Anaerobic digestion of food waste: Effect of autoclave pre-treatment on NH_4-N

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Introduction

Anaerobic digestion of food (FW) waste may be difficult due to the high protein content leading to a high ammonium (NH_4-N) concentration during digestion. In this study the effect of autoclaving on the ammonium formation during anaerobic digestion of FW was studied at different organic loading rates (OLRs).

Materials and methods

11-litre semi-continuously stirred tank reactors, R1 and R2, were operating at 37 °C. R1 was fed with control FW (NH_4-N 0.3 ± 0.1 g kg^{-1}, Total Kjeldahl Nitrogen 7.4 ± 0.3 g kg^{-1}) and R2 with autoclaved $FW_{(160\ °C,\ 6.2\ bar)}$ (NH_4-N 0.4 ± 0.1 g kg^{-1}, Total Kjeldahl Nitrogen 6.8 ± 0.3 g kg^{-1}). Both digesters were supplemented with trace element solutions from day 199 onwards (Banks et al. 2012). The OLRs and hydraulic retention times (HRTs) during the study period are presented in Table 1. The initial inoculum NH_4-N concentration was 2.4 g kg^{-1}.

Table 1. OLRs and HRTs applied to the reactors (R1 control, R2 autoclaved).

OLR (kg VS m^{-3} day^{-1})	Days	Reactor	HRT (d)
2	19-150	R1	117
		R2	94
3	151-255	R1	78
		R2	63
4	256-417	R1	58
		R2	47
6	418-439	R1	39
		R2	31

Results and discussion

NH_4-N formation during anaerobic digestion was observed to decrease as a result of the autoclave treatment from 2.4 to 1.2 g kg^{-1} as the OLR was increased from 2 to 6 kg VS m^{-3} day^{-1} (Figure 1). In contrast NH_4-N in the control reactor increased to 4 g kg^{-1} over the same OLR increases after which the concentration stabilized at around 3.5 g kg^{-1}. The different NH_4-N concentrations affected the pH value and stability of the reactors.

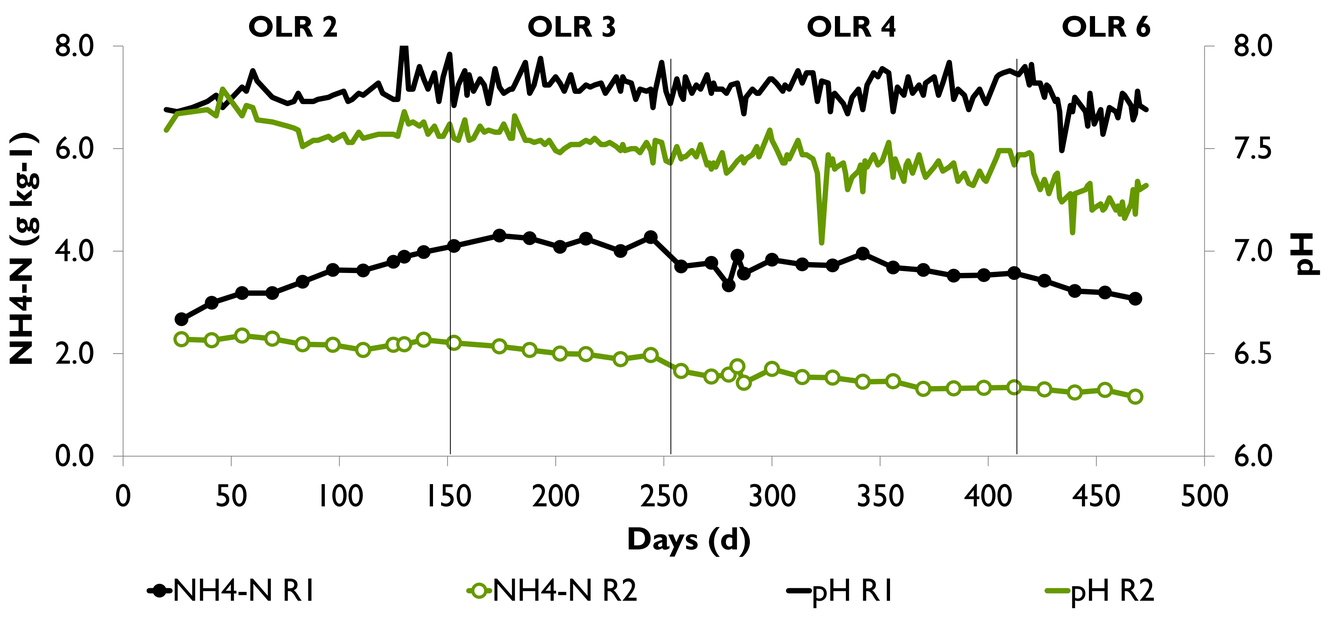

Figure 1. NH_4-N and pH during organic loading rates 2, 3, 4 and 6 kgVSm^{-3}day^{-1} in control (R1) and autoclaved (R2) reactors. OLR increase is presented with vertical lines.

With the autoclaved FW the nitrogen present as proteins was not able to be hydrolysed during the anaerobic digestion. Most likely this was caused by formation of Maillard compounds through reactions between proteins and sugars. These compounds change the biodegradability of the material making it harder or even impossible to degrade, with the result that the simple free and ionic forms of ammonia are not present. The increasing NH_4-N in control reactor was as a result of the effective hydrolysis of protein material.

Conclusions

Autoclave treatment of FW decreased NH_4-N concentration during anaerobic digestion which may reduce the risk of ammonia inhibition, but will also affect the overall conversion efficiency.

References

Banks, C.J., Zhang, Y., Jiang, Y., Heaven, S., 2012. Trace element requirements for stable food waste digestion at elevated ammonia concentrations. Bioresour. Technol. 104, 127-135.

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