A literature Review on Disinfecting Chemicals for Improved Bio-Security of Emergency Animal Mortality Composting and Anaerobic Digestion

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This work reviews literature on disinfecting chemicals that could be used to inactivate pathogens in carcass composting and anaerobic digestate. Our review suggests the pathogens sometimes survive in compost and anaerobic digestate. The objective of this review is to look for a possibility of a two-phase treatment, composting and anaerobic digestion followed by a chemical treatment, to improve the bio-security of livestock mortality management. First, we review the available information on liquid and gaseous disinfecting chemicals that have been used historically for inactivating pathogens in solid and liquid matrixes such as soil, grains, and certain food products. Based on the scientific, practical appeal of those chemicals, we evaluate and discuss their potentials and suggest some chemicals that could be used in emergency disposals of animal mortalities. Finally, we highlight future emerging research needs.

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A review of chemicals to improve bio-security of emergency animal mortality composting and anaerobic digestion

Abstract:
This is a review of literature on disinfecting chemicals that could be used to inactivate pathogens in composting and anaerobic digestate of animal catastrophic disposals. Our review suggests that pathogens sometimes survive in compost and digested residues. The objectives of this study are to look for: (1) The available information on liquid and gaseous disinfecting chemicals that have been used for inactivating pathogens in solid and liquid matrices such as soil, grains, and certain food products; (2) An alternative method for chemical treatment of composting and/or anaerobic digestate, to improve the bio-security of emergency animal disposals. Based on the scientific data, practical appeal and the applications of the reviewed chemicals, ammonia (NH₃) appears to have the best potential for disinfection of composting and/or anaerobic digestate for emergency disposals of animal mortalities.

Background:
Massive loss of poultry and livestock caused by diseases and natural disasters are of health and environmental concerns. These animal mortalities need to be readily disposed of, but lack of bio-safety measures in buried-out method leads to groundwater hazardous and odors. In South Korea, 9.7 million cattle, swine, and poultry carcasses were buried in mass graves after outbreaks of foot-and-mouth disease and bird-flu in the winter of 2010. This raised concerns that contaminants may enter groundwater when the soil has thawed. Composting and anaerobic digestion are disposal methods of interest. Therefore, health officials want to be very sure that these processes are safe. The effectiveness in reduction of pathogens in both processes is affected by temperature, a factor that generally cannot be controlled when used under emergency conditions. Composting is not always completely heat-treated. Research has documented cases of pathogen survival and re-growth in composted materials, 1,2 Escherichia coli and Salmonella spp are not damaged by mesophilic temperatures.3

Suitable chemicals for pathogen disinfection:
The disinfectants should be at a sufficient level in order to inactivate the pathogens by: (1) Interaction on microbial surface (C1) Penetration into microorganism; (2) Interaction at the target sites.4

Figure 2 summarizes in order of importance the factors to be considered when using them as disinfectants for composting and digestes. Activity.5

| List of chemicals that have been used for disinfection of grains, soils, & certain food products: |
|---------------------------------|---------------------------------|---------------------------------|
| **Chemical/Agent** | **Pathogen carriers** | **Inactivation** |
| Ozone** (O₃)** | Corn grain | 1.76 to 7.68 log |
| Peroxy-acetic acid solution (CH₃CO₃H) | Apples | 2 to 5.5 log/apple |
| Cyanogen (C₂N₂) | Mushroom | 2.6 to 3 log |
| Ammonia (NH₃) | Tomatoes | 1.59 to 6 log |
| Sulfuryl fluoride | Lettuce | 1 log |

Table 2. List of disinfectants for grains, soils, and certain food products

Suitable physical forms of disinfectants

<table>
<thead>
<tr>
<th>Chemical/Agent</th>
<th>Form</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone (O₃)</td>
<td>Gas</td>
<td>Yes</td>
</tr>
<tr>
<td>Peroxy-acetic acid (CH₃CO₃H)</td>
<td>Liquid</td>
<td>Yes</td>
</tr>
<tr>
<td>Cyanogen (C₂N₂)</td>
<td>Solid</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 3. List of disinfectants for grains, soils, and certain food products

Conclusions:
1. Ammonia (NH₃) will be the most useful disinfectant for a chemical treatment of composting and anaerobic digestion products. This chemical is not too very toxic and not expensive.
2. For composting: Ammonia and/or ammonia gas would be the best suite for treatment application. It will be very difficult to poor liquid ammonia on compost and have it distribute to the whole compost pile.
3. For anaerobic digestion: The potential for mechanical mixing of the digestate means that solid, liquid or gas form of ammonia could be introduced into digesters.

References:
17. USEPA, 2011. National Pollutant Inventory. Air Toxics. Table 3. List of disinfectants for grains, soils, and certain food products

Availability and use consideration for some of disinfecting agents

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