



Unveiling the technology and mechanisms of medium-chain fatty acid production from waste activated sludge fermentation liquor



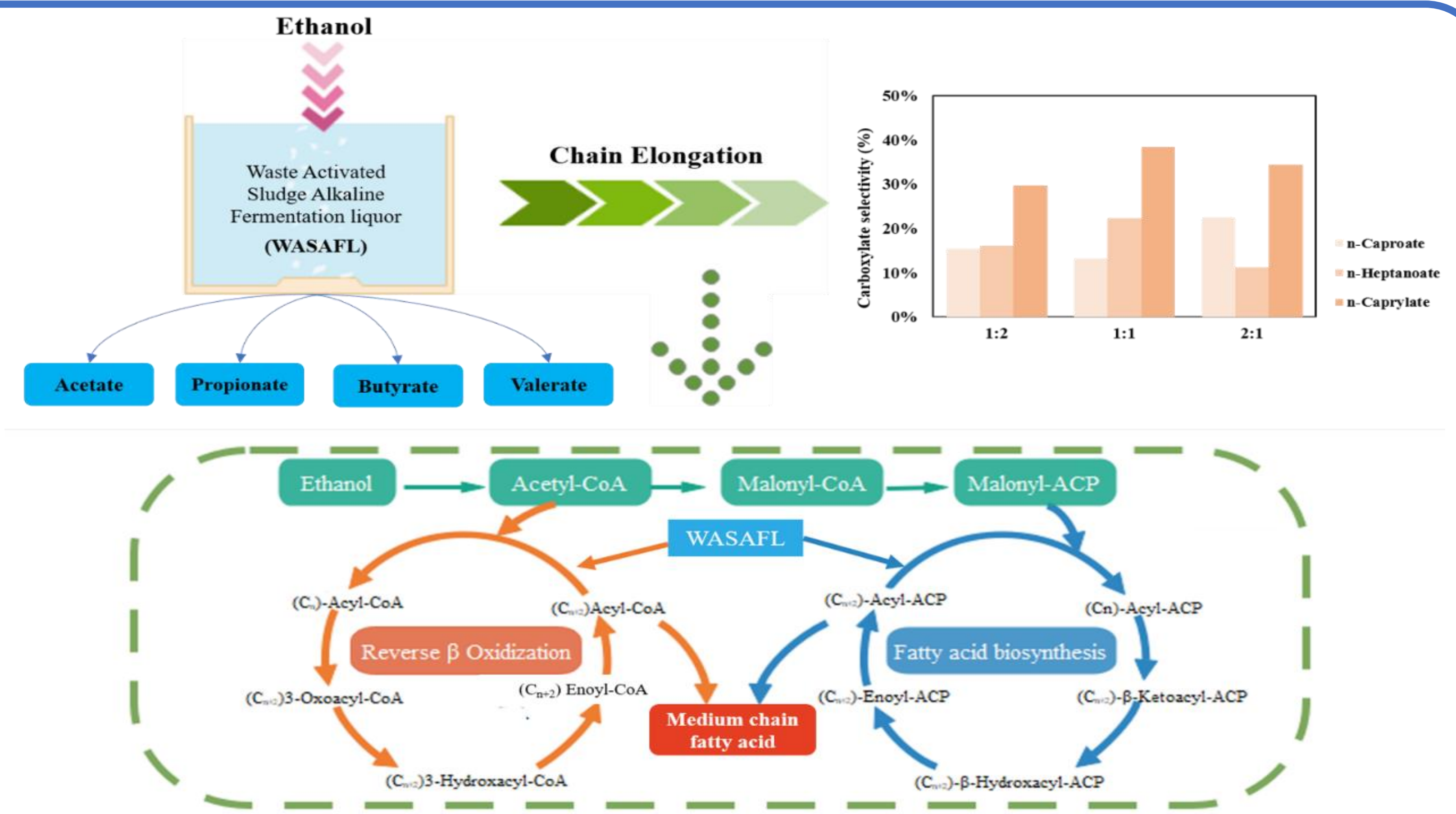
Shu-Lin Wu^{1,2}, Yuyang Long^{1,2} and Dongsheng Shen^{1,2}

¹ School of Environmental Science and Engineering, Zhejiang Provincial Key Laboratory of Solid Waste Treatment and Recycling, Zhejiang Gongshang University Hangzhou 310012, China

² China Zhejiang Engineering Research Center of Non-ferrous Metal Waste Recycling, Hangzhou 310012, China

ABSTRACT

Chain elongation (CE) with open-culture microbiomes has been demonstrated to be an effective biotechnological platform to produce valuable medium chain fatty acids (MCFAs). Herein we reported a new biotechnological process for producing MCFAs by using waste-activated sludge alkaline fermentation liquor as feedstock and electron acceptors (EAs) with ethanol as electron donor (ED). Under three different carbon-molar ratios of ED to EAs (i.e., 1:2, 1:1 and 2:1), three different types of MCFAs (i.e., n-caproate, n-heptanoate and n-caprylate) were produced. Thermodynamic analysis showed the higher amount of ethanol was more favorable for MCFAs production. Microbial community revealed that the ethanol participation caused microbes shift in the favorable direction for CE process. Metagenome analysis showed both reverse β -oxidation and fatty acid biosynthesis pathways simultaneously enhanced and occurred in the CE process.



MATERIAL AND METHODS

Waste activated sludge alkaline fermentation liquid (WASFL) was cultivated under alkaline condition (pH=10) with waste activated sludge from secondary sedimentation tank of municipal waste water treatment plant. After reaching the steady state, different levels of ethanol were added into fermenters as electron donor (ED). To investigate a wide range of carbon molar ratio of ED to EA on the CE process and to avoid the toxicity of ethanol and produced MCFAs on microorganisms, CE experiments were carried out with ethanol as the ED under three different carbon molar ratios of ED to EA, i.e., 1:2 (R1), 1:1 (R2), and 2:1 (R3). Thermodynamic analysis was applied to explore the spontaneity of the CE process with WASFL as EA and ethanol as ED. Illumina Miseq sequencing was applied to explore the shift of microbial communities and functional microbes in CE process. Metagenomic analysis was applied for figuring out the pathway participated in CE process.

THERMODYNAMIC ANALYSIS

All CE reactions were exothermic and high additive of ethanol was favorable for CE

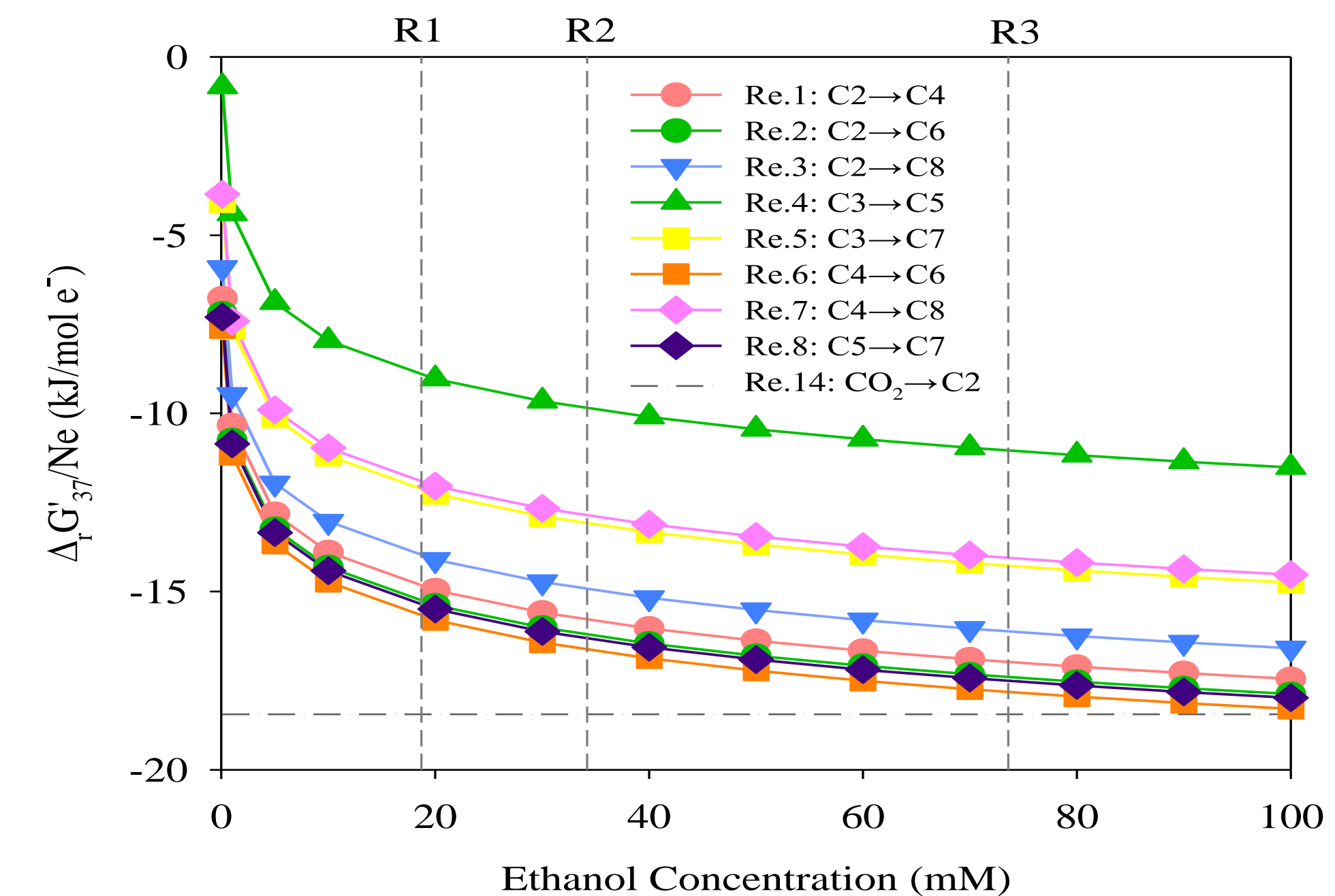


Figure 2. Thermodynamics calculation in three sets of ED to EA ratios

MCFA PRODUCTION PERFORMANCE

The experiment of converting WASAFL into MCFAs as a fermentation substrate is feasible, and the yield of MCFAs increases with the increase of the ED/EA ratio

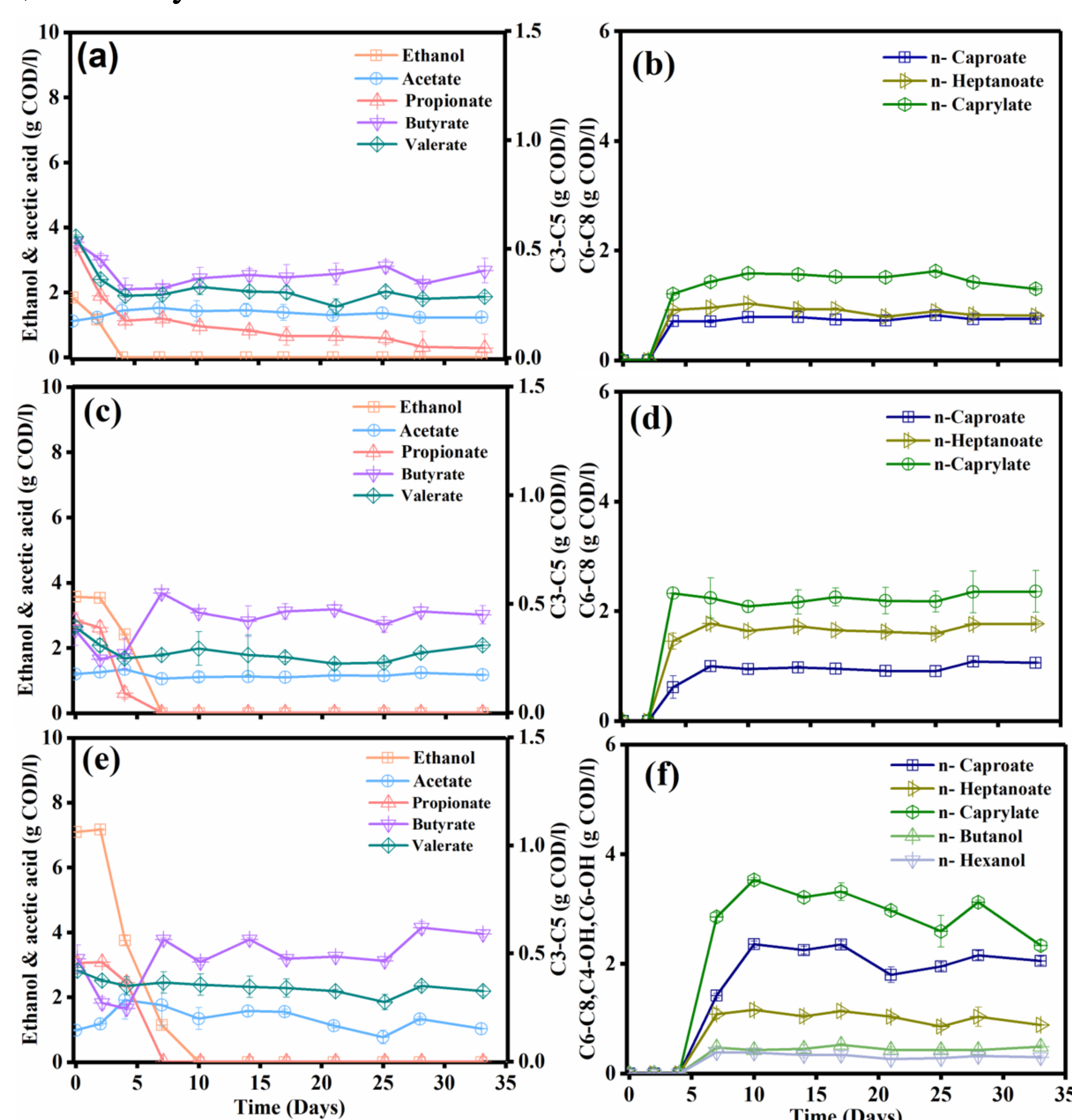
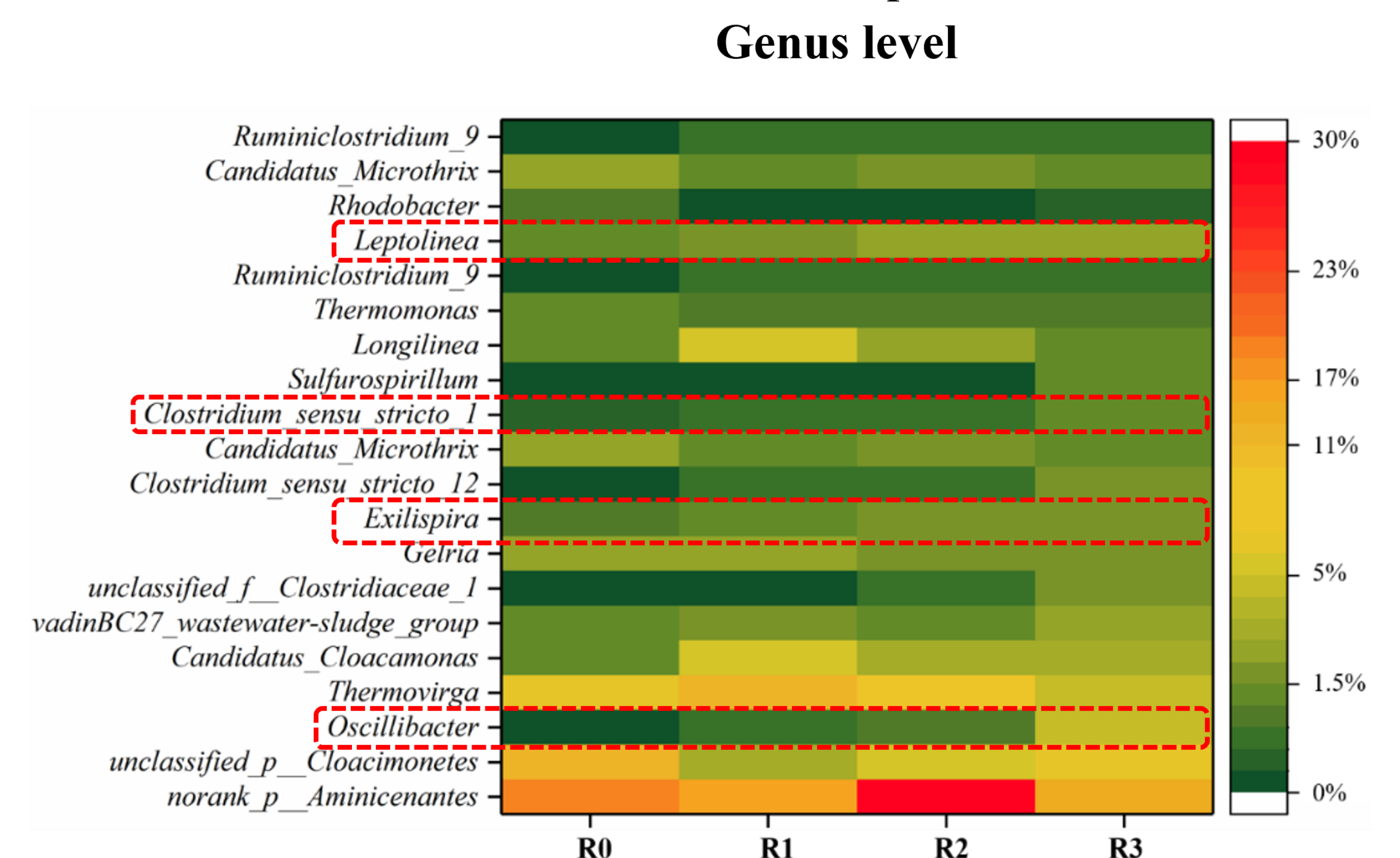


Figure 1. Concentrations evolution of ethanol, SCFAs and MCFAs (C6~C8) in three sets of CE experiments

MICROBIAL COMMUNITY ANALYSIS

The *Clostridium sensu stricto*, *Oscillibacter*, *Leptolinea* and *Exilispira* were increased with the ethanol addition and MCFA production



CONCLUSION

- ◆ MCFAs production from WAS alkaline fermentation liquor was achieved
- ◆ MCFAs production is positively related to the level of ethanol as electron donor
- ◆ A high level of ethanol could reduce the selectivity of MCFA production
- ◆ Key functional microbes involved *C. Kluyveri*, *C. botulinum* and *C. magnum*

REFERENCE

Wu Shu-Lin and Ni Bing-Jie. Unveiling the mechanisms of medium-chain fatty acid production from waste activated sludge alkaline fermentation liquor through physiological, thermodynamic and metagenomic investigations. Water Research 2019; 169: 115218.