Emissions of ammonia and greenhouse gases during the vermicomposting of duck manure

Jinzhi Wang, Binghui Zheng, Xia Jiang, Hui Yu, Kun Wan

State Key Laboratory of Environmental Criteria and Risk Assessment, Chinese Research Academy of Environment Sciences, Beijing 100012, China

The reed wetland of Baiyangdian catchment in China is an important duck farm base with about 8 million ducks, which produces more than 213,300 tons manure each year. Most of the duck manure ends up in the water system, causing eutrophication of surface water. Combined traditional composting and vermicomposting has shown potential for reclamation of solid wastes. However, disposal of poultry manure inevitably involves emissions of ammonia (NH_3) and greenhouse gases (GHGs), including nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2), which contribute to global warming. Deposition of emitted NH_3 and N_2O in aquatic and terrestrial systems can cause eutrophication and acidification. Emissions of NH_3 and GHG also decrease the quality of end-products as fertilizers. Therefore, there is a need to develop the practical technologies to mitigate NH_3 and GHGs emissions. In this study, we firstly investigated the influence of different amendments on emissions of NH_3 and GHG during the storage of duck manure from a duck farm in Baiyangdian, Hebei province to select the optimal amendments for the reclamation of duck manure. Subsequently we compared emissions of NH_3 and GHGs in two systems for the disposal of duck manure in order to develop a sustainable technique.
We firstly tested the single and combined effects of addition of reed straw, zeolite, and superphosphate on the emission of NH_3 and GHG emissions from stored duck manure. The results showed that reed straw and/or zeolite can be recommended as amendments to reduce GHGs emissions during the storage of duck manure; however, superphosphate is more effective in reducing NH_3 emissions.
Subsequently, we tested the effects of addition of reed straw and combined addition of reed straw and zeolite on NH_3 and GHG emissions during pre-composting of duck manure, either with or without a follow-up phase of vermicomposting. Results showed that

cumulative N_2O, CH_4, and CO_2 emissions during pre-composting and vermicomposting ranged from 92.8, 5.8, and 260.6 mg kg^{-1} DM to 274.2, 30.4, and 314.0 mg kg^{-1} DM, respectively. Earthworms and amendments significantly decreased N_2O and CH_4 emissions. Emission of CO_2 was not affected by earthworms, but increased in responses to addition of reed straw. Cumulative NH_3 emission ranged from 3.0 to 8.1 g kg^{-1}DM, and was significantly decreased by reed straw and zeolite addition. In conclusion, combined precomposting and vermicomposting with reed straw and zeolite addition would be strongly recommended in mitigating emissions of N_2O, CH_4, and NH_3 from duck manure, and providing nutrient-rich products that can be used as a fertilizer.