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Thermostable enzymes involved in alcohol fermentation at high temperatures

It is known that many hyper thermophilic microorganisms can grow on carbohydrates and peptides to produce ethanol as a product. Pyruvate is a central metabolic intermediate that can be further fermented to ethanol. There are two pathways for the alcohol production from pyruvate. One is the two-enzyme pathway, and another is the three-enzyme pathway. It was not clear which one or a novel one could be used by hyperthermophiles. Activities of alcohol dehydrogenase (ADH), pyruvate ferredoxin oxidoreductase (POR) and pyruvate decarboxylase (PDC) were detected in hyper thermophilic bacteria *(Thermotoga* species) and archaea *(Pyrococcus furiosus* and *Thermococcus* species), but no CoA-dependent aldehyde dehydrogenase (AcDH) and its homolog genes have been found, indicating the presence of a two-enzyme pathway in hyperthermophiles. Novel ADHs and PDCs were further studied. A highly active ADH from hyper thermophilic archaeon *Thermococcus guaymasensis* (Tg) was purified to homogeneity and was found to be an NADP+-dependent enzyme contained 0.9±0.03 g atom zinc per subunit. Another alcohol dehydrogenase was purified from Thermotoga hypogea (Th), and the purified enzyme contained 1.02±0.06 g-atoms of iron per subunit. Its physiological role was proposed to catalyze the reduction of aldehydes to alcohols, which is very similar to those iron-containing alcohol dehydrogenases from hyper thermophilic archaeal Thermococcus species. A novel bifunctional PDC was found to catalyze both oxidative (POR) and non-oxidative (PDC) decarboxylation of pyruvate, producing acetyl-CoA and acetaldehyde, respectively. The PDC activities were present in hyper thermophilic archaeon T. guaymasensis (Tg) and bacterial species *Thermotoga maritima* (Tm) and T. hypogea (Th). Coenzyme A or desulfo-CoA was required for the PDC activity. It is concluded that the thermostable ADH and bifunctional PDC enzyme are present in hyper thermophilic archaeon *T. guaymasensis* and bacteria T. *maritima and T. hypogea*, and there is a modified two-enzyme pathway for alcohol fermentation at high temperatures.

Biography

Kesen Ma is a Microbiologist graduated from the Department of Biology, Wuhan University. After completing graduation with an MSc degree from the Institute of Microbiology, Chinese Academy of Science (CAS), he went to Germany as a Max-Planck-Institute fellow and obtained his PhD from Philipps-University Marburg. He worked as a Research Associate at the University, and a postdoctoral fellow and then an Assistant Research Scientist at the University of Georgia, United States. He became a graduate Faculty at the Department of Biochemistry and Molecular Biology at the University of Georgia. He is an Associate Professor in the Department of Biology at the University of Waterloo, Canada. His current research has a focus on enzymology, metabolism, bio-processing and biotechnological applications of hyper thermophilic microorganisms.

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