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Author: Dr. Bing Huang
Chinese PLA General Hospital, China

Dr. Peng Lei
Fullarton Space Biotech Co., Ltd., Australia
Prof. Hongwei Hao
Fullarton Bio-Tech (Beijing) Co., Ltd., China
Prof. Ying Huang
Institute of Microbiology, Chinese Academy of Sciences, China

EFFECTS OF SPACEFLIGHT AND SIMULATED MICROGRAVITY ON MICROBIAL GROWTH AND SECONDARY METABOLISM

Abstract

Spaceflight and ground-based microgravity analog experiments have suggested that microgravity can affect microbial growth and metabolism. Although the effects of microgravity and its analogs on microorganisms have been studied for more than 50 years, plausible conicting and diverse results have been frequently reported in different spaceight and clinorotation experiments, especially in the elds of cell growth and secondary metabolism. At present, only the responses of a few typical microbes, including fungi and archaea, to microgravity and its analogs have been investigated; systematic studies of the genetic and phenotypic responses of these microorganisms to microgravity in space are still insufficient due to technological and logistical hurdles. The use of different test strains and secondary metabolites in these studies appear to have caused the diverse and conicting results. We compare the technological methods of microgravity experiments used for spaceflight and ground-based simulated microgravity. We also analyze the similarities and differences in the effects on microbial growth and secondary metabolism, as well as the causes of the inconsistent results. Based on our comprehensive analysis of previous studies conducted by us and others, it is clear that the experiments performed under spaceflight and ground-based microgravity condition analogs differed in some procedures, including use of different strains (e.g., motile with flagella or non-motile without flagella), growth media (e.g., fluidity and nutrient concentrations), and types of ground-based facilities (GBFs), which may lead to the conicting results described below. Moreover, subtle changes in the extracellular microenvironment around the microbial cells play a key role in the diverse responses of microbial growth and secondary metabolism. Therefore, "indirect" effects represent a reasonable pathway to explain the occurrence of these phenomena in microorganisms. We summarizes and discusses the results of microbial growth and secondary metabolism in response to spaceflight and ground-based microgravity analogs in previous and recent investigations, and deeply probes the causes of the diverse and conicting results. Our study on the effects of spaceight (Shenzhou-8) and ground-simulated microgravity (SMG) on the growth and secondary metabolism of Streptomyces coelicolor A3(2) has showed that the external physical factors would play a more dominant role in the effects of microbial growth under spaceflight or its analog conditions. It is reasonable to propose our insights into the diversified responses of microbial growth and secondary metabolism to microgravity and the possible mechanisms. Accordingly, recommendations are given for future studies on microbial growth and secondary metabolism in response to microgravity in space.