Further Development of Dry Toilet Sanitation by Application of Lactic Acid Fermentation Process in Terra Preta Sanitation System

A. Yemaneh, R. Otterpohl, Institute of Wastewater Management and Water Protection

In recent years there has been an increasing focus on technology development in sanitation which is safe and enabling more efficient and effective recovery of resources in human waste. Terra Preta Sanitation (TPS) system is one of such developments which is an alternative pathway in dry toilet sanitation based on two combined natural biological treatment processes: lactic acid fermentation (LAF) in toilet during collection and vermi-humification of lacto-fermented excreta off-site. In TPS system human excreta is treated and transformed to pathogen free humus which is rich in nutrients and organic matter. TPS system is developed inspired by the discovery of the ancient highly fertile anthropogenic Amazonian black soil called 'Terra Preta' which is believed to have been formed as a result of addition of household bio-waste and many other forms of organic material including excreta and black carbon to originally very poor soils of the Amazon region.

Lactic acid fermentation allows easy waterless collection achieving odour suppression, pathogen reduction and conserving nutrients and organic matter during human excreta collection. Batch laboratory-scale experiments are conducted in small fermentation reactors to investigate the effects of different microbial inoculants, different level of sugar supplement and different modes of human excreta collection on the fermentation process. The process is monitored by measuring pH, lactic acid (LA) concentration, volatile fatty acids (VFA), total titrable acidity (TA), nutrients, dry matter (DM), volatile solids (VS), and faecal coliforms (FC).

During fermentation of separately collected faecal matter, for all treatments with the different inoculums variants and 10% (w/w) molasses as sugar supplement, there is a reduction in pH, from initial 5.5 to less than 4 in five days which stayed nearly constant for the rest of the fermentation period. Also increase in LA concentration, increase in TA and decrease in VFA production are observed with insignificant differences among the different inoculum variants. Faecal odour is completely suppressed and is replaced by sour smell which is rated as acceptable according to the odor panel established for sensory evaluation. No FC is detected after one week, which is considered as indicator for hygienization of human excreta. For LAF experiments simulating combined collection there are significant differences for the monitored parameters among the different inoculum variants and only few variants performed well towards the desired objectives. Experiments simulating partial collection mode showed similar pH reduction trend and comparable result for changes in other parameters to the experiments that simulate only faecal matter collection.

The results of the experiments show that LAF can be applied, in suitably designed toilets, for collection of human excreta suppressing faecal odour effectively. The LAF process also helps to achieve significant pathogen reduction during collection. Possibility of application in partially separate collection mode will enable using toilet with only one inlet avoiding complexity associated with constructing and operating urine diversion toilets which are mostly considered as models for dry toilet sanitation option. The process of lactic acid fermentation opens many new ways for dry toilets and will help for large scale applications of dry toilet sanitation in different regions of the world in varying settlement conditions. Further investigation of the whole TPS system with full mapping of nutrients, organic matter and pathogens is the focus of this study.