Survival of the halophilic archaeon Halovarius luteus after desiccation, simulated Martian UV radiation and vacuum in comparison to Bacillus atrophaeus

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Abstract

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The detection and identification of life on planetary objects other than Earth is one of the most important questions in current science. Extraterrestrial environments impact the biochemistry of organisms with high levels of radiation, vacuum, temperature extremes and a lack of water and nutrients. A wide variety of terrestrial microorganisms, counted amongst the most ancient inhabitants of Earth, can cope with high levels of salinity, extreme temperatures, desiccation and radiation. Key among these are the Haloarchaea, considered particularly relevant for astrobiological studies due to their ability to thrive in hypersaline environments. In this study, a novel haloarchaea isolated from Urmia Salt Lake, Iran, *Halovarius luteus* strain DA50T, was exposed to varying levels of simulated extraterrestrial conditions. The haloarchaea's response to these conditions was compared with the response of the bacteria *Bacillus atrophaeus*. *Bacillus atrophaeus* was selected as a point of comparison for its well-described resistance to extreme conditions and its capability to produce strong spore structures consisting of coat, cortex, outer membrane, germ cell wall, inner membrane and core (Zandomeni *et al.*, 2005b). Thin films of different thickness were produced to investigate viability without the protective influence of cell multi-layers. *Hvr. luteus* and *B. atrophaeus* were placed in brine and phosphate buffered saline (PBS) media, respectively. The solutions were allowed to evaporate and cells were encapsulated, consequently. Samples were exposed to desiccation and vacuum conditions, and their post-exposure viability was studied by the Most Probable Number (MPN) method. The proteome was analyzed by electrophoresis. Results showed that the changes in viability of the spore-forming bacteria *B. atrophaeus* were only minor whereas the *Hvr. luteus* demonstrated a range of viability under different conditions. At the peak radiation flux of 105 J/m2 under nitrogen flow and after two weeks of desiccation, *Hvr. luteus* demonstrated the greatest decrease in viability. This study further expands our understanding of the boundary conditions of astrobiologically relevant organisms in the harsh space environment.

Key words: *Halovarius luteus*, *Bacillus atrophaeus*, desiccation, Mars simulation chamber, simulated Martian UV radiation, vacuum.

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