Reduction of faecal microbiological indicators in different compost toilets

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Introduction

There is much interest in the recycling of organic waste products in Denmark. As a consequence, decentralized sanitary solutions consisting of urine-separating toilets with collection units for faecal material, i.e. compost toilets, are increasingly being build. At present, the Danish legislation does not allow use of material from compost toilets on agricultural lands. However, because of the increased public interest in compost toilets as well as limited knowledge about the efficiency of these types of toilets to reduce pathogens, the Danish Environmental Protection Agency has initiated projects investigating the hygienic and health risks associated with the use of material from compost toilets.

Methods

In experiment 1, survival of normally occurring faecal indicator bacteria and helminth eggs were determined in samples of faecal material from five compost toilets in two Danish eco-villages. The toilets studied consisted of urine-separating toilets with collection of faecal material and other solids in a separate unit, typically a 180 L waste bin. When full, the waste bins were stored for 3 to 8 months. Faecal material was collected from the two villages during the storage period. Samples were also obtained from a more specialized type of collection unit with continuous addition of faeces. In these systems, samples were taken from the oldest faecal material. All samples were analyzed for thermotolerant coliforms, enterococci, *Clostridium perfringens* spores and helminth eggs (*Ascaris* spp. *Trichuris* spp., *Enterobius* spp. and *Taenia* spp.). The temperature in the waste bins was measured at each sampling date. In experiment 2, a waste bin was filled with well-mixed faecal material. Temperature probes were installed in the bin at two different depths and data were logged every half hour. Homogenized faecal material was placed in small (2 cm^3) plastic chambers (Excelsior Sentinel, Inc., Ny, USA) and culture broths containing *Salmonella* senftenberg 775W and the virus indicator *Salmonella* typhimurium phage 28B were added to the chambers. The chambers were then closed with nylon membranes and placed at the same depths as the temperature probes in the waste bin. At regular intervals the chambers were sampled and their content analyzed for total viable counts at 37ºC, thermotolerant coliforms, enterococci, *Salmonella* senftenberg 775W and *Salmonella* typhimurium phage 28B using standard methods.

Results

In experiment 1, temperatures were < 25ºC at any sampling time from April to August 2001 (table 1). Thus, heat-generating composting did not occur during storage of the waste bins. The microbiological analysis showed the presence of *Clostridium perfringens* spores in all samples except one, where as the numbers of thermotolerant coliforms ranged from below

the detection limit (<10 cfu/g) to 19,000/g of faecal material. The numbers of enterococci varied a lot and were found in high numbers in one waste bins, but were below the detection limit (<100 cfu/g) in a similar unit. There did not seem to be any clear relationship between the occurrences of the different microorganisms in the collection units and the period of storage. *Taenia* spp. eggs were found in three samples (data not shown).

Table 1. Microbiological results from sampling in December 2001 of faecal material from five compost toilets in two Danish eco-villages

Type of system	Thermotolerant coliforms (cfu/g)	Enterrococci (cfu/g)	Spores of *Cl. perfringens* (pfu/g)	Temperature in collection unit (ºC)
180 l waste bin no 1	<10	<100	<10	17
180 l waste bin no 2	560	1,500	17,000	5
180 l waste bin no 3	50	710,000	3,000	5
Continuously filled system no 1	19,000	8,000	8,000	13
Continuously filled system no 2	100	1,400	13,000	11

Results from the experiments with *Salmonella* senftenberg 775W and *Salmonella* typhimurium phage 28B are shown in fig. 1. The *Salmonella* senftenberg 775W was rapidly inactivated and reduced more than 9-log units following 40 days of inoculation. The numbers of thermotolerant coliforms were reduced 3-log units during the same period. The numbers of *Salmonella* typhimurium phage 28B and total viable counts were only marginally reduced and the numbers of enterococci actually increased indicating occurrence of after-growth. The temperature in this experimental unit did for a short period reach 42.2ºC, but generally the temperature was < 25ºC (data not shown).

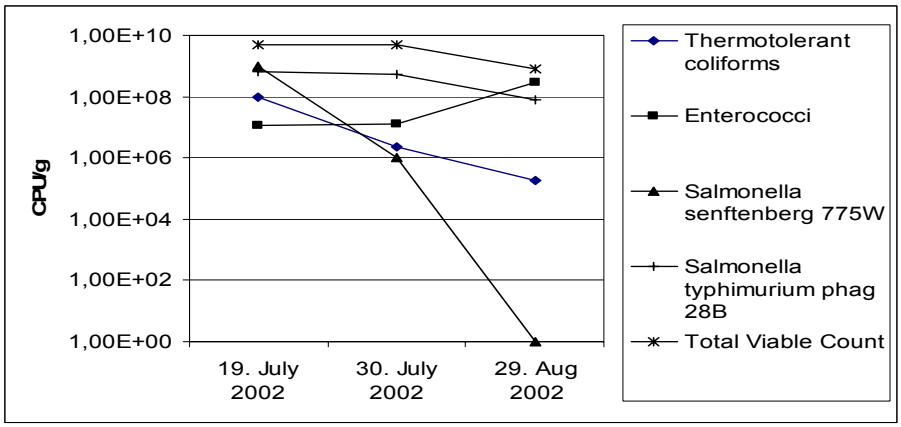

Fig. 1. Survival of faecal indicator bacteria and added pathogens in a 180-L waste bin.

Conclusions

Large variations in numbers of faecal indicator bacteria were found irrespective of the storage time of collected human faeces. Little heat seemed generated from composting processes when bin units were stored locally in households. The low reduction in microbiological parameters and very limited temperature increase were generally corroborated by the results obtained in experiment 2 when pathogen indicators were added to thoroughly mixed faecal matter. Even though *Salmonella* died of rapidly the other faecal bacterial indicators survived in large numbers. We conclude, that the collection and storage of human faeces in the closed plastic bins studied here is associated with only little temperature increase and subsequent reduction in faecal bacterial indicators and pathogens. Thus, the bin units do not seem especially suitable for composting and hygienisation of human faeces.