Ammonia-Oxidizing Bacteria Provide Electron Acceptors for Sulphur Oxidation and Reduce Odour Emission in Composting

L.X. Wang[1], Y.M. Li[1, *]

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[1] College of Resources and Environmental Sciences, China Agricultural University, Beijing, China
Keywords: Food waste composting, Bacterial inoculation, Functional genes, Sulfur oxidation, Odor gas.
Presenting author email: wlx8766@cau.edu.cn

Ammonia (NH_3) and hydrogen sulfide (H_2S) were the main odors during composting, which could cause environmental pollution and reduce the fertilizer value of composting products. Ammonia-oxidizing bacteria (AOB) may provide more electron acceptors for sulfur oxidation through ammonia oxidation, and ultimately reduce ammonia (NH_3) and hydrogen sulfide (H_2S) emissions. In this study, functional bacteria were added to food waste composting 1) to evaluate the emission reduction effect of NH_3 and H_2S under the condition of adding different functional bacteria, 2) to explore the effects of AOB and SOB on nitrogen and sulfur metabolism during food waste composting, 3) to clarify the microbial relationship between AOB and SOB, and reveal the microbial community that plays a key role in ammonia oxidation and sulfur oxidation. The results provide theoretical basis and data support for the application of functional microorganisms in the field of composting deodorization.

Kitchen waste, vegetable waste, and garden waste were mixed at a ratio of 3:3:2(wet weight basis) to obtain suitable material conditions such as C/N ratio and moisture content. Four treatments were designed in this study: (1) the control treatment (CK) contained 5% (v/w, dry weight) sterile water. (2) The A treatment contained 5% (v/w, dry weight) AOB agent. (3) The S treatment contained 5% (v/w, dry weight) SOB agent. (4) The AS treatment contained 2.5% (v/w, dry weight) AOB agent and 2.5% (v/w, dry weight) SOB agent. A cylindrical composting reactor with a working volume of 8 L was used in this study. Gas samples were collected daily using gas sampling bags. Manual pile turning and sample collection were performed on day 0, 1, 3, 7, 10, 14, and 21 after composting.

Compared with CK treatment, the accumulative NH_3 emission in A treatment and the accumulative emission of H_2S in the S treatment were reduced by 38.90 % and 46.24 %, respectively. This is attributed to the fact that AOB and SOB each play a role in promoting ammonia oxidation and sulfur oxidation(Chen et al., 2022; Xu et al., 2022). The addition of SOB in AS treatment was half of that in S treatment, but the reduction rate of H_2S emission was only 6.00 % lower than that in S treatment, indicating that the addition of AOB stimulated the metabolic activity of SOB and enhanced the sulfur oxidation process. The variation of NH_4^+-N, NO_3^--N and S^{2-} during composting also provided evidence for these results(Chen et al., 2023; Ren et al., 2020; Zhao et al., 2020).

A treatment and S treatment correspond to the highest abundance of *amoA* gene and *sox* gene, respectively, which proving the role of functional microorganisms from a microbial perspective. The results of Spearman correlation network analysis between functional genes and bacterial genera showed that the addition of AOB and SOB increased the correlation between sulfur-oxidizing functional bacteria and *sox* genes. LEfSe analysis further determined the contribution of *Acinetobacter* and *Aeribacillus* to ammonia oxidation, while *Brevibacterium* and *Ureibacillus* were the main functional bacteria involved in sulfur oxidation(Liu et al., 2023; Yang et al., 2019).

In conclusion, the addition of AOB or SOB alone enhanced the metabolism of some microorganisms with ammonia oxidation or sulfur oxidation functions, thereby reducing NH_3 or H_2S emissions. The simultaneous addition of AOB and SOB enhanced the contribution of functional bacteria to sulfur oxidation, revealing the internal mechanism of AOB promoting sulfur oxidation pathway.

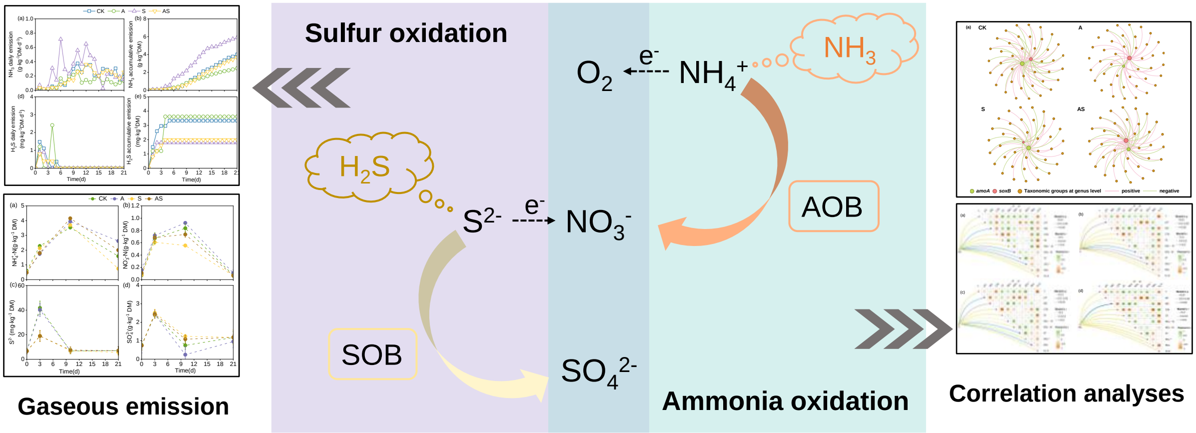

Fig. 1. Graphical Abstract

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