

The Effect of Cosmic Radiation on Antibiotic Production

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Introduction

Long-term space missions require sustainable options for astronaut health and nutrition. The fungus *Penicillium chrysogenum* could provide a source for on-demand antibiotic production in space. However, the effects of cosmic radiation on penicillin biosynthesis are minimally researched.

The 2025 RRCC DemoSat Team sent a payload to the stratosphere to study how radiation affects the antibiotic production of *P. chrysogenum*. The results could support the production of antibiotics for space travel and life beyond earth.



Figure 1.
RRCC DemoSat "Fungi In The Skies" team photo

Methods

Before flight, *P. chrysogenum* was grown on PDA (potato dextrose agar) plates. Once antibiotic growth was confirmed, two samples of *P. chrysogenum* cultures were separated into two microcentrifuge tubes and flown in a payload in to test the effects of cosmic radiation on biological processes.

The payload needed to remain in a specific temperature range to ensure sample viability. The temperature regulation mechanisms are as follows:

- Viability range from 5°C to 37°C
- Heating:
 - 3 ceramic resistance heaters
 - 1 hand warmer
 - Heavily insulated with foam

After flight, both the flight samples and the ground controls were streaked on PDA plates with *Staphylococcus aureus* to compare growth and antibiotic production.

Overall Flight Results

Most of the *P. chrysogenum* samples survived overall flight.

- Inside payload sensor measured below viable temperatures for 66 minutes out of the 2 hour flight time. Lowest recorded temperature was -3°C
- Did not reach the upper limit of temperature viability.
- Actual temperature of the samples are unknown due to extra layers of insulation.
- Even with the below viable temperatures, both flight samples and one out of the two ground samples of *P. chrysogenum* grew on the PDA plates after flight
- There is not any measured antibiotic activity for the ground controls or flight samples.

Temperature Flight Data

The external temperature dropped rapidly to a minimum near -35°C, while the internal temperature decreased more gradually, reaching a minimum of -3°C. Even with external temperatures being below the viability range, the insulation and onboard heating system successfully kept the internal of the payload from becoming extremely cold. The internal temperature stayed within the viable range for about 54 minutes of the flight.

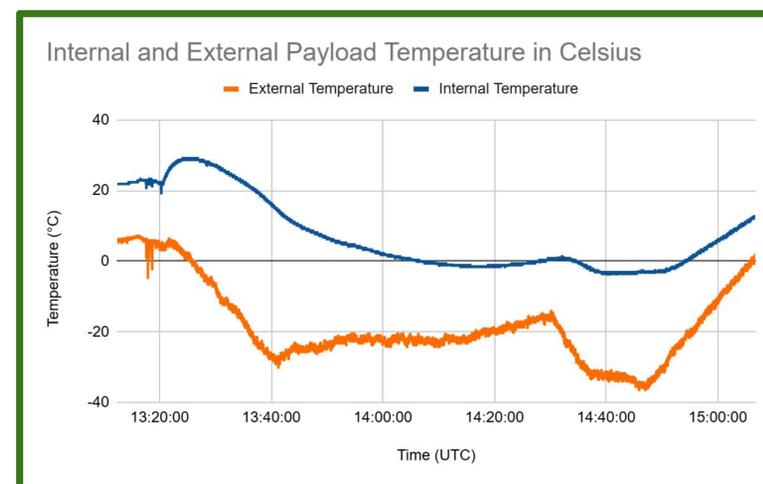


Figure 2.
Internal and external temperatures recorded during flight

Post-Flight Growth Results

The plates below show growth of *P. chrysogenum* and mushroom mycelium. It is unclear if a zone of inhibition has produced by either the flight or ground test subjects due to a yellow dye that is obfuscating activity. If antibiotics are present, then their strength has been significantly reduced. Additionally, the amount of spore forming tissue in the flight sample increased compared to the ground sample.



Figures 3-4.
The flight and ground control *P. chrysogenum* cultures re-streaked on PDA plates after flight

Discussion

The effects of cosmic radiation on antibiotics, and in this situation, *Penicillium chrysogenum*'s ability to produce penicillin, is a newer research topic, especially with the prospect of long term space travel. Recent research with antibiotics and bacteria in space will continue to be explored and can be expanded upon to other antibiotics or bacteria to look at antibiotic resistance in space. Antibiotics will be a crucial resource needed for medicine in space as more research for long term space exploration is pursued.

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