RESISTANCE OF DNA (MICROBIAL) TO RADIATION DAMAGE ON THE FROSTY JOVIAN EUROPA SURFACE

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INTRODUCTION:
The dsDNA molecules are relatively stable but could quickly degrade/fragmented by ionization radiation. If we are looking for extraterrestrial life (at least on different bodies — planets and their satellites, of our Solar System), the best place to search for it is icy satellites (e.g., Jovian Europa or Saturn's Enceladus) along with polar ice caps on 'atmosphere-lost' Mars. However, the fluxes of highly energized protons (mostly), electrons (mostly for Europa; the surface 1cm deep irradiation — 30 kGy/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.

OBJECTIVES:
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 braking/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 — how long their DNA inside the cells could withstand the surface radiation fluxes.

MATERIAL AND METHODS:
As a model, the plasmid vector pCR-4 (~ 4000 bp) for cloning containing the insert of a bacterial rRNA gene (v3 – v4 region — 485 bp) was used in irradiation trials under the liquid nitrogen conditions (- 195.8 ^{o}C). The gamma-induced fragmentation was tested in specific PCR generating the dsDNA band of the expected size (~ 600 bp); in fact, it is disappearing upon complete fragmentation of the insert. As a radiation source, the ^{60}Co-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 5 kGy per hour. The down-up of the irradiation camera was taken 18 Gy only. The time series were up to 300 kGy (60 hrs). The detection level of the DNA signal in a gel stained with SYNR Gold was about 10 pg.

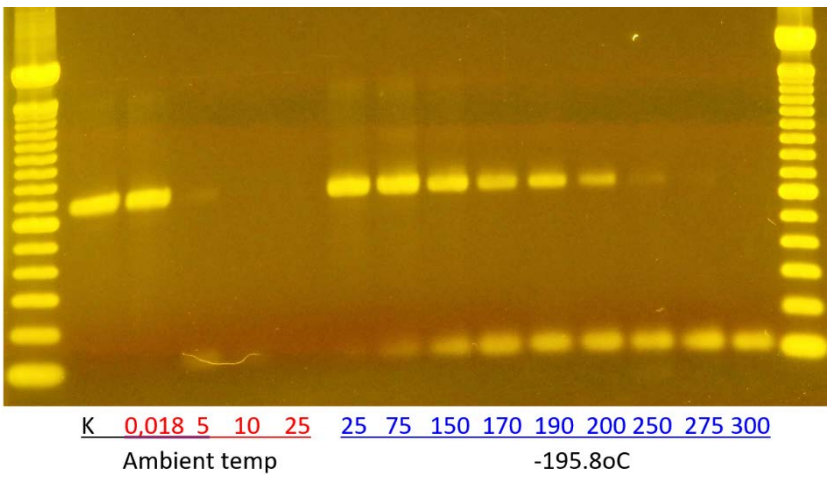

Fig. 1. Agarose gel-electrophoresis loaded with amplicons (~ 600 bp) generated upon gamma-irradiation at ambient and liquid nitrogen temperature. The gel was stained with SYBR Gold. K – non-irradiated control. Doses are shown in kGy.

RESULTS:

At the ambient temperature, the insert entirely disappeared (DNA stained with SYBR Gold) upon the doze ~ 7.5k Gy while under the deep freeze at -195.8 ^{o}C – ~ 270kGy what accounts for ~ 35 difference (Fig. 1). A similar effect was observed at a bit high temperature (- 78.5 ^{o}C — dry ice) (the work in progress).

DISCUSSION AND CONCLUSION:

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.

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