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MICROBIAL PROPIONATE PRODUCTION FROM CARBON MONOXIDE – A NOVEL BIOPROCESS

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Introduction: The fermentation of CO-rich gases by carboxidotrophic microbes is a promising way to produce valuable organic compounds. Propionate is a value-added compound with numerous industrial applications, e.g. as an antifungal agent in food and feed, and as a building block to produce plastics and herbicides. Propionate is currently produced by petrochemical processes, but it can be produced from ethanol and acetate by some propionogenic bacteria. Ethanol and acetate are usually formed by acetogenic bacteria from CO-rich gases. Accordingly, propionate can be indirectly produced from CO-rich gases, representing a new approach on the realm of microbial CO conversion.

Methodology: Four distinct synthetic co-cultures were constructed, consisting of: *Acetobacterium wieringae* (DSM 1911^{T}) and *Pelobacter propionicus* (DSM 2379^{T}); *A. wieringae* (DSM 1911^{T}) and *Anaerotignum neopropionicum* (DSM 3847^{T}); *A. wieringae* strain JM and *P. propionicus* (DSM 2379^{T}); *A. wieringae* strain JM and *A. neopropionicum* (DSM 3847^{T}). The physiology of CO conversion to propionate was accessed and a proteogenomic analysis was performed in the best performing co-culture to get insight into the involved biochemical pathways and microbial interactions within the synthetic consortium.

Results: Propionate was produced by all the co-cultures, with the highest titer (~24 mM) measured in the co-culture composed of *A. wieringae* strain JM + *A. neopropionicum*, which also produced isovalerate (~4 mM), butyrate (~1 mM), and isobutyrate (~0.3 mM). In this synthetic consortium, *A. wieringae* strain JM converts CO to a acetate and ethanol via the Wood-Ljungdahl pathway; acetate can also be converted to ethanol through the action of aldehyde oxidoreductase (AOR); *A. neopropionicum* converts ethanol to propionate via the acrylate pathway. In addition, proteins related to amino acid metabolism and stress response were highly abundant during co-cultivation, which raises the hypothesis that amino acids are exchanged by the two microorganisms, and this results in isovalerate and isobutyrate production.

Conclusions: This synthetic co-culture represents a new bioprocess for the microbial production of propionate from carbon monoxide, that couples the Wood-Ljungdahl and acrylate pathways. Furthermore, this symbiosis engages an interesting perspective on how C1-fixing and C3-producing microorganisms can be used to expand the product scope of gas fermentation.

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