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Rapid production of maggots as feed supplement and organic fertilizer by the two-stage composting of pig manure

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ABSTRACT

A two-stage composting experiment was performed to utilize pig manure for producing maggots as feed supplement and organic fertilizer. Seven-day composting of 1.8 ton fresh manure inoculated with 9 kg mixture of housefly neonates and wheat bran produced 193 kg aging maggots, followed by 12 week composting to maturity. Reaching the thermophilic phase and final maturity faster was characteristic of the maggot-treated compost compared with the same-size natural compost. Upon the transit of the maggot-treated compost to the second stage, the composting temperature maintained around 55 °C for 9 days and the moisture decreased to ~40%. Moreover, higher pH, faster detoxification and different activity patterns for some microbial enzymes were observed. There was a strong material loss (35% water-soluble carbon and 16% total nitrogen) caused by the maggot culture in the first stage. Our results highlight a higher economic value of pig manure achieved through the two-stage composting without bulking agents.

1. Introduction

In the past two decades, a burst of pig industry in China has brought about a huge amount of manure, which is not only a reservoir of pathogens, parasites and weed seeds (Larney and Hao, 2007) but a favorable breeding substrate for the housefly *Musca domestica* (Farkas et al., 1998). The harmful agents must be eliminated from the manure through proper composting for the production of organic fertilizer. This is often challenged by the high water content of 70–80% in fresh pig manure because the excessive moisture is a barrier to reaching a high temperature in a manure compost. The moisture suitable for compositing often ranges from 50% to 60%, beyond which oxygen movement is inhibited in the composite (Das and Keener, 1997; Gajalakshmi and Abbasi, 2008). Upon field application of immature compost, inadequate oxygen in soil may inhibit seed germination or suppress root and plant growth (Brinton and Evans, 2001; Said-Pullicino et al., 2007). For this reason, bulking agents, such as sawdust and rice chaff, are usually added to the manure compost for moisture reduction. However, such bulking agents have become increasingly expensive for composting as they are more used as alternative energy resources. Thus, it is necessary to explore alternative means to composting pig manure for fertilizer production.

On the other hand, the rapid development of aquaculture in China needs more sources of feed proteins. The housefly larvae, namely maggots, are an ideal supply of aquaculture feeds due to >50% crude proteins in dry weight (Akpodiete et al., 1997; Iniguez-covarrubias et al., 1994) and an excellent source of limiting amino acids, such as lysine, methionine and phenylalanine (Ocio and Vinaras, 1979). The maggot protein content is even higher than those in soybean, meat and bone scrap (Iniguez-covarrubias et al., 1994). Moreover, living maggots provide a variety of biologically active substances, such as antimicrobial peptides, lectins and chitins (Fu et al., 2009; Hou et al., 2007). Maggot proteins added to animal feed may stimulate animal appetite. For instance, rats consumed more maggot protein-inclusive meal (Iniguez-covarrubias et al., 1994). Housefly larvae and pupae cultivated in manure showed a nutritive value similar to that of fish meal or animal proteins (Akpodiete et al., 1997; Miller et al., 1974; Ocio and Vinaras, 1979). Interestingly, poultry manure treated by breeding maggots became somewhat granular for an ease of drying due to improved aeration (Miller et al., 1974). Recently, chitosan, a maggot extract, was even used in cosmetics and medicines (Ai et al., 2008; Jing et al., 2007). These studies indicate that, as a source of feed proteins and biologically active substances, the manure-cultured maggots are of high economic value although exposure to the maggots may lead to health problems in humans and animals and means of preventing human and animal exposure will have to be developed for the application of the maggot culture technique.

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