PROBLEM PREVENTION

PUBLIC HEALTH ISSUES AND COMPOSTING

What are the potential problems? How can the proper design and operation of composting facilities abate their impact?

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The objective of this paper is to discuss the public health issues that are related to the design and operations of composting facilities. We place particular emphasis on methods that reduce the impact of potential health problems. The following are representative incidences which have occurred in the past two years regarding the above issues.

1. At a public hearing in conjunction with a leaf and yard waste composting site, a question was asked as to the potential threat of Aspergillus fumigatus to the health of residents near the site.

2. Similarly, the issue of Aspergillus fumigatus was brought up at a meeting regarding a solid waste facility and worker health.

3. Endotoxins were a concern at a wastewater treatment plant having a composting operation. Workers were concerned about dust and endotoxins.

4. A soil blender was concerned about the health of employees in relation to use of sludge compost products.

Aspergillus fumigatus

Aspergillus fumigatus is a fungus which is ubiquitous. It is found throughout the world and is common in a variety of materials, such as hay, grain, decaying vegetation, compost, and soil. Aspergillus fumigatus is found in commercial soil potting products (Millner et al., 1977) and woodchip piles in the forest product industry (Passman 1980). Hirsch and Sosman (1976) studied the occurrence of Aspergillus fumigatus in homes. They found the fungus in 42 percent of bedrooms, 56 percent of bathrooms, and 85 percent of basements. It was the fourth most common mold in households and present in all seasons. Aspergillus fumigatus was more frequent in homes with pets. Similar data were found by Solomon (1974), who investigated the indoor atmosphere of 150 homes. Salvin and Winzenburgen (1977) found the fungus in basements, bedding, and house dust.

Aspergillus fumigatus is common in composting operations. Table 1 shows concentrations of Aspergillus fumigatus found at a compost site. Millner et al. 1977 reported similar data. It is heat tolerant and grows well at thermophilic temperatures (above 45°C) and therefore survives the composting process. Passman (1980) and Millner et al., (1977) showed that viable conidia can be recovered in the immediate vicinity of agitator of aerosolization of fungal-containing material but the counts drop rapidly only a short distance from the source or a short time after cessation of the activity.

Studies by Clark et al. (1984) showed no trend to infection or allergic responses to workers at compost sites in the United States. The authors found no consistent difference between compost workers and workers not involved in compost activities as determined by antibody methods. The lack of increased antibodies to Aspergillus supports the conclusion that, though Aspergillus colonization is more common in compost

Table 1. Levels of Aspergillus fumigatus at a Compost Site and Surrounding Areas

<table>
<thead>
<tr>
<th>Location</th>
<th>Concentration CFU/M³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix area</td>
<td>110-120</td>
</tr>
<tr>
<td>Near tear down pile</td>
<td>8-24</td>
</tr>
<tr>
<td>Compost pile</td>
<td>12-15</td>
</tr>
<tr>
<td>Front end loader operations</td>
<td>11-79</td>
</tr>
<tr>
<td>Periphery of compost site</td>
<td>2</td>
</tr>
<tr>
<td>Centrifuge operating room</td>
<td>38-75</td>
</tr>
<tr>
<td>Grit building</td>
<td>10</td>
</tr>
<tr>
<td>Pump house</td>
<td>10</td>
</tr>
<tr>
<td>Background level</td>
<td>2</td>
</tr>
</tbody>
</table>

workers, infection with the organisms is not. One would expect a rise in antibodies to the fungus if there were infections due to the fungus. Severe Aspergillus infections from any of the species occur almost exclusively in people who are severely debilitated or immunocompromised (Rippon, 1974) e.g. persons with kidney transplants, leukemia, or lymphoma.

**ENDOTOXINS**

Endotoxins are noxious substances produced by gram negative bacteria. The term endotoxin refers to the gram negative cell wall lipopolysaccharide. It is produced by many bacteria including many which are non-pathogenic. This suggests that it plays no part in virulence, i.e. in the degree of disease producing properties of a species of bacteria. One of the more important properties of these lipopolysaccharide substances is their heat stability. The metabolic products of gram negative bacteria may remain in the dead bacteria or their fragments after they break up. Endotoxins can be present in airborne dust particles. If inhaled in large quantities they can cause tissue damage. Airborne endotoxins have been directly or indirectly implicated in occupational worker health problems in many different situations. Some examples are: agricultural animal housing and animal processing plants (Jones et al., 1983; Olenchock, et al., 1982), textile mills and cotton dust (Olenchock et al., 1983, Castellan et al., 1984), poultry handling plants (Thelin et al., 1984), cotton carding (Rylander et al., 1985) humidifiers (Rylander and Haglund, 1984) wastewater treatment plants and composting operations (Rylander et al., 1982; Rylander and Lundholm, 1979; Rylander et al., 1977).

Levels in composting plants showed airborne endotoxin ranging from 0.001 to 0.014 mg/m³. In an office environment, levels as high as 0.39 mg/m³ were found (Rylander and Haglund, 1984).

Human exposure to large quantities of airborne endotoxin produce symptoms which include fever, diarrhea, fatigue, headaches, nausea, irritation, nasal irritation, chest tightness, cough, and expectoration of phlegm (Olenchock et al., 1982).

Many of the normal bacterial flora of humans are gram negative. The mucous membranes of the nose, throat, and gut contain large numbers of gram negative bacteria, both living and dead and large amounts of endotoxins (Sheagren 1986). There is no evidence that the physical presence of large numbers of gram negative bacteria, living or dead, or extremely large quantities of endotoxins within the gut (intestines of man) cause any symptoms of any kind.

Table 2 shows endotoxin levels in compost from several sources. The endotoxin levels in sludge compost, 3.9 to 6.3 ng/gm were similar to levels found in compost from leaves, cattle, and sheep.

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The data today show that many other work environments have higher levels of endotoxins and workers are at a greater risk than at composting facilities. Dr. John Rippon, Director of The Mycology Services Laboratory, The University of Chicago, Division of the Biological Sciences and The Pritzker School of Medicine (personal communication) states that:

"It is concluded therefore that the examination and monitoring of compost operations in several sites in several counties has not indicated a significant level of bio-hazard risk associated with viable bacteria or fungi, dust or endotoxin. Studies directed at detecting work-associated health problems have also been unable to find significant or consistent abnormalities. It would appear that at the present time, significant bio-hazards from composting operations have not been established. It should be noted that this environment of composting operations does contain potential bio-hazards (fungal conidia, endotoxins, allergens, etc.) and particular individuals hypersensitive to allergens or predisposed to opportunistic infections may be at risk."

**PATHOGENS**

The main pathogen groups found in sludge are:

- **Bacteria:** salmonella, tuberculli bacteria, yersinia
- **Virus:** entroviruses (poliovirus), hepatitis, adenoviruses
- **Helminths:** nematodes (roundworms), cestodes (tapeworms)
- **Protozoa:** giardia lamblia, entamoeba histolytica

These pathogens are sensitive to heat and are eliminated at temperatures exceeding 55°C (131°F). This is the basis for the Federal Regulations 40 CFR Part 257 "Criteria for the Classification of Solid Waste." Proper composting should result in the elimination of these organisms. Recently, a document by William Yanko of the County Sanitation Districts of Los Angeles County was produced for the U.S. EPA providing results on pathogen analysis of sludge products from various facilities (Goldstein et al., 1988).

An intensive sampling was conducted at one static pile facility in Pennsylvania and a windrow facility in California. Subsequent bi-monthly samples were carried out at 24 sites which included static pile, in-vessel, aerated windrow, heat drying, and other sludge facilities. The bi-monthly samples at 24 sites generally showed low bacterial contamination in...
posting operations has been odors. Odors have plagued composting facilities regardless of type, i.e. static pile, window or proprietary in-vessel. Odor control can be achieved through proper aeration and other operations, odor scrubbing and good housekeeping. Haug (1980) points out that odor emissions can increase significantly if the thermodynamic and operational constraints are exceeded. In most cases the surface odor emission rate is greatest at the beginning of the compost cycle and decreases with time. Leachate and runoff contamination of ground and surface waters have not been a problem at composting sites since most activities are on a sealed paved surface or under a roof. Provision needs to be made for collection and disposal of any excess water which is a by-product of the composting operation.

One of the most significant aspects in the maintenance of good environmental and health conditions at a composting site is the provision of sound operator training. Coupled with the training is the need for good operation and maintenance manuals. These manuals need to be clear, concise and specific to the facility. All too often one finds generic manuals loaded with vendor equipment specifications which neither instruct the operator as to the importance of various operations, nor instruct the operator on the mitigating measures that must be taken to correct or avoid problems.

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LITERATURE CITED


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