Effect of UV radiation on the “survival” of free amino acids and a peptide under Martian simulated conditions

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1 Introduction

It is generally accepted that the lack of organic compounds in the surface of Mars is due to the oxidizing environment. To gain information for future missions, about the risk of forward contamination of Mars with terrestrial biomolecules by way of Mars missions, and also to investigate the suitability of the Martian environment for supporting life, we have initiated a series of experiments on the persistence of biomolecules under simulated Martian condition. The first preliminary results of these studies are presented here. The experiments will specifically investigate the effect of UV radiation on the persistence of single amino acids and peptides. The experiment were carried out in the Mars Environmental Simulation Chamber (MESCH) in which it is possible to reproduce environmental conditions as found on Mars (Jensen et al., 2008).

Figure 1. Experiment diagram. Samples were hydrolyzed (HCl, 6 M) and analyzed by using o-phthaldialdehyde (OPA)-derivatized products and high-performance liquid chromatography (HPLC, Waters Chromatography System).

2 Materials and Methods

Figure 2. Snapshots of the sample plate (A), the interior of the chamber (B), the LEDs lamp (C), and the experiment design (D).

Table 1. Comparative table of Mars simulated condition experiments with this present experiment. It is shown the half-life in Sols of the L- amino acids and the peptide D-la-la-d-ala-d-ala. Sol is the Martian day (24.6 h).

3 Results

After 6 h of UV irradiation, 12-16% of the unprotected free L-aspartic acid, L-glutamic acid and L-serine and 22% of L-alanine were degraded. In the case of the small peptide 9% was degraded. The resultant half-lives were 25-32 Sols for the first three mentioned and 17 Sols for L-alanine; the small peptide had more persistence with a half-life of was 52 Sols. In addition, there were indications on UV-induced racemization of the amino acids (data not shown).

Figure 4. Spectrum of the LEDs UV lamp in the NIST compared to the Mars modeling spectrum (Panel et al., 2002), both spectra are very close at this wavelength range.

Figure 5. Temperature inside the chamber and of the sample during the 6 hours of the experiment.

Figure 6. Degradation of the 4 free L-amino acids and the peptide D-la-la-d-ala-d-ala.

4 Conclusions

This is the first experiment were LEDs UV lamps have been used to simulate Martian UV-irradiation. The advantages of this UV source is that it better reflects the UV spectrum present on Mars, and it does not include the infrared spectra that cause undesired heating. It seems that alanine alone is more susceptible to UV-induced degradation than when it is concomiting peptide bridges. Apparently, aspartic acid and glutamic acid have the similar capacity to struggle UV radiation. Even though this preliminary result gave us an indication about UV radiation persistence under a proxy Mars environment, future experiments will clarify the differences in half-lives between individual amino acids with different exposure times. In addition, we will investigate UV-induced racemization of individual amino acids in peptides and the degradation of DNA under different protecting materials.

5 References

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Acknowledgements

We would like to thank the Danish National Science Research Council (grant no. 272-07-0545) and the department of Biological Sciences, Aarhus University, for providing the necessary infrastructure for the project. In addition we would like to thank Lise Poulsen for her skillful help in the HPLC-laboratory. We also, would like to thank Helge Wahlgren and Jan I. Iversen for providing the facilities for the experiment in the Marslab and to Jesper B. Voortmann, for his help in the designing of the sample plate. Moreover, we would like to thank to the Mexican National Council of Science and Technology (CONACyT), for supplying the PhD scholarship.