学　位　論　文　内　容　の　要　旨

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学　位　論　文　題　名

The fate of intestinal parasites and pathogenic bacteria in the composting toilet
(寄生虫卵と病原性バクテリアのコンポスト型トイレにおける挙動に関する研究)

On-site sanitation systems have gained much interest in recent years. One such system is the urine diverting composting toilet, which are promoted to sanitize human excreta for recycling them into fertilizer. A composting toilet using waste material as bulking agent has the potential to trap pathogens that might be contained in human faeces. Unfortunately, in some marginal area, composting toilet couldn't get specific conditions for destroy all pathogens. Several studies have reported the inactivation of pathogenic bacteria and virus in composting toilet. However, the removal of parasites has not been studied yet since parasites tend to have stronger resistance than pathogenic bacteria and virus. Therefore, this study aimed to investigate the fate of intestinal parasites and pathogenic bacteria in the composting toilet for sanitizing compost.

Chapter 1 describes the background and the objectives of this study. The literature review has summarized the state of the art regarding to the inactivation of pathogens in composting toilet, the inactivation mechanisms of the pathogenic cell during the composting process and the different adequate post-treatments for sanitizing compost.

Chapter 2 investigates the removal of intestinal parasites (helminthes eggs and protozoan cysts) compared to that of pathogenic bacteria during the composting process in a composting toilet. Batch experiments were conducted by composting human faeces in an aerobic composting reactor using shea nut shells as bulking agent during 60 composting days. The results showed that protozoan cysts (Entamoeba hystolitica) were present in humans faeces collected at high concentration (854/g mean) than helminthes eggs (Ascaris lumbricoides) (204/g mean). A mesophilic temperature, desiccation and alkaline pH were obtained during the composting process. Compared to pathogenic bacteria (Salmonella sp), which were eliminated totally after 30 composting days, helminthes eggs were reduced after 35 days; while protozoan cysts were still present after 60 days. Total helminthes eggs were inactivate, while protozoan cysts were still present in the end-compost. In high concentration protozoan cysts have survived stronger than helminthes eggs in the composting toilet and may constitute a sanitary risk when used as fertilizer. Because of the persistence of some pathogens in composting toilet, both helminthes eggs and protozoan cysts are good indicator for the removal of parasites.

Chapter 3 elucidates the inactivation mechanisms of pathogenic bacteria during the composting process in composting toilet. The inactivation mechanisms were evaluated by culture E. coli strain as pathogenic bacteria, in 3 types of media namely Tryptic Soy Agar, Desoxycholate Agar and Compact Dry EC. By comparing, the inactivation rate constant of E. coli, the damaged parts and/or functions were estimated. The inactivation rate constants of E. coli during composting process, in three different composting matrixes (sawdust, rice husk and charcoal), were also compared. The results showed that

composting process and composting matrixes did not significantly affect inactivation rate of pathogenic bacteria; however, these differences affected damaging part or function of the bacteria. The composting process affected the pathogenic cell from membrane and enzyme to metabolisms while the composting matrix affected from membrane to enzymes and metabolisms. However, the ccomposting process, when accompanied with alkaline pH, changed the damage part of bacteria more lethally with nucleic acid damage. This result could help to choose matrix and time process from the viewpoint of hygienic aspect in composting toilet.

Chapter 4 evaluates the post-treatment by storage, urea and thermal treatment for sanitizing compost. For storage treatment, fresh compost from household composting toilet was stored for short time in uncontrolled conditions. For urea treatment, urea at concentrations 0,5-2% (w/w) was added to compost (pH=7.6-9.4, respectively) and monitored at temperatures 20, 30 and 40°C. The thermal treatment was performed by heating compost in a solar box. The results of storage compost showed a slow reduction of micro-organism and thus, no significant difference of the microbial level in fresh and stored compost. Urea treatment enhanced inactivation of pathogens during treatment and inactivation rates were positively related to the increase of pH and temperature. However, there is no significant reduction of pathogens with urea treatment. Thermal treatment by solar box has provided uniform and pasteurization temperature in compost during treatment. The thermal treatment by solar box has shown a rapid inactivation decay of pathogens and has proved to be an efficient option for sanitizing compost.

Chapter 5 summarized the most important findings and conclusions of this research and future studies are listed.