Time-Temperature Testing in a Biosolids Composting Facility

Good chefs use temperature probes to ensure that poultry is thoroughly cooked to at least 80°C, to ensure that any pathogens like *E. coli* or *Salmonella* have been destroyed. Operators at composting facilities also face these challenges; but on a scale thousands of times larger. Compost piles act like self-heating ovens, and guidelines indicate they need to reach 55°C in order to kill human pathogens associated with biosolids from municipal wastewater treatment. Co-composting of biosolids with organic waste materials (like woodchips) is an approved method in Canada to reduce sewage sludge pathogens. The Edmonton Waste Management Centre of Excellence (EWMCE) and its partners developed customized temperature probes and used them to evaluate the effectiveness of static pile composting to heat all the particles in the pile, to ensure pathogen destruction and a safe product.

The City of Edmonton processes over 20,000 dry tonnes of biosolids annually. The biosolids are composted on-site, either with municipal solid waste, or in the GORE^{tm} process with woodchips. Compost must be free from pathogenic organisms however that can be difficult to monitor directly in such large-scale operations; the EWMCE and researchers at the University of Alberta collaborated to develop custom tools to monitor the temperatures experienced by compost particles going through the process. These were used to develop approaches to assure compost sanitation at the scale of compost particles, and then were combined with microbial testing to investigate the time-temperature criteria specified in the guidelines.

Many studies have shown that pathogens can persist during a composting process, even when the specified time-temperature criterion is met. Guidelines from both the CCME (2005) and USEPA (2003) specify that every particle in the compost pile should be exposed to a temperature of at least 55°C for at least three consecutive days to ensure the finished compost is pathogen-free. The survival of pathogenic microorganisms could be related to: i) poor temperature monitoring (highly variable temperatures throughout the piles could create cool zones) and/or ii) insufficient time-temperature criterion (the guidelines may underestimate the tenacity of the pathogens).

The study partners were able to apply and test these theories using real waste materials at a full-scale facility. Municipal biosolids were mixed with wood chips as bulking agents, then composted using covered aerated static piles at the Edmonton Waste Management Centre. Twenty-two temperature probes were seeded with pathogenic indicator microorganisms including *E. coli* and *Salmonella* then randomly introduced into the piles. Previous studies during probe development showed that the probes behave like random particles in the compost pile. Each probe was programmed to record its temperature every 15 minutes. Compost piles were turned after 4 weeks, mixing the material prior to a second stage of composting for 2 weeks. At the end of the composting, each probe was recovered and microbial survival was tested.

The bulk of the compost pile reached or exceeded the time-temperature criterion. However, 8% of the probes did not achieve the required temperatures by the end of the first stage of composting, and even after turning and further composting, 7% of the probes had still not met the time-temperature criterion. Microbial testing (quantifying the microbes using molecular and culture-based methods) indicated that both *E. coli* and *Salmonella* in the temperature probes were no longer culturable, but both pathogens were still present. However,

the researchers caution that only temperature was investigated, and the study did not account for other factors in the compost environment (physical, chemical, and microbiological) that could contribute to reducing pathogens. Given the right conditions, surviving pathogens could be resuscitated and could pose a health concern.

As the composting of biosolids becomes more widely accepted as a sustainable approach of converting wastes into valuable products, effective quality assurance measures are essential to maintaining public trust and safety. This study demonstrates how the use of these temperature probes can provide operators of composting facilities with the necessary technical information to ensure their product meets or exceeds CCME and USEPA guidelines.

If you would like to learn more about this project or research topic please contact Kathleen Londry at EWMCE.
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