



The effect of perchlorate inhibitor on the growth of Pseudomonas fluorescens



Project Statement

After three successful Mars InSight mission and surface analysis of collected soil samples in several planetary locations, no sign of micro-organismal life has been detected. Although these samples have returned several false positive readings, the final verdict has been that these surface facility samples are sterile and devoid of life, so we know it. But why?

Significance

The results of this study could give researchers a better insight into the chemical interaction in Martian surface soil how it may affect the growth and development of known terrestrial micro-organisms, and may generate discussion on this subject as a possible category for further study. In a broader context, this study may assist researchers in defining more possibly universal bioactive chemical requirements for the development and sustenance of micro-organismal life. It is possible that some basic environmental conditions similar to those that terrestrial life requires to develop and thrive may exist beyond the earth, and may be their as to either the suitability or the inability for the development of basic life on other planets as well as our own.

Objectives

- Investigate the relationship between soil chemistry and its effect on the growth of microalgal life through laboratory experimentation.
- Chemically replicate a terrestrial environment with soil conditions similar to Mars as an analog to investigate a partial hypothesis addressing the apparent sterility of Mars samples.
- Introduce a selected organism into the chemical analog to study the effect that it may have on the organism's growth cycle. There will be a number of chemical variations of the medium.

The Mars Analog

The Atacama Desert of Chile is a sparsely populated virtually rainless plateau, resting from the Pacific Ocean to the Andes Mountains. The average rainfall is less than 100 inches but it exceeds 600 inches south from the Peruvian border. The northern sector of the ocean are the Pacific coastal ranges, with an average elevation of 2000 feet. The Cordillera Domeyko, a range of foothills of the Andes Mountains, lies east. The climate is made up of arid basin (valley) sand and lava flows. The landscape is so desolate it is sometimes described as "barren like Mars". In fact the Atacama has been chosen as a good site to test a prototype future human rover. Source courtesy of www.nasa.gov/content/

Justification

- Conditions similar to that found on Mars. Very dry and cold. Some areas have not seen rain for centuries. At an estimated million years old, this is the oldest desert on earth.
- Soil composition is oxidative with large amounts of minerals, similar to Martian soil samples analyzed by the landers.
- Little in the way of expected organisms given the amount of time available. There is an absence even of those cyanobacteria.
- Many organisms found are heterotrophic, feeding off of other organisms.



Atacama soil

Composition

- High levels of sodium
- Perchlorate present in soil
- Oxidizing
- Mainly anoxic, organic free



Mars soil

Composition

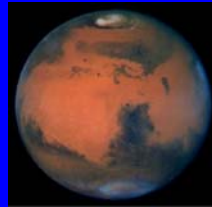
- Mainly Oxygen, Silicon, and Iron
- Smaller amounts of Calcium, Aluminum, Magnesium, and Sodium
- Trace amounts of other elements



Martian statistics

Planet Profile:

Mass (kg)	6.42 x 10 ²³
Diameter (km)	4137
Density (kg/m ³)	3940
Escape velocity (km/s)	5000
Average distance from Sun (AU)	1.524
Rotational period (length of day in Earth days)	1.026
Revolution period (length of year in Earth days)	686.98
Obliquity (tilt of axis in degrees)	25
Orbit inclination (degrees)	1.9
Orbit eccentricity (deviation from circular)	0.093
Maximum surface temperature (K)	310
Minimum surface temperature (K)	150
Yearly greenhouse effect (effectively)	11.5
Highest point on surface	Olympus Mons (about 22 km above surrounding low plains)
Atmospheric composition	96% carbon dioxide, 1.6% argon, Surface temperature: variable rock and altered materials.



The Organism

Pseudomonas fluorescens encompasses a group of common, saprophytic, aerobically fast growing water and plant nutrient scavengers that colonize soil, vegetation, and other surfaces. It is a member of the gamma proteobacteria phylum and is a common soil bacterium. It is a common water source for some strains that can utilize H₂O₂.



Growth Medium

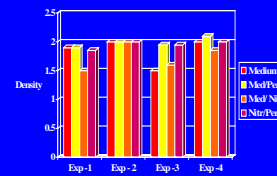
Variations

Basic Medium no additives
Medium with perchlorate
Medium with perchlorate and sodium nitrate
Medium with sodium nitrate

Methodology

- A prepared culture of *P. fluorescens* is inoculated into a liquid medium (total of 64 specimens).
- The medium has been mixed to provide a standard experimental group as well as a non-added control group.
- The two categories of medium are further divided into two groups: each one with perchlorate added, one without. The perchlorate is added in increments of 1M, 5M, and 10M.
- Each category is then divided into an aerobic group and an anaerobic group.
- The aerobic group is exposed to room temperature and standard pressure (760 torr) and it is inoculated with a mixing table.
- The anaerobic group is placed in an anaerobic container and is also grown at room temperature and standard pressure.
- Each tube is subjected to a density reading on a daily basis and the value is recorded. The readings continue until the values indicate that peak density has been reached and is in decline. At this point the specimens are labeled and frozen.
- When the initial phase of the experiment is complete, the samples will be subjected to analysis to determine the amount of nitrogen absorbed by the organisms. The results will be studied to determine what effect, if any, the perchlorate inhibitor had on the growth of the organisms.

Highest Densities*



Results

- This series of experiments are still on-going to this point 4 complete sets of data have been recorded, however 1 set is invalid due to some. Enough data has not yet been gathered and analyzed to reach any meaningful conclusion.
- Early growth curves do indicate the level of perchlorate in the growth medium does have some effect on the growth of the *P. fluorescens* organisms. The results are still an inconclusive report.
- The nitrogen absorption analysis has not yet been accomplished and no data is available.
- As anticipated, the organisms experiences little growth under anaerobic conditions in a non-added format.
- Best growth rates to this point have been in the standard medium with an added perchlorate under aerobic conditions.
- Organisms grown in a perchlorate added medium have reached densities comparable to those of organisms grown in a non-perchlorate, standard medium. However the length of time to reach these densities is longer than the non-perchlorate medium.
- The aerobically grown organisms have achieved greater density levels than those grown anaerobically.
- This study is ongoing.

Acknowledgements

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