In-situ composting strategies for sustainable food waste digestate management

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Keywords: food waste digestate, composting, biochar, circular economy.
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Anaerobic digestion (AD) is a sustainable biological process for converting food waste to bioenergy alongside the production of digestate. In the past decade, the limited focus has been devoted to digestate utilization despite its increasing production. The physicochemical characteristics of dewatered food waste digestate (FWD) cause environmental and health hazards upon direct land application due to its high salt and ammonium N contents. Hence, further stabilization of FWD through aerobic composting is recommended. Irrespective of food waste type in different countries, high concentrations of NH_4^+-N (~6000 mg/kg dry weight (dw)), high moisture content (~75%) and low C/N ratio (5-7) have been reported in several countries, which causes 60-70% of nitrogen loss as NH_3 emission and phytotoxicity to plants (Manu *et al*., 2021a). These innate characteristics significantly affect the composting process thereby reducing the compost quality, and emitting unwanted greenhouse gases, NH_3 and N_2O. Hence, research was carried out both in field and laboratory scale to develop innovative composting strategies for the effective management of FWD. To improve the composting process, in-situ technologies such as C/N ratio adjustment and additive strategies were adopted.

Hong Kong commenced the first biological waste treatment, named as 'Organic resource recovery center 1 (ORRC1)' to treat 200 TPD of source-separated food waste by single-stage anaerobic digestion process followed by composting of dewatered food waste digestate (FWD). Currently, ORRC1 is facing difficulties in the composting process due to the innate characteristics of FWD resulting in the elongated composting process and low-quality compost. To improve the composting process, aeration strategy and composting formulation were optimized. Co-composting recipe with 50% FWD, 25% structurant, 16.7% sawdust and 8.3% mature compost produced good quality compost with seed germination index (SGI) values of 86-90% within 14 days of composting and reduced phytotoxic NH_4^+-N to 700-1000 mg/kg dry matter. The developed strategies could be adopted globally to any country as the FWD characteristics are similar irrespective of their type of food waste promoting circular bio economy and carbon neutrality.

For effective digestate composting management, several in-situ strategies including feedstock optimization by co-composting with sawdust and mature compost (Song *et al*., 2021), physical additive strategies using different types of biochar (Manu *et al*., 2021b, Li *et al*., 2022), zeolite (Manu *et al*., 2022; Li *et al*., 2022) were investigated. Mixing of FWD with sawdust and mature compost provided suitable composting conditions (moisture content: 50-60%; C/N ratio: 25-30). NH_4^+-N concentration reduced to HKORC permissible limit (< 500 mg/kg DM) only in treatments with sawdust after 30 days of composting. The seed germination index (> 80%) clearly indicated that the maturation period could be significantly reduced to 11 days by co-composting FWD with sawdust and mature compost. Hence, co-composting of FWD with sawdust and mature compost can produce good quality compost with less environmental emissions within a short duration of composting. Furthermore, bench-scale laboratory composting studies demonstrated that biochar produced from different sources such as coconut shells, bamboo, tobacco and softwood could significantly conserve nitrogen thereby reducing the gaseous NH_3 and N_2O emissions as well as producing good quality compost. However, the biochar characteristics significantly influenced the composting process and the nitrogen dynamics. Hence, detailed studies were conducted to assess the impact of biochar type and pyrolytic temperature on the nitrogen transformation dynamics of FWD composting (Li *et al*., 2022). Overall, 10% biochar (by dry weight) could reduce nitrogen loss by 40-60% by mitigating NH_3 volatilization and greenhouse gas, N_2O emission.

References

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