Direct and indirect electron uptake drives different product production from CO_2 electrosynthesis in Rhodobacter sphaeroides

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The electron donor is essential to provide respiratory energy to the metabolism of living organisms. Although most microbes usually uptake electrons from soluble organic matter or reduced inorganic compounds (i.e. electron donors), some electroactive bacteria can directly uptake electrons from the solid electrode surface. However, most previous studies focus on reduction of C1, so far less is known about the metabolic shift and electron transfer mechanism of direct and indirect electron uptake in CO_2 fixation. In this study, we focused on polyhydroxybutyrate as the target product from CO_2 electrosynthesis to examine the direct and indirect electron uptake of Rhodobacter sphaeroides. Our results show that R. sphaeroides converts more CO_2 into products by direct electron uptake, but the cell grow slowly compare to indirect electron uptake. Notably, although cells growth is retarded, and both Rubisco form I and form Ⅱ are highly down-regulated in direct electron uptake, but the NADH depend isocitrate dehydrogenase expression is stimulated by direct electron uptake. The Direct electron uptake and CO_2 fixation also occurs under dark conditions, uncoupled from photosynthesis.