Latrine composting – a hygienic evaluation

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Introduction

When recycling human latrine, the hygienic and human health aspects need to be taken into consideration. Correct handling and treatment of such waste should result in a hygienic end product that can be used with low risks. But recycling of human latrine may also be associated with the spread of pathogenic micro-organisms into the environment. Separating the nutrient rich toilet waste into two fractions leave a urine fraction relatively free from microbial faecal pathogens, the numbers of which will be reduced during urine storage. In contrast, the faecal matter contains high numbers of naturally occurring enteric bacteria, and occasionally disease-causing pathogens like *Salmonella*, *Campylobacter*, *Shigella*, enteric viruses, and parasites. Thus, the latrine waste must be treated to obtain an end product free or nearly free of pathogens.
Correct thermophilic composting of latrine, in particular the generated heat, would be expected to inactivate or kill pathogenic micro-organisms. Our study was initiated to investigate the inactivation of faecal micro-organisms during composting of latrine from urine diverting toilets as a function of temperature and exposure-time. The experiments were conducted using a controlled model compost system.

Methods

During composting at temperatures between 50 and 65°C, the material was analysed regularly at short time intervals for natural occurring indicator organisms (suspected *E. coli* and enterococci), and for the added *Salmonella* senftenberg 775W and the virus indicator *Salmonella* typhimurium phage 28B. Both added micro-organisms have a documented relative high level of heat resistance. The experimental set-up was as follows: Latrine mixed with sawdust was collected from a urine diverting toilet and put into 10-litres composting reactors with controlled aeration and temperature regulation. Small amounts of latrine material were put into semi-permeable chambers (Excelsior Sentinel, Inc., Ny, USA) to which *Salmonella* senftenberg 775W and *Salmonella* typhimurium phage 28B were added. After initiation of the composting process and registration of high microbial activity, the temperature was regulated to 50, 55, 60 and 65°C in different batch experiments. When the desired temperature was achieved, a number of chambers were added to each

reactor. Sampling was done at short time intervals, and two chambers were taken out for analysis from each reactor at each time interval. The material in the chambers was analysed quantitatively for suspected *E. coli*, enterococci and *Salmonella* typhimurium phage 28B, and semi-quantitatively for *Salmonella* senftenberg 775W using accepted standard methods.

Results

Suspected *E. coli* and *Salmonella* senftenberg 775W showed almost identical approx. 1. order die-off rates. It took 6 hours to get a 5-$\log_{10}$ reduction at 50°C, 4 hours at 55°C, 1 hour at 60°C and 30 minutes at 65°C. By combining these data the relationship between die-of rates and composting temperature can be determined. Fig. 1 shows the T_{90}-values, i.e. the time constants for 1-$\log_{10}$ reductions in numbers for suspected E. Coli and *Salmonella*. From this curve the reduction rate at any temperature between 50 and 65°C can be estimated. The enterococci, however, showed a slower die-off rate: It took 3 days to get a 4-$\log_{10}$ reduction at 50°C, 2 days at 55°C, 6 hours at 60°C, and 2 hours at 65°C. It was further seen that after a reduction to a level of about 10^2 cfu/g, growth of enterococci on Slanetz and Bartleys agar medium was detected for approximately two weeks at 50°C. The bacteriophages were found to be more sensitive than enterococci to the lower temperature range, but relatively more resistant at higher temperatures. It took 2 days to get a 4-$\log_{10}$ reduction at 50°C and 13 hours at 60°C.

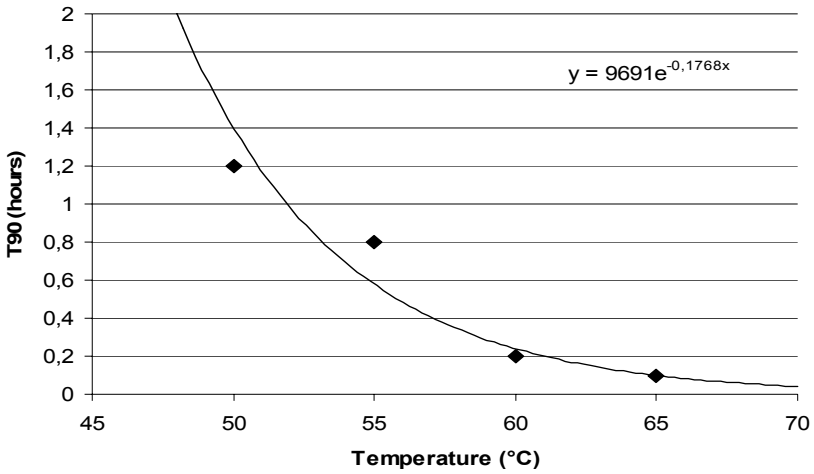

Figure 1. T_{90}-values for susp. *E. coli* and *Salmonella* senftenberg 775W.

Conclusions

Thermophilic composting of faecal matter from urine diverting toilets can effectively reduce the numbers of faecal bacterial indicators and pathogen. Already at 50°C, the numbers of pathogens, including the *Salmonella* phage, and indicator organisms analysed were effectively reduced within a few days of exposure. Although the numbers of enterococci were reduced, they were continuous isolated as purple colonies on Slanetz and Bartleys agar after prolonged exposure at all temperature levels studied. This indicates that certain micro-organisms present in the composted faecal material, *Enterococcus* spp. or micro-organisms resembling enterococci on the agar medium, can survive and multiply even at 60°C. These findings question the use of enterococci as faecal indicators and test organisms to control the efficiency of composting of human faeces. Further work is in progress to identify the taxonomy of these organisms.