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DNA STABILITY AND INTEGRITY AFTER SPACE FLIGHT AND RE-ENTRY

Abstract

Desoxyribonucleic acid (DNA) plays a unique role in storage and transmission of the genetic information of all living organisms on Earth and represents a valuable biomarker to detect life. The massive bombardement in the early stage of the Earth's history represents a possibility to explain the hypothetical interplanetary transport of matrix-bound DNA to Earth. In this szenario, the DNA would have to withstand the hostile conditions in space as well as the extreme conditons during atmospheric-entry. In our experiment we analysed if DNA withstands the Earth atmosphere entry-conditions prevailing during a ballistic rocket flight and if it retains its biological activity. We investigated the stability and functionality of artificial plasmid DNA during atmospheric re-entry conditions. We chose an expression vector carrying a fluorescent marker (enhanced green fluorecent protein: EGFP) and an antibiotic resistance cassette (Kanamycin). During the TEXUS-49 mission we applied 50-100μg of DNA on 15 different positions on the outer surface of the payload:i) directly on the surface,ii) on screws of the TEM-EML4 module and iii) on the bottom side of the TEM06-16 module. The payload obtained a maximal height of 264km after the launch. On the inside of the recovery module temperatures of 130 degree Celsius were measured while at the sample application locations, temperatures of more than 1000 degree Celsius were estimated. Directly after retrieval and back transport of the payload, DNA samples were recovered. The recovery rate was in the range of 4.92–27.3%, photometric measurements of DNA purity showed values between 1.65 and 1.81 (260nm/280nm ratio). Representative samples were analysed to determine the DNA integrity by transformation in bacteria. Subsequently to an incubation time of 12-14h, bacterial growth was detected due to the incorporated plasmid antibiotic resistance. This indicates that at least a fraction of the plasmid DNA was intact after recovery. A second functionality test was performed by transfecting the DNA into mouse-fibroblast-cells to analyse the integrity of the fluorescent marker. For all selected DNA samples we could show cellular expression of the EGFP, demonstrating the functionality of the recovered plasmid DNA. Finally, we investigated the DNA mutation and degradation rate by sequencing and agarose gel electrophoresis analyses. We were able to show that plasmid DNA bound to a matrix can withstand a period of residence in space and the re-entry conditions into the Earth atmosphere as well as the landing and stays intact and active in its function as carrier of genetic information.