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Characterization of odor emissions and microbial community structure during degradation of pig carcasses using the soil burial-composting method

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ABSTRACT

A soil burial-composting method was proposed as a hybrid disposal method for infected carcasses. This is a modified soil burial technique that involves covering carcasses with compost to achieve a final compost bed of 1.0–1.2 m during the soil burial process. To evaluate the feasibility and applicability of the soil burial-composting method, a pilot-scale system was constructed to dispose of pig carcasses and monitored its performance for 346 days. Temperature around the pig carcasses in the compost bed increased gradually, and was in the range of 35–45 °C after 200 days. Mesophilic (*Sporosarcina* and *Steroidobacter*) and thermophilic (*Truepera*) bacteria were dominant in the compost bed. Based on odor gas profiling and the morphological properties of the carcasses excavated after 346 days, it was estimated that an advanced decay stage was reached after 243 days. Considering the results of previous studies, the carcass degradation rate achieved by soil burial-composting was faster than that of soil burial, but slower than that of the composting method. Sum of odor quotient (SOQ) in the upper soil bed was lower than the SOQ in the compost bed where the carcasses were buried. This result demonstrated that the upper soil bed functioned as a biofilter to mitigate odor gases emitted during degradation of the carcasses. The soil burial-composting disposal method is preferred over soil burial because the degradation of carcasses is faster, and over composting because odor complaints and compost usage can be minimized.

1. Introduction

The incidence of economically damaging livestock epidemics, such as highly pathogenic avian influenza (HPAI) and foot-and-mouth disease (FMD), has increased in recent years in East Asian countries. South Korea, located in the East Asian-Australasian flyway, has experienced frequent HPAI outbreaks since 2003. According to the Korean Ministry of Agriculture, Food and Rural Affairs, approximately 20% of all domestic kept fowls (165 million) from winter 2016 to spring 2017 were exterminated due to this disease (OIE, 2017; QIA Korea, 2017). FMD, which occurred during 2010 and 2011 in South Korea, also resulted in the extermination of 3.48 million cattle and pigs (Park et al., 2014). Since 2008, carcasses have been buried at approximately 6500 sites in Korea.

Disposal methods for infected carcasses include soil burial, composting, incineration, rendering, alkaline hydrolysis, and anaerobic digestion (Gwyther et al., 2011). Physico-chemical methods such as incineration, rendering, and alkaline hydrolysis require special facilities, and their operating costs are relatively high because of the large amounts of energy and chemicals required (NABC, 2004; Gwyther et al., 2011). Anaerobic digestion method requires pretreatment of animal carcasses as well as special equipment (Johnston et al., 1998; NABC, 2004). Burial is a widely-used disposal method because it is relatively cheap, convenient, and logistically simple (NABC, 2004; Gwyther et al., 2011). In South Korea, infected carcasses have been buried in the soil near the farms where the infection occurred to avoid more outbreaks. However, livestock farms are scattered around the entire country in fairly close proximity to private residences due to the comparatively small size of Korea and the highly dense population (Fig. 1a), and farmers have faced difficulties in securing burial sites. Moreover, the soil burial method requires a long degradation time of 3 to 5 years, and leachates from the degradation process contaminate groundwater and soil

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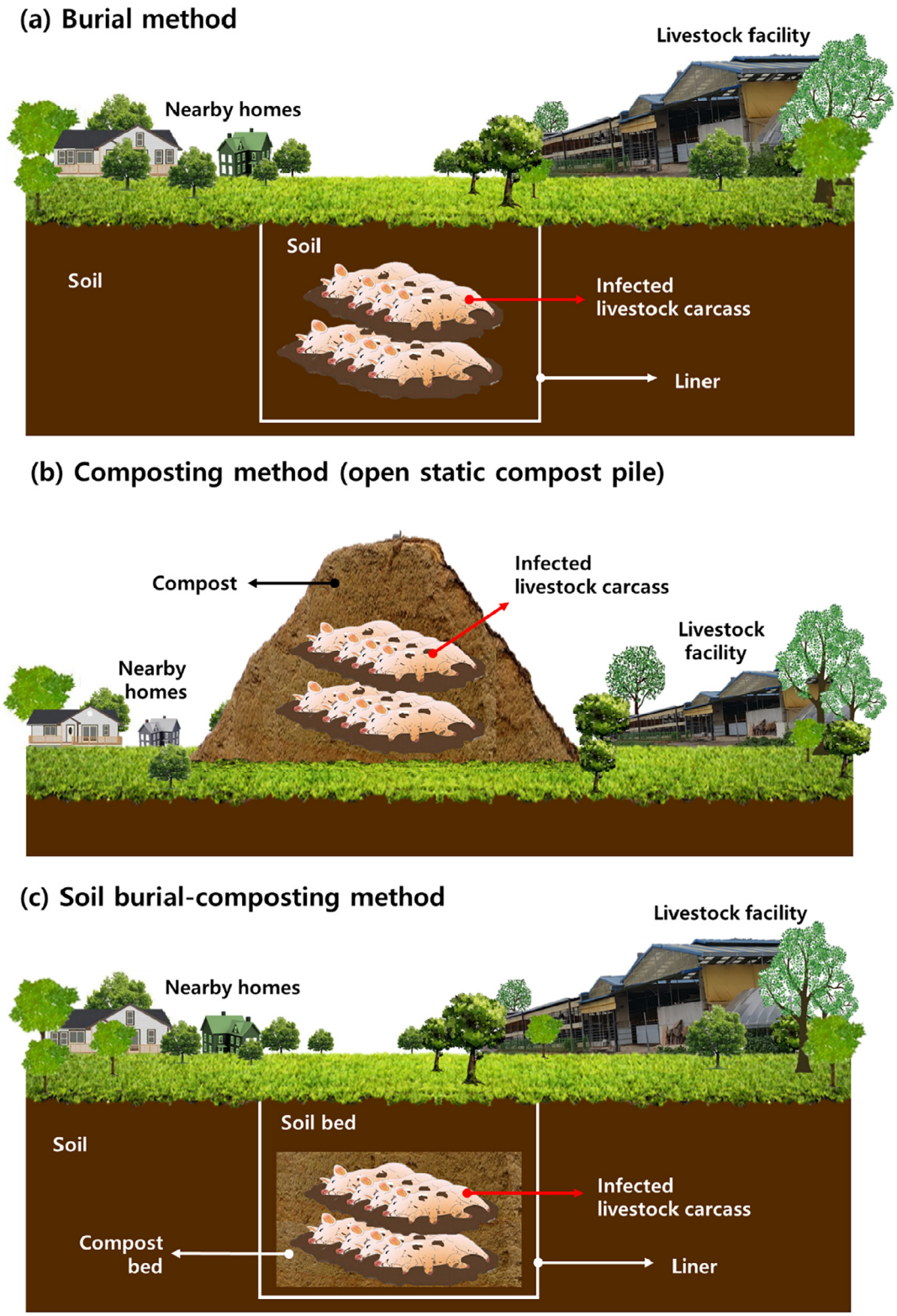

Fig. 1. Comparisons between burial, composting, and hybrid carcass disposal methods. (a) Burial method, (b) composting method, and (c) soil burial-composting method.

(Glanville et al., 2009; Kang et al., 2012; Kim and Pramanik, 2016; Kim and Kim, 2012; Yuan et al., 2013) and release unpleasant odors (Akdeniz et al., 2010a, 2010b). Due to the long degradation time, burial site management costs have increased and land use for this purpose has been restricted.

Composting (Fig. 1b), which is widely used in the United States and Australia, has a number of advantages (Bonhotal et al., 2014; Morse et al., 2006). (1) It is biosecure, because of high-temperature sterilization of pathogens in compost piles and the fast decomposition of carcasses, (2) it is environmentally friendly as minimal odor gases and leachates are produced, and the resulting products can be used as fertilizers and soil amendments, (3) it is cost-effective because of the low operating expenses, and (4) it is easy to accomplish. However, the composting method for