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Effect of composting on the removal of semivolatile organic chemicals (SVOCs) from sewage sludge

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ABSTRACT

In order to investigate the occurrence and removal of semivolatile organic chemicals (SVOCs) in the compost of sewage sludge, three different composting treatments, including manual turned compost (MTC), intermittent aerated compost (IAC), and naturally aerated compost (NAC) were conducted. Thirty SVOCs in composts were Soxhlet-extracted and analyzed by GC/MS. After 56 days of composting, the total concentrations of 16 polycyclic aromatic hydrocarbons (∑PAHs) ranged from 0.55 to 8.20 mg kg^{-1} dry weight, decreasing in order of IAC > MTC > NAC. The total concentrations of six phthalic acid esters (∑PAEs), five chlorobenzenes or three nitroaromatic compounds were less than 5.0 mg kg^{-1}. Compared with the initial concentrations in sewage sludge, a significant reduction of ∑PAHs, ∑PAEs and chlorobenzenes was observed. The removal rates of ∑PAHs and ∑PAEs ranged from 54.6% to 75.9% and from 58.3% to 90.6%, respectively. Compared with different composting processes, MTC showed the highest potential for removal of SVOCs.

1. Introduction

Sewage sludge is an inevitable by-product of the process in wastewater treatment plants. The amount of sludge increases in proportion to the number and capacity of sewage treatment facilities in the world (Pathak et al., 2009). The current main disposal routes for sludge include incineration, sanitary landfill, or use in agriculture. The land application is considered as a potential way because it recycles both organic matter and nutrients. However, sewage sludge contains heavy metals and organic contaminants including polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (Katsoyiannis and Samara, 2005; Harrison et al., 2006; Cai et al., 2007a; Khadhar et al., 2010). The levels of some compounds exceeded the maximum permissible concentration proposed by the Europe Union for land application (Cai et al., 2007a).

Composting sewage sludge is a potential alternative to recycling waste, and it has been conducted with various additives such as rice straw, sawdust (Cai et al., 2007b; Himanen and Hänninen, 2011). For example, Wong and Selvam (2006) studied chemical speciation of heavy metals and their availability in sewage sludge co-composted with lime (sawdust as a bulking agent). In the literature, sawdust has been proven to be a good bulking agent for sludge composting. However, very few studies had focused on the occurrence and the removal rates of organic contaminants in the co-composting of sewage sludge with sawdust. Therefore, the aim of this work was to investigate the effects of co-composting of sewage sludge with sawdust on the occurrence and the removal rates of organic contaminants.

2. Methods

2.1. Composting

Dewatered sludge was collected from Zhen'an wastewater treatment plant (domestic sewage:industrial sewage, 9:1) in Foshan, Guangdong Province (defined as Foshan sludge) and Beishiqiao wastewater treatment plant (domestic sewage:industrial sewage, 4:6) in Xi'an, Shanxi Province (defined as Xi'an sludge), China. Foshan sludge and Xi'an sludge contained organic carbon of 205 and 144 g kg^{-1} d.w., total nitrogen of 29.6 and 15.2 g kg^{-1} d.w. (C/N ratio: 6.92/1 and 9.47/1), and the moisture content of 80.7% and 81.0%, respectively. Sawdust (<5 mm) was collected from Guangzhou Baiyun Greening Nursery Company, Guangzhou. It contained organic carbon of 370 g kg^{-1} d.w., 18.9 g N kg^{-1} d.w. (C/N ratio: 19.6/1), and the moisture content was 12.2%.

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