Energy production from lipids by novel anaerobes

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Anaerobic microbial diversity encloses a very high potential that can be used for biotechnological applications. This potential is still largely unexplored, since the majority of the microorganisms in Nature are unknown or poorly characterized. This work is focused on the study of novel anaerobic microorganisms that participate in the metabolism of lipids, long chain fatty acids (LCFA) and glycerol, with the main goal of producing valuable energy-rich organic compounds. For that, conventional anaerobic culturing procedures were combined with continuous bioreactors operation and allied to microbial ecology approaches. Two main examples of the work performed will be presented.

Anaerobic sludge from a thermophilic (55ºC) bioreactor fed with lipids was used to study glycerol conversion. A glycerol-degrading enriched culture, mainly composed of two microorganisms affiliated with *Thermotoga* and *Anaerobaculum* genera, was obtained by batch successive transfers and serial dilution. Methane and acetate were the only products detected from glycerol conversion by this culture.

Besides glycerol, the hydrolysis of lipids produces LCFA. These compounds can be converted to methane by the combined activity of anaerobic bacteria, that degrade LCFA to acetate and hydrogen, and methanogens that use those compounds to produce methane. Our recent results provide strong evidence of an unexpected and crucial role of facultative anaerobic bacteria in LCFA degradation. In order to investigate this further, two bioreactors were operated in parallel, one under strict anaerobic conditions (R1) and the other with a feeding tank opened to the air (R2). When high LCFA loadings were applied, the degradation of LCFA was inhibited in R1 but not in R2, which seems to be directly related with the higher redox potentials observed in R2. These results reflect the real conditions that prevail in industrial wastewater treatment plants, since strict anaerobic conditions are difficult to achieve and maintain. Characterization of facultative anaerobes performing these conversions will be presented.

This research opens new insights into the physiology of anaerobic microorganisms with importance in biotechnological processes and for the biobased economy, and allows to link microbial identity to function.