Yeast as a model for ionizing radiation resistance - from Earth to the Space

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Over the last century humanity has achieved to leave Earth and explore the Universe. The harsh extraterrestrial environment makes human exploration a challenging goal, such as high levels of ionizing radiation, dehydration, high vacuum, and extreme temperatures[1]. Radiation exposure affects cellular components including nucleic acids, proteins, and lipids. *Saccharomyces cerevisiae* is a well-established eukaryotic model organism for biotechnology. From fermented food to the bench, yeast has not only been used to produce food, beverage, energy, but also to study orthologs genes, recombinant biotechnology, basic science and much more. Such an organism could also benefit space exploration, as a biotechnology tool and understand space harsh conditions resistance[2]. Biopolymers of yeast cell walls may protect them against ionizing radiation and thermal effect[3]. Understanding the effect of ionizing radiation on yeast cell walls could provide biomaterial for human space exploration. Our experiments explored the unique effects of outer space conditions simulated on a synchrotron beamline (TGM - CNPEM), taking as parameters the low pressure (vacuum) and VUV radiation. Other ionizing radiation were analyzed; gamma radiation on Gammacell irradiator at IPEN-CNEN/SP and X-ray radiation at the Mogno beamline of Sirius - CNPEM. Wild extremophile yeasts were tested as well as radio tolerant bacterium *Deinococcus radiodurans*. Additionally, commercial yeast *Saccharomyces cerevisiae* strain was also tested. Our results showed that all yeast strains had survived the vacuum experiments. All yeast has survived at VUV radiation with the higher survival rate been to *Naganishia friedmannii*, one *Saccharomyces cerevisiae* strain, and *Rhodotorula mucilaginosa*, where they survived almost 100% till 10.000J of VUV. . Most yeast's strains have survived under ionizing radiation up to 5 kGy. *Deinococcus radiodurans* have survived for more than 10 kGy as expected. Further experiments are needed to elucidate ionizing radiation effect on yeast. Due to the high survival rates of yeasts, it reinforced their importance as model organisms for studies of extreme environments, including for space colonization and particle accelerator applications.

References:

[1] Abrevaya XC et al. Astrobiology, 11, 1034-1040. (2011a)
[2] Pulschen, A.et al. MicrobiologyOpen, 4(4), 574-588. (2015)
[3] Utama, GL, et al. Polymers 15.16 3481 (2023)