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Detection of chemical biomarkers in Mars exploration: GC-MS analysis of amino acid enantiomers

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The research for possible signs of past or extant life on Mars is mainly focused on amino acids, key molecules for life which have been detected in several Martian meteorites. Amino acid homochirality provides a relevant way of distinguishing between abiotic and biotic origins: in fact L-amino acids are almost exclusively used by terrestrial organisms in protein biosynthesis. Gas chromatography is a powerful analytical instrument for exobiology science and extraterrestrial environment exploration [1]. The goal of this work is to develop a simple and automatic procedure for detection of amino acid enantiomers as a suitable candidate for their GC in-situ analysis. The method is based on Gas chromatography, since it is a powerful analytical instrument for exobiology science and extraterrestrial environment exploration: to make amino acids suitable to the GC-MS analysis a derivatization procedure is required [2]. The main final goal is to achieve the chemoselective and enantioselective separation of many amino acid pairs with good resolution values fulfilling the main requirements imposed by space constraints (limitation in volume, weight, power consumption, possibility of process automation).

Two derivatization procedures of amino acids were investigated. The first one uses a mixture of perfluorinated alcohols and perfluorinated anhydrides to obtain N(O,S)-perfluoroacyl perfluoroalkyl esters in a single step procedure [3]. The second method is based on an acylation–alkylation reaction using methyl or ethyl chloroformates as derivatization reagents in the presence of an alcohol.

The mass spectra of the obtained derivatives are studied and mass fragmentation

patterns are proposed: significant fragment ions can be identified to detect amino acid derivatives. The obtained derivatives were analysed using two different chiral columns: a Chirasil-L-Val and a γ-cyclodextrin (Rt-γ-DEXsa) stationary phases which show different and complementary enantiomeric selectivity. The obtained results are compared in terms of the achieved enantiomeric separation and mass spectrometric response. Studies on the response linearity and limit of detection prove that both the proposed methods are suitable for a quantitative separation of several amino acid enantiomers of exobiological interest which are expected to be present in the Martian soil.

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