.60%	0.74%

2.2 Method

The experiments were conducted from December 2ed, 2012 to March 1st, 2013, in three different composting conditions: aerobiotic condition, anaerobic condition and semi-aerobic condition[2]. In the aerobic group, the experimented plants were maxed with soil ventilated on a regular basis to ensure the oxygen content. In the anaerobic group, the experimented plants were sealed in a container for composting after sprayed water. In the semi-aerobic group, the experimented plants were composed in water. During the four months of composting, the physical changes were observed and recorded. After the experiment, some kinds of physical properties and chemical properties were tested and analyzed.

2.3 Analysis

After the four months of composting, the plants in three groups were dried and pulverized for further analyzed.
Moisture content: the sample were dried to constant weight of 0.1g under 105℃for 24h.
Total nitrogen: Kjeldahl determination.
Total phosphorus: vanadium molybdate yellow colorimetric method.
Available kalium: flame photometry[3].

3 Results and Discussion

3.1 The Changes in Soil Physical Properties

After 10 days of composting, the plants in three groups softened blackened. The plants began to decompose and accompanied by the smell after 15 days. One month later, a white mycelium developed on the surface of the plants in aerobic group. And the smell started to reduced. While the smell was still strong in the anaerobic group and semi-

aerobic group. Two months later, the plants in aerobic group were covered with white mycelium and the smell was gone. Meanwhile there were white mycelium in anaerobic group. After three months, the plants in aerobic group were decomposed into fiber fines. The plants in anaerobic group were covered with white mycelium. While the semi-aerobic group was still stink. Four months later, the plants in aerobic group almost decomposed into brown earth. And there were fiber fines in anaerobic group. In the semi-aerobic group, plants decayed in water and there was no composting processing in this group. To explain the phenomenon, it was because that the percentage of oxygen was high in the aerobic group, and the microbes can propagated quickly to quickened the composting[4]. The anaerobic group was in isolation. The percentage of oxygen was low. Therefore, the composting was slower than in the aerobic group. The plants in semi-aerobic group were soaked in water, The moisture content is too high for the microbial growth. The plants decayed without composting.

3.2 Moisture Content

Moisture content is an important factor for composting. To keep moisture be suitable is prerequisite. As most of the microbe doesn't have the ability of water retention, they are water sensitive. Organic matter swells and softens after absorbing water. It will be easier for microbe to decompose. As the water movement contributed to the microbe diffusion, the composting can be evenly and fast. Simultaneously, the solutes in water supplied microbe with nutrient. The water also has an impact on temperature regulation and ventilating in composting. Too little water would limit the movement of microbe. Too much water would block the gaps between the plants and cause deficiency of oxygen. The moisture content was tested before and after the experiment. The results were shown below in table 2.

Table 2: water-cut trend

moisture content	aerobic a（%）	aerobic b（%）	aerobic c（%）	anaerobic a（%）	anaerobic b（%）	anaerobic c（%）	semi-aerobic a（%）	semi-aerobic b（%）	semi-aerobic c（%）
Before	90.3	89.2	91.2	88.9	90.1	88.5	91.3	89.9	89.7
After	75.99	83.21	68.71	80.47	74.25	75.59	93.31	94.36	93.27

As shown in table 2, the moisture content reduced by 16% in aerobic group, dropped 14% in anaerobic group. While in the semi-aerobic group the water content increased 4%. The different variations attributed to the different composting conditions. The water-cut trend in aerobic group and anaerobic group had a simple change. The reason may be that the water content in tested plants was high before the experiment. And the stem in plants had abilities of water retention. Therefore the reduction of water content in the two groups was not big[5]. For the semi-aerobic group, the water content had a little increase because of that the plants were soaked in the water.

3.3 Analysis of Total Nitrogen Content

In the composting process, there were two aspects in nitrogen transformation, including fixation of nitrogen and nutrient release. The conversion process of nitrogen transformation is consisted of ammonification, Nitrification, SND, biological nitrogen fixation and volatilization[6]. Different raw materials have different characteristic in nitrogen transformation. Generally, the nitrogen loss is inevitable in the composting process. This is due mainly to the N mineralization and ammonia volatilization. Denitrification of Nitrate Nitrogen also plays an important role in nitrogen loss.

Researchers have tested the total nitrogen content in experimental plants. Results are shown in table 3.

Table 3: Total nitrogen content

Total nitrogen content	aerobic a（%）	aerobic b（%）	aerobic c（%）	anaerobic a（%）	anaerobic b（%）	anaerobic c（%）	semi-aerobic a（%）	semi-aerobic b（%）	semi-aerobic c（%）
Before	2.01	1.96	1.82	2.19	2.21	1.98	2.16	1.88	2.03
After	0.8714	0.8162	0.6255	1.1189	0.8309	1.3802	1.4123	1.4205	1.1523

From table 3，the total nitrogen content had a reduction of 50.2% in aerobic group. In the anaerobic group the loss rate was 47.2%. The content of nitrogen in semi-aerobic group reduced 34.1%. The aerobic group had the highest loss rate. It was caused that the large ventilation can speed up volatilization ammonia volatilization rate. While in the anaerobic group, the oxygen content was low, leading to weak activity of bacteria[7]. The plants in semi-aerobic group decomposed in water. A part of nitrogen dissolved into the water. It can result nitrogen loss.

3.4 Analysis of Total Phosphorus Content

Phosphorus is an essential plant nutrients. Phosphatic fertilizer is one of the most important organic fertilizer in China. The phosphorus content in 75% of the soil was deficit[8]. Composting is an effective method to transfer the phosphorus of plants into soil. It can not only improve the fertilizer of soil, but also another way for straw hazard-free treatment.

The change of phosphorus content was shown in table 4. The experimental data showed that the phosphorus content reduced to some extent. The phosphorus content in aerobic group reduced 65%. In the anaerobic group the content had a reduction of 47%. In the semi-aerobic group the loss rate was 18%. The loss rate in aerobic group and anaerobic group was similar. It was because that the bacteria decomposed the Organophosphates into soluble phosphorus. And it can be absorbed by soil[9]. In the semi-aerobic group, phosphorus loss was mainly caused that the phosphorus dissolved into water with the decay process of the plants.

Table 4: Total phosphorus content

Total phosphorus content	aerobic a（%）	aerobic b（%）	aerobic c（%）	anaerobic a（%）	anaerobic b（%）	anaerobic c（%）	semi-aerobic a（%）	semi-aerobic b（%）	semi-aerobic c（%）
Before	1.59	1.54	1.55	1.66	1.62	1.55	1.69	1.60	1.58
After	0.72	0.62	0.59	0.74	1.06	0.78	1.35	1.38	1.27

3.5 Analysis of Available Kalium

Available kalium is an important evaluation index of fertilizer efficiency. The available kalium content of three groups were displayed in table 5. In the aerobic group the available kalium content increased by 12%.the content in anaerobic group had a increment of 32%.while in the semi-aerobic group the available kalium content reduced by 17%. In the aerobic group and anaerobic group, other forms of kalium had decomposed into available kalium during a long composting process[10]. In the semi-aerobic group, the kalium dissolved into the water and result to kalium loss.

Table 5: Available kalium content

Available kalium content	aerobic a（%）	aerobic b（%）	aerobic c（%）	anaerobic a（%）	anaerobic b（%）	anaerobic c（%）	semi-aerobic a（%）	semi-aerobic b（%）	semi-aerobic c（%）
Before	0.7100	0.7600	0.8100	0.7300	0.7000	0.7410	0.7300	0.8000	0.6900
After	0.7810	0.8510	0.9790	0.8498	1.5175	1.0132	0.6127	0.5785	0.7340

4 Conclusion

After four months of composting , the aerobic group and anaerobic group have composted completely, while the semi-aerobic group failed. The aerobic group had the fastest speed of composting and the most nutrient losses. The anaerobic group composted slowly and had the highest concentration of available kalium. The plants in semi-aerobic group decayed in water. It is recommended the composting by water spinach from floating beds is feasible. It should be noted that suitable ventilation quantity should be ensured to speed up the composting and reduce the nutrient losses[11].

References

[1] Song Xiangfu, Zou Guoyan, Wu Weiming. Study on the Removal Effect and Regulation of Rice Plants on Floating-bads on Main Nutrients N and P in Eutrophicated Water Bodies. Acta Scientiae Circumstantiae, 1998, **18**(5):490-494.

[2] Wang Gehua. The Main Routes of Realizing Straw Resource Reuse. Shanghai Environmental Sciences, 2002.11:37-40.

[3] The Ministry of Agriculture of the People's Republic of China. Agricultural industry standard of the People's Republic of China (NY525-2002). Beijing, 2002.

[4] Shen Qirong, Wang Ruibao,Wang yan. Biochemical Characteristics of Composting. Journal of Nanjing Agricultural University, 1997, **20**(2):51-57.

[5] Zhai hong, Zhang Yanlin, Ai ping, Li Shanjun, Yan Shuiping,Wang Yuanyuan. Effects of Different Initial Moisture Content on the Composting Process of Biogas Residue and Straw. Hubei Agricultural Sciences, 2011, **11**:43674360.

[6] Zhou Shaoqi, Li Duan. Mechanism of Nitrogen Loss and Technique for Nitrogen Conservation in Composting of Sludge. Soils, 2003, **35** (6): 481-484.

[7] Wei Yuansong, Li Chengqiang, FanYaobo. Effect on Sewage Sludge Composting with Different Aeration Modes. Environmental Science, 2001, **22**(3):54-60.

[8] Zhang Yongsong, Lin Xianyong, Luo Ancheng. Organic Acids from Decomposition of Organic Manure (matter) and Their Effect on Activation to Different Artificial Phosphate[J]. Plant Nutrition and Fertilizer Science, 1998, **4**(2):145-150.

[9] WVB. Sundara Raoand and MK. Sin ha, Phosphate dissolving microorgamisms in the rhizosphere and soil. India J. Agric. Sci, 1963, **33**(4):272-278.

[10] Kuang Shizi, Li Chunyun, Tian Shiyao, Yi Ganjun, Liu Chuanhe. Composting Impact on Banana Pseudostem and Chicken Manure. Journal of Agro-Environment Science, 2011, **30**(3):591-598.

[11] Li Chengqiang, Wei Yuansong, Fan Yaobo. Advances in Study of Compost Maturity. Advances in Environmental Science, 1999, **7**(6):1-12.