Anaerobic co-digestion of oleic acid and whey protein: the role of emulsification

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Oleic acid is the most widespread unsaturated fatty acid in nature. It is suitable for biogas production, however, it is often responsible for process inhibition, due its high toxicity even at low concentrations. In this study, anaerobic co-digestion of oleic acid and whey protein was examined in continuous (batch-fed) stirred tank digesters.

The feed consisted of 5 g/L oleic acid and 20 g/L whey protein. Emulsification was performed with a high shear emulsifier while the mixture was pre-heated at 75 ^{o}C to optimize the procedure. The anaerobic reactors had a working volume of 2 L and were operated at 39 ^{o}C. Inside the reactor MLSS concentration was maintained at 10.2±2.5 g/L and the ammonia nitrogen at 2.5±0.2 g/L Micro-nutrients were supplemented according to Eftaxias et al. (2018). Chemical analysis were performed according to the Standard Methods (APHA, 1992).

Continuous anaerobic treatment of emulsified oleic acid displayed higher biogas yield (0.47 L/gCOD), compared to non- emulsified (0.38 L/gCOD) (Figure 1). The latter, resulted in major foaming inside the digester, while individual lipid particles were floating on top of the mixed liquor. On the contrary, supernatant COD and the VFA concentrations were significantly higher for the digester treating emulsified oleic acid, which was indicative of process inhibition. The methanogenic (acetoclastic) activity of the anaerobic sludge decreased after treatment of the oleic acid based effluent (Figure 2).

Concluding, oleic acid solubility plays a critical role on the anaerobic digestion process. The results of this study demonstrate the importance of emulsification pre-treatment for high-rate anaerobic treatment of oleic acid based effluents. Increasing, however, oleic acid solubility can inhibit acetoclastic methanogenesis.

Acknowledgements

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References

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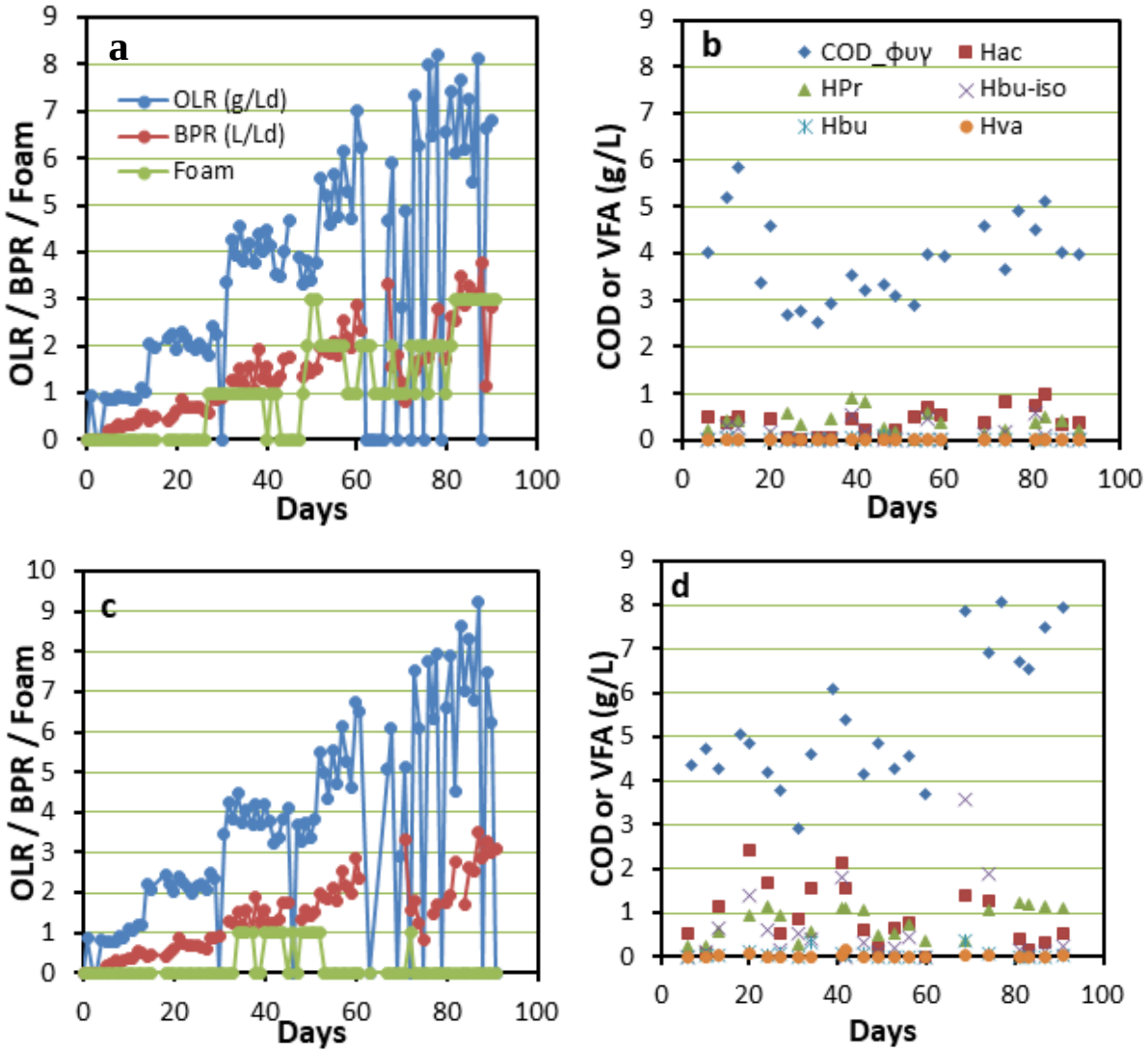

Figure 1. Evolution of the (a, c) organic loading rate (OLR in g/Ld), biogas production rate (BPR in L/Ld) and foaming degree (in cm), and (b, d) digester supernatant COD and VFA concentrations, during continuous anaerobic digestion of (a,b) non-emulsified and (c,d) emulsified oleic acid.

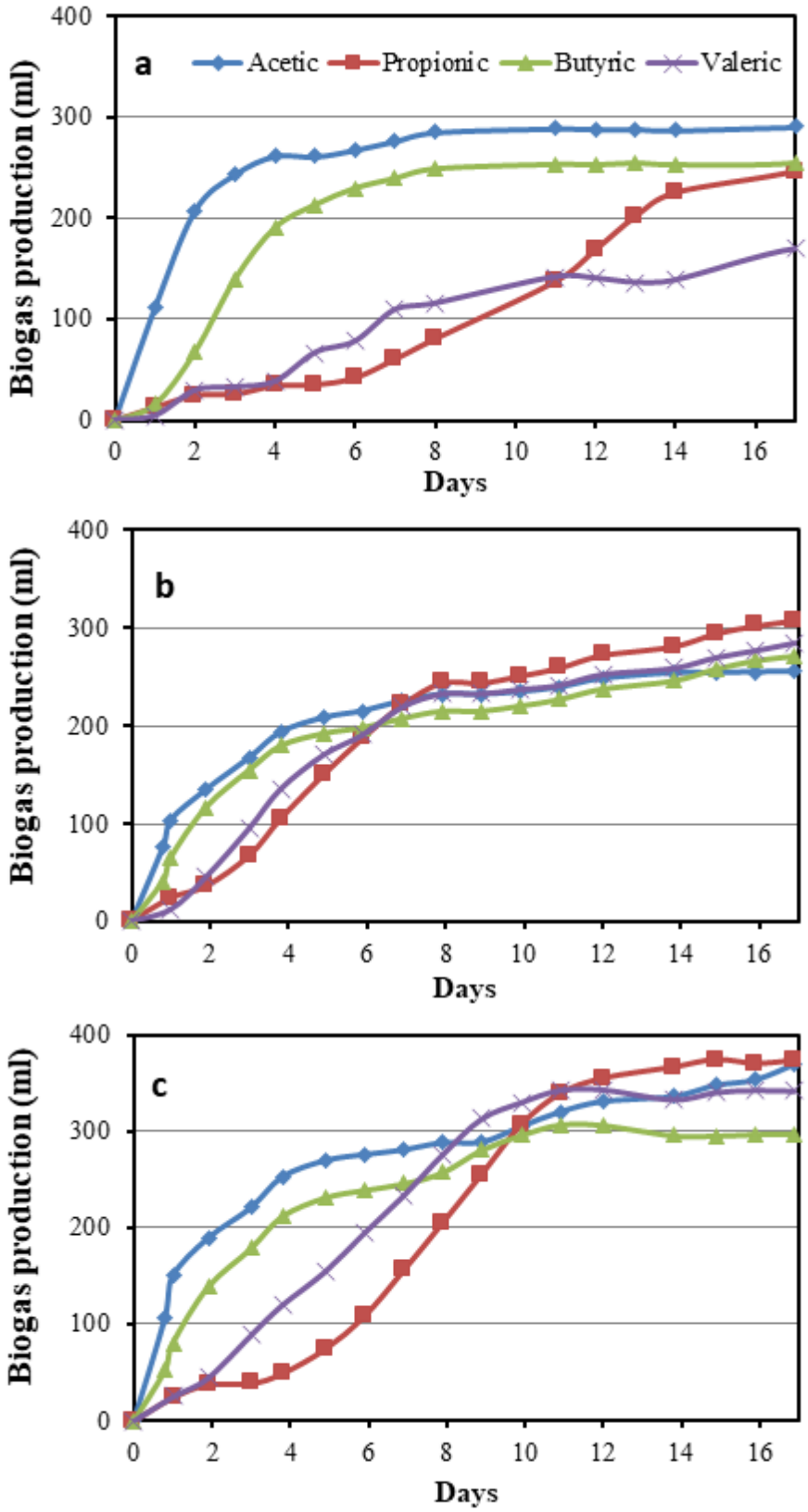

Figure 2. a. Biogas production during batch anaerobic digestion of acetic, proprionic, butyric and valeric acid by the (a) seed anaerobic sludge, (b) anaerobic sludge after treatment of non-emulsified oleic acid, (c) anaerobic sludge after treatment of emulsified oleic acid.