Addressing the fungal contamination – testing antifungal materials and radiation-driven decontamination methods

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Filamentous fungi such as *Aspergillus* and *Penicillium* sp. (also known as "mold") represent some of the predominant contaminations found onboard the Mir (Russian Space Station) and the International Space Station (ISS).[1,2] *Aspergillus* sp. have been found in NASA clean rooms belonging to Johnson Space Center Curation Laboratory as well as in spacecraft assembly facilities. As spores, they can spread and survive under extreme and seemingly sterile conditions.[1] With regard to human health, these filamentous fungi are capable to release a wide range of organic volatile compounds and mycotoxins. They are one of the most abundant human associated opportunistic pathogens, causing allergies and various disease patterns to humans with compromised immune system. Their presence in manned spaceflight missions can cause complex risks due to their fast growth, spore forming and dispersal, high tolerance to disinfectants and wide metabolic activity.[2] *Aspergillus* sp. are also known material degraders and a cause for food spoilage.

The resistance of fungal spores towards the spaceflight-relevant conditions needs to be explored and understood. It is and will be crucial to monitor and control fungal dispersal and growth in spaceflight indoor settings and material contamination.[3]

In our research, we aim to find efficient and innovative decontamination methods to either prevent fungal spore distribution, growth or spore inactivation.

In preliminary experiments we tested the resistance of fungal spores to low pressure plasma sterilization, UV-C and copper-containing metal surfaces. Spores of *Aspergillus niger* with a black pigmentation (melanized) are more resistant to low pressure plasma sterilization and UV-C irradiation as melanin-deficient (less pigmented) mutant spores.

This suggests that the pigmentation of a fungal spore acts as a photoprotectant and enhances fungal spore resistance. In order to prevent spore dispersal and attachment, we tested different types of metal surfaces, e.g. with and without copper, on their effects on spore vitality. Here, especially copper ions seem to have a reducing effect of fungal spore survivability when drawing conclusions in comparison to the reference material (steel).

Summarizing, our results signify a high tolerance of fungal spores of *A. niger* towards various decontamination parameters showing the urgent need of novel or combined decontaminations methods for upcoming and planned space missions.[2,4]

1. La Duc, M.T., R. Kern, and K. Venkateswaran, *Microbial monitoring of spacecraft and associated environments.* Microb Ecol, 2004. **47**(2): p. 150-8.
2. Romsdahl, J., et al., *Characterization of Aspergillus niger Isolated from the International Space Station.* mSystems, 2018. **3**(5).
3. Moissl-Eichinger, C., et al., *Quo vadis? Microbial profiling revealed strong effects of cleanroom maintenance and routes of contamination in indoor environments.* Sci Rep, 2015. **5**: p. 9156.
4. Fratamico, P.M., et al., *Genomes of foodborne and waterborne pathogens*. 2011, Washington, DC: ASM Press. xii, 352 p.