Perspectives on syngas fermentation

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The replacement of fossil fuels by renewable energy sources is, nowadays, a worldwide priority. Gasification processes and further bioconversion of syngas appears to be a promising alternative compared to the existing chemical techniques, since this process convert renewable sources into alternative fuels and commodity chemicals, such as CH_4, fatty acids, alcohols, etc., additionally contributing to the reduction of greenhouse gases [1]. Nearly any form of organic matter can be transformed through gasification, into syngas, mainly composed of CO, H_2 and CO_2. The biological conversion of syngas offers several advantages over catalytic processes, specifically the greater resistance to catalyst poisoning and the higher specificity for the substrates [2]. Syngas- and CO-fermenting microorganisms use the Wood-Ljungdahl pathway to produce several multi-carbon compounds such as short- and medium-fatty acids and alcohols. Even though many studies were performed in the last few years, fermentation of syngas still involves practical challenges due to limitations of the process. The major bottleneck of syngas fermentation that blocks the commercialization of this technology is gas-to-liquid mass transfer limitations, since it reduces the microorganisms' access to the substrate and consequently reduces the productivity rates. It is of utmost importance the development of alternatives that promote the enhancement of mass transfer, the improvement on the productivity rates from syngas fermentation and the deep study of the biocatalysts involved in syngas bioconversion pathways. Biological syngas conversion has been a research topic at the BRIDGE group since 2009, by studying both technological and microbiological aspects of the process. Previous work developed in our group focused on the use of anaerobic complex microbial communities to obtain enriched cultures and/or pure cultures that could convert syngas or CO into mainly acetate, CH_4 and H_2. Regarding to the technological aspects of syngas bioconversion process, a multi-orifice baffled bioreactor was used to study the effect of using different reactors designs to improve the gas-liquid mass transfer. Moreover, recent studies conducted at BRIDGE group with collaboration of BIOSYSTEMS group showed that the use of increased pressure (up to 5 bar) to increase gas-liquid mass transfer, leads to different metabolic routes on microorganisms. These results represent a step forward to direct the biochemical pathways of microbial community towards the specific products from syngas. As future perspectives, we aimed to continue a research line on syngas fermentation, by studying different operational approaches for this process and focusing on the production of butanol, 2,3-butanediol and propionate.

References

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