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Insights into the landfill leachate properties and bacterial structure succession resulting from the colandfilling of municipal solid waste and incineration bottom ash

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1. Introduction

The increasing amount of municipal solid waste (MSW) has been one of the most serious environmental issues restricting economic and social development. MSW incineration generates a large amount of bottom ash (BA). The “Standard for Pollution Control on the Landfill Site of Municipal Solid Waste ” stipulated that BA can be directly disposed of in MSW landfill sites in China. In this study, simulated bioreactor landfills in which BA and MSW were mixed at different ratios were constructed. The effects of different codisposal ratios of BA on the variations in leachate properties as well as the leachate stabilization degree were explored, the succession of the microbial community and the relationships between the microbial community and the leachate properties were illuminated. In addition, the effects of BA on the microbial function characteristics and metabolism pathways were illustrated.

2. Materials and Methods

2.1 Experimental device

total height	1000mm
inner diameter	160mm
leachate storage area	100mm
gravel area	50mm
MSW-and-BA mixing area	750mm
fine sand area	50mm
free space area	50mm

The experimental device was continuously running for one year at room temperature.

Fig. 2.1 The schematic diagram of a simulated bioreactor landfill loaded with incineration BA and MSW.

2.2 Experimental materials

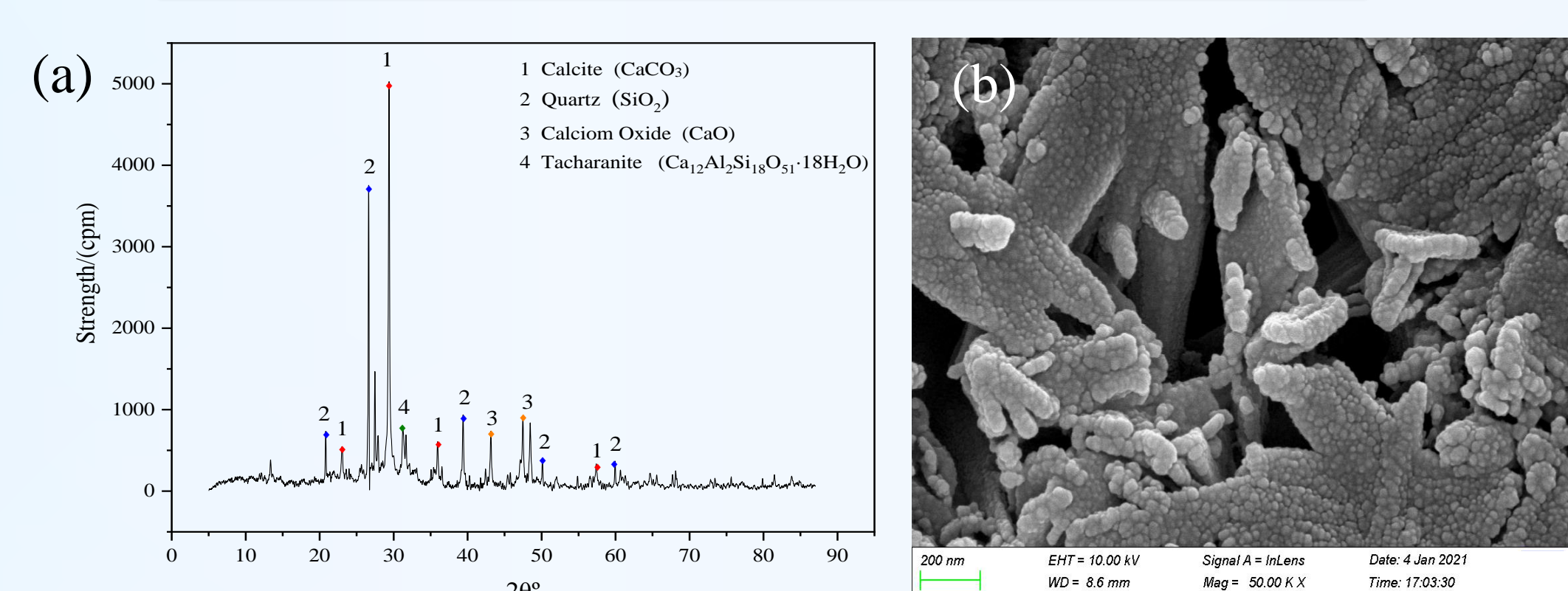


Fig. 2.2 The X-ray diffraction(XRD) (a) and the scanning electron microscopy (SEM) of the BA under the magnification times of 50000 (b).

2.3 Experimental procedure

Columns -A	only 11.25 kg MSW
Columns -B	0.56 kg BA and 11.25 kg MSW
Columns -C	1.13 kg BA and 11.25 kg MSW
Columns -D	2.25 kg BA and 11.25 kg MSW

stage I	stage II
without leachate recirculation	leachate recirculation

the leachate samples were collected through the leachate collection pipe every month

(2.5L leachate and 0.5 L distilled water) was recirculated into the column once a week by using a peristaltic pump

3. Results and discussions

3.1 Changing leachate property trends during the colandfilling process

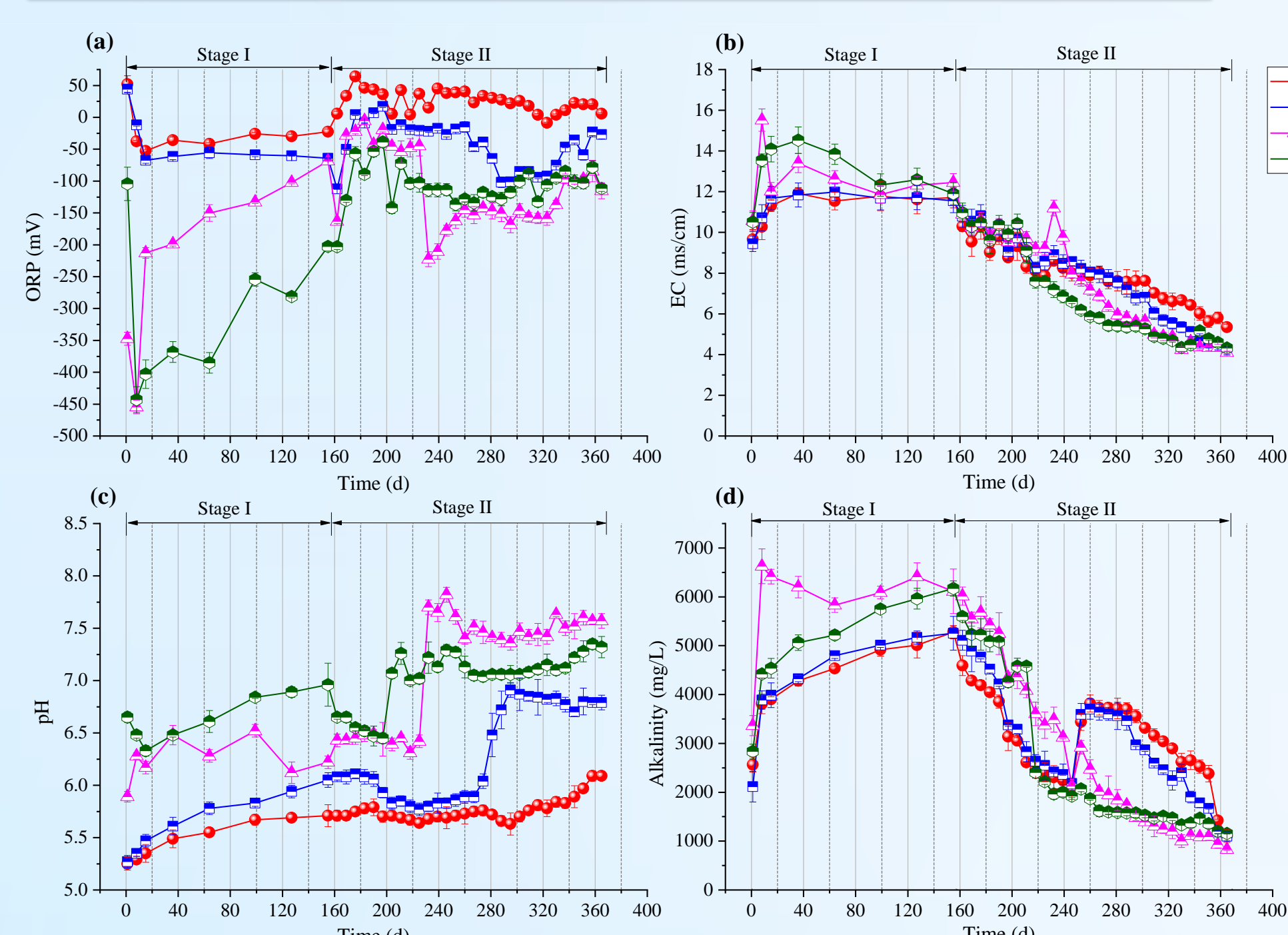


Fig. 3.1.1 The changing trends of leachate ORP (a), EC (b), pH (c), and alkalinity (d) in each column during the colandfilling of MSW and BA.

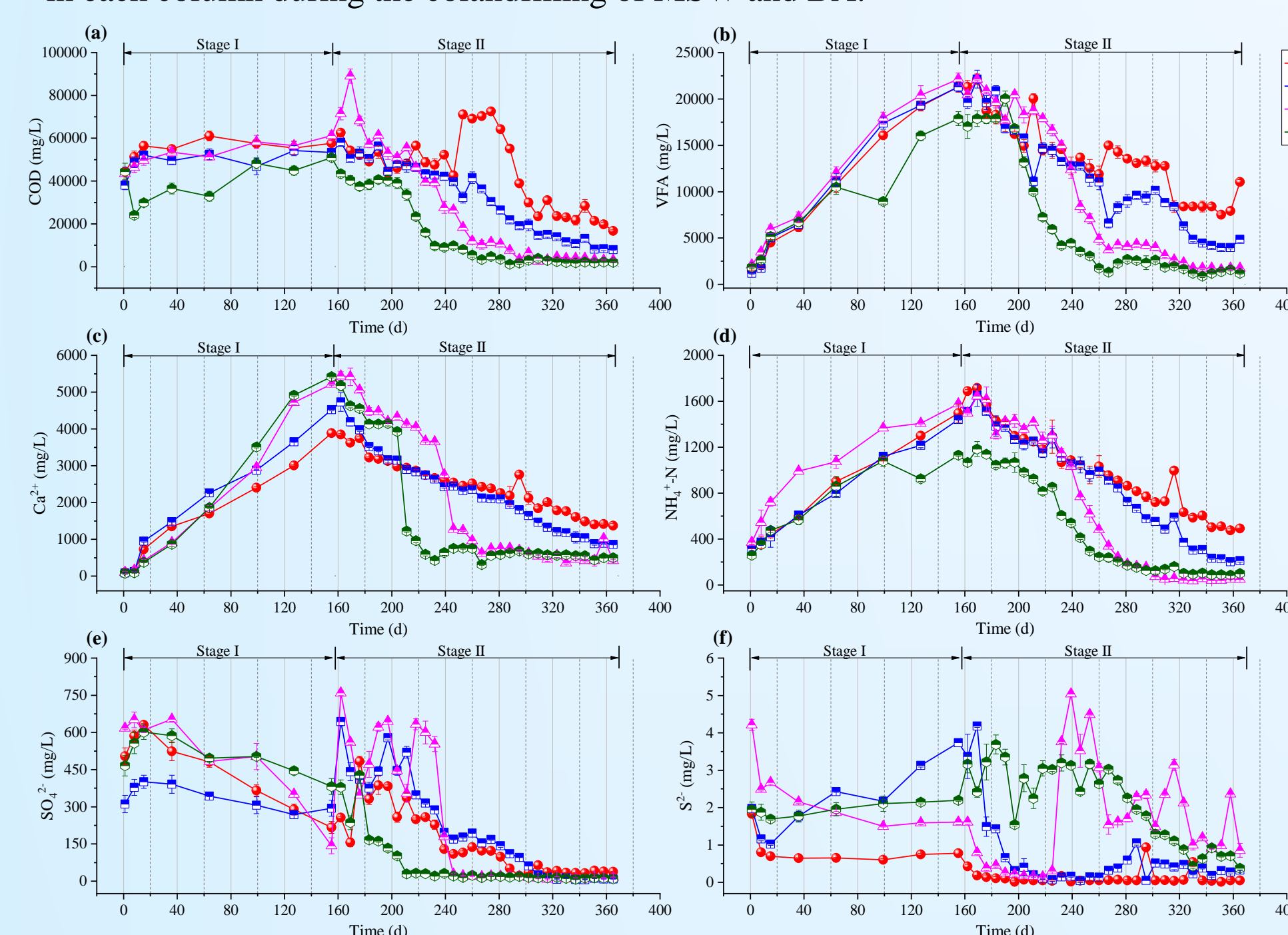


Fig. 3.1.2 The changing trends of leachate COD (a), VFA (b), Ca²⁺ (c), NH₄⁺-N (d), SO₄²⁻ (e), and S²⁻ (f) in each column during the colandfilling of MSW and BA.

3.2 Succession of the bacterial community

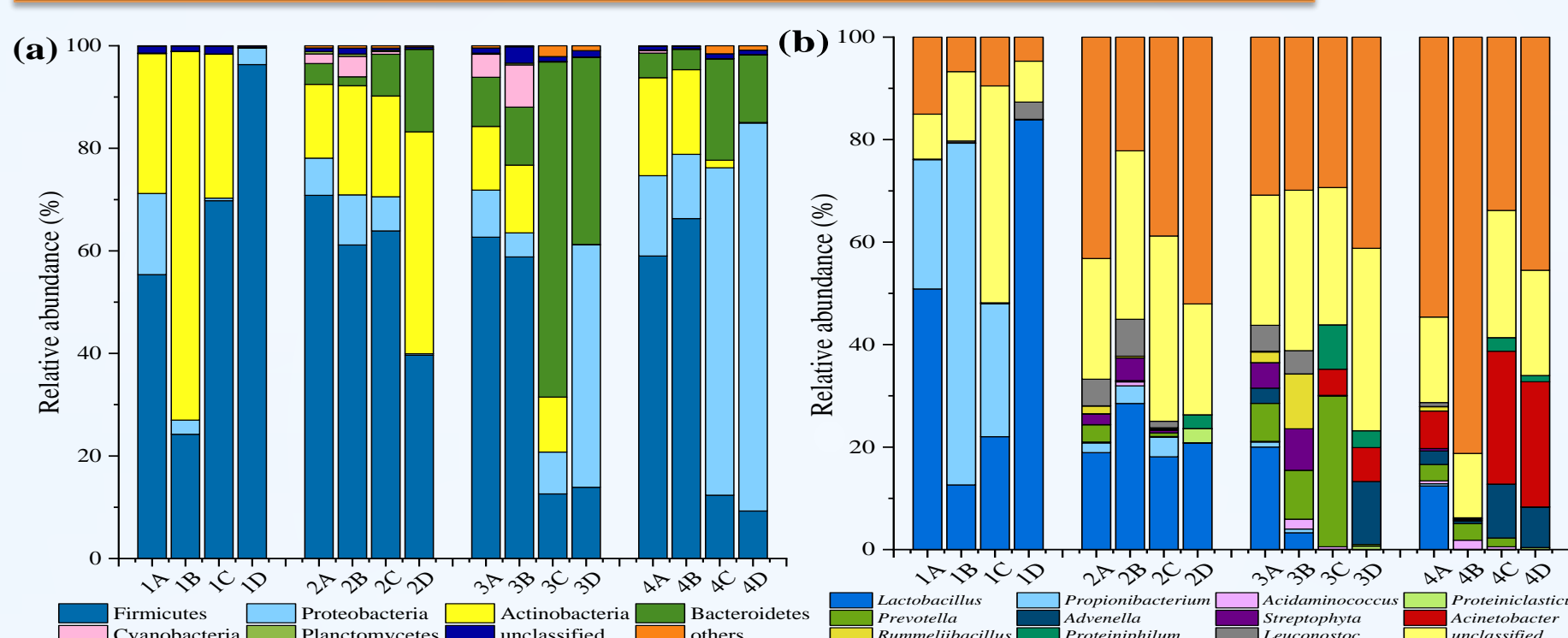


Fig. 3.2 The bacterial community structure at the phylum (a) and genus (b) levels in each column during the co-landfill process.

3.3 Correlation

Table 3.3.1 Correlation analysis between environmental physicochemical properties and bacterial community composition at the phylum level

	pH	COD	EC	ORP	E ₃₀₀₋₄₀₀	Alkalinity
Firmicutes	-0.43	0.53	0.49	0.13	0.00	0.52
Actinobacteria	-0.49	0.66	0.49	0.46	0.05	0.49
Proteobacteria	0.38	-0.46	-0.65	0.00	-0.37	-0.64
Bacteroidetes	0.69	-0.87	-0.48	-0.43	-0.07	-0.24
Cyanobacteria	-0.17	0.06	0.05	0.57	-0.54	0.44
Synergistetes	0.54	-0.82	-0.76	-0.33	-0.39	-0.58
Unclassified	-0.47	0.21	0.05	0.03	-0.17	-0.04

Table 3.3.2 Correlation analysis between environmental physicochemical properties and bacterial community composition at the genus level

	pH	COD	EC	ORP	E ₃₀₀₋₄₀₀	Alkalinity
Lactobacillus	-0.73	0.89	0.76	0.34	0.33	0.58
Propionibacterium	-0.82	0.86	0.66	0.55	0.10	0.55
Acinetobacter	0.56	-0.57	-0.66	-0.47	-0.10	-0.70
Prevotella	0.13	-0.41	-0.44	0.11	-0.67	-0.08
Adventella	0.48	-0.64	-0.65	-0.16	-0.35	-0.54
Leuconostoc	-0.48	0.51	0.52	0.58	-0.19	0.69
Streptophyta	-0.17	0.04	0.04	0.57	-0.55	0.43
Petrimonas	0.74	-0.83	-0.42	-0.38	0.04	-0.23
Proteiniphilum	0.78	-0.91	-0.46	-0.42	0.01	-0.24
Rummellibacillus	-0.16	0.06	0.16	0.54	-0.38	0.63

4 Conclusion

- The increased ratio of BA promotes COD degradation and leachate humification process.
- The more addition amount of BA, the more significant change in microbial community.
- A low BA proportion can increase metabolism pathway abundance during the initial stage, but a high BA proportion had an inhibitory effect on the metabolism pathway.

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