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Author: Dr. Sergey Bulat
Federal State Institution Russian Research Center Kurchatov Institute, Russian Federation

SUPER RESISTANCE OF DSDNA TO GAMMA-RADIATION DAMAGE AT DEEP COLD (-195.8OC)

Abstract

The dsDNA molecules are relatively stable but could quickly fragmented by ionization radiation. If we are looking for extraterrestrial life, the best place to search for it is icy satellites (e.g., Jovian Europa or Saturn's Enceladus). However, the fluxes of highly energized protons, electrons (mostly for Europa; the surface 1cm deep irradiation – 30kGy/year) and heavy ions on these targets from the parent body (e.g., Jupiter) or cosmic radiation can provide a challenge for DNA (microbial) integrity. The objective of the study was to estimate the low bound of already-known attenuation effect of ultralow temperature at normal pressure on the efficacy of gamma-radiation in fragmenting dsDNA. The general purpose of the study was to simulate the 'fate' of ocean-below-ice-inhabiting microbes flushed out via cracks on the Jovian Europa. As a model, the plasmid vector pCR-4 (4000bp) for cloning containing the insert of a bacterial rRNA gene (v3-v4 region – 485bp) was used in irradiation trials under the liquid nitrogen conditions (-195.8oC). The gamma-induced fragmentation was tested in specific PCR generating the dsDNA band of the expected size (600bp); in fact, it is disappearing upon complete fragmentation of the insert. As a radiation source, the 60Co-charged device 'Issledovatel' (PNPI) was in use. The tubes with a crude bacterial lysate containing the target (vector with an insert in a cell debris mix) were put at the bottom of a stain steel thermos (with the help of heavy load) filled with the liquid nitrogen. The dose rate was 5kGy per hour. The time series were up to 300kGy (60 hrs). The detection level of the DNA signal in a gel stained with SYBR Gold was about 10pg. At the ambient temperature, the insert entirely disappeared (DNA stained with SYBR Gold) upon the doze 7.5kGy while under the deep freeze at -195.8oC – 270kGy what accounts for 35 difference. A similar effect was observed at a bit high temperature (-78.5oC – dry ice). Such a considerable difference in dsDNA 'survival' may benefit in resisting DNA (microbial) to radiation damage and help in searching freshly deposited from the below (ice crust) extraterrestrial life on icy moons and planets despite their harsh radiation conditions at the surface. It seems there is a chance to pick freshly flushed out microbes/DNA on the Jovian Europa (via tidally driven ice sheet cracks) to verify the extraterrestrial life. The reported study was funded by RFBR and DFG according to the research project 20-55-12006.