Human Excreta Treatment Technologies – Prerequisites, Constraints and Performance

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Abstract

This thesis investigates treatment technologies for human excreta for safe recycling of the plant nutrients present as fertilizers.

The thesis consists of three papers, the first of which investigates incineration of faecal matter as a treatment and sanitation method using a locally fabricated incinerator made of steel sheets. The second and third papers investigate composting of faeces and food waste at two size scales, using 78-litre and 216-litre wooden reactors.

Incineration of faeces containing ash added during the collection phase showed that faeces/ash mixtures with ash content >80% caught fire when the temperature exceeded 800°C. Thereafter, temperatures in the range 800-1000°C were recorded. Incineration reduced mass almost instantly by 15-36%, organic matter by 78-99%, total nitrogen by 90-94% and available phosphorus by 70-94%. Incinerating faeces/ash mixtures with dry matter (DM) content <90% resulted in a strong smell that lessened when DM was higher.

Composting of faeces-to-food waste (F:FW) in wet weight ratios of 1:0, 3:1 and 1:1 was studied in 78-litre reactors. Styrofoam insulation (25 mm thick) around the compost reactors and compost turning every three days enabled sanitising temperatures (>50°C) to be reached and sustained for over a week in the F:FW = 1:1 compost, giving a reduction of >3$\log_{10}$ for *E. coli* and >4$\log_{10}$ for *Enterococcus* spp. Composting of faeces/ash mixtures (F:FW = 1:0) with food waste (F:FW = 1:1 and 1:3) was also studied in 216-litre reactors insulated with 75 mm styrofoam and in non-insulated control units with faeces/ash. Composts that attained sanitising temperatures (>50°C) had high initial pH (8.5-9.7), moisture content between 43-63% and initial ash content up to 77%. *E. coli* and total coliforms decreased below detection in composts with temperatures above 50°C for at least six days. With no food waste, the time above sanitising temperatures was short.

Incineration disinfects human excreta almost instantly and reduces their mass, while the ash produced can be used as a toilet additive, which is advantageous in urban areas where access to ash is limited. Disadvantages of incineration and composting, *e.g.* possible environmental pollution, risk of contamination and disease when handling initially unsanitised material and lack of social acceptance, can be overcome by improved design, use of protective wear and community training.

Key words: Composting, faeces, food waste, incineration, sanitation, temperature.

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