ACIDITHIOBACILLUS FERROOXIDANS BACTERIA STRAIN DSM 583 AS POSSIBLE ANALOGUES OF MICROORGANISMS POTENTIALLY LIVING IN THE LOWER CLOUD LAYER OF VENUS

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Introduction

Acidithiobacillus ferrooxidans are extremophilic, acidophilic microorganisms living on Earth in environments with a very low pH level [1]. Similarly, acidic conditions (pH values range: -1.30 to -0.85 [2]) prevail in the lower cloud layer of Venus (47.5-50.5 km), where sulphuric acid particles are present in the form of aerosols [3]. The size of Acidithiobacillus ferrooxidans bacteria is about 1.0-1.7 μm [4] and may be comparable to the particles found in the lower cloud layer of Venus (2 μm diamater, mode 2′) [3]. It was also calculated [3] that the aerosol particles in the lower layer of Venus clouds, corresponding to mode 2′ and mode 3 (~7.3-8 μm diamater, irregularly shaped), have a sufficient mass balance, as well as an adequate amount of water and solutes. Moreover, they are large enough to contain microorganisms of spherical shape and with a mean diameter of 1 μm. The anaerobic metabolism of these bacteria uses carbon dioxide and nitrogen [5] which are the main components of the atmosphere of Venus [6]. 3-D climate simulations have shown that this planet had similar climatic conditions to Earth at the time when prokaryotic organisms appeared on Earth [7]. It is believed that surface of Venus may have been covered by ocean waters [8], which may be confirmed by the high levels of D/H [9]. As on Earth, on Venus in its ocean, life could have arisen in the form of protobacterial cells, which, with increasing adverse climate changes caused by the strong greenhouse effect, through various transport mechanisms, could have evolved under extreme conditions and entered the Venusian clouds and it is possible that it remains to this day [3].

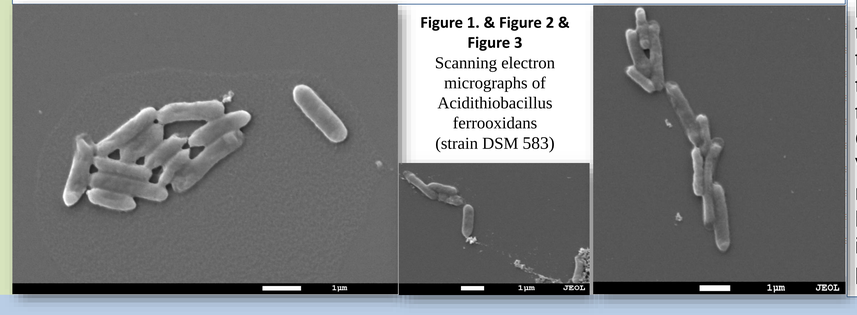
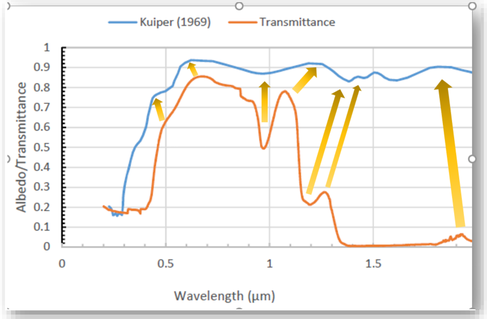


Figure 1. & Figure 2 & Figure 3 Scanning electron micrographs of Acidithiobacillus ferrooxidans (strain DSM 583)

Aims

Spectrophotometric analysis of UV-Vis-NIR spectra of Acidithiobacillus ferrooxidans bacteria, strain DSM 583 and comparison of the obtained experimental results with the spectrum in the similar wavelength range obtained for Venus.



Results and discussion

The nature of the experimentally obtained UV-Vis-NIR spectrum for Acidithiobacillus ferrooxidans bacteria, strain DSM 583 treated as a graph of the function incident radiation wavelength λ [μm] versus transmittance [arbitrary units] in the range of about 0.2-1.3 μm is similar to the nature of the curve showing the same dependence incident radiation wavelength vs. transmittance for the clouds of Venus [10]. This observation - together with the previous analyses of the UV spectrum obtained for ferredoxins, one of the proteins present in the bacterium Acidithiobacillus ferrooxidans, strain G15, in the 220-300 nm range and analyses of the UV spectrum obtained for Venus in the same wavelength range λ [3] - may suggest that microorganisms potentially present in the lower cloud layer of Venus may have similar structural and metabolic properties, resulting from the almost identical physicochemical features of macromolecules, such as cell building proteins, to the terrestrial Acidithiobacillus ferrooxidans bacteria.

Materials and Methods

The bacteria used in the study were Acidithiobacillus ferrooxidans, strain DSM 583, for which UV-Vis-NIR spectrum in the range 200-2500 nm was obtained using a Perkin Elmer Lambda 950 spectrophotometer. Micrographs of single bacteria cells were also taken using the JEOL 7001FTTLS microscope.

Conclusions

The spectrum analysis of the UV-Vis-NIR for Acidithiobacillus ferrooxidans bacteria (strain DSM 583) and spectrum in the similar wavelength range obtained for Venus as well as previous studies of ferredoxins - proteins of the nitrogen reduction cycle of Acidithiobacillus ferrooxidans (strain G15) - may suggest the presence in Venus' atmosphere of protein-like compounds, or even proteins, which can be attributed to living forms by analogy.

Further studies will cover other strains of Acidithiobacillus ferrooxidans bacteria. Strains of these bacteria will be tested in a special chamber with aerosols (i.a. sulfuric acid) and with reproduced physical and chemical conditions of the lower cloud layer of Venus.

References

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