NEW STRATEGIES FOR EXTRACTING BIOMARKERS IN 'ASTROBIOLOGICAL' ENVIRONMENTS: TOWARDS IN-SITU ANALYSIS

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Résumé: Le développement de nouveaux instruments et de stratégies analytiques associées est essentiel pour la recherche de bio-signatures dans les corps extraterrestres. Si l'étape d'extraction est communément reconnue comme un point clé dans la plupart des études analytiques, cette étape a rarement été étudiée en exobiologie. Dans ce contexte, l'objectif de ce projet est de développer des stratégies innovantes basées sur l'extraction assistée aux ultrasons (UAE) permettant une extraction quantitative de différents biomarquerus (acides aminés, bases nucléiques et peptides) présentes à l'état d'ultra-traces dans les corps extraterrestres. De nombreux paramètres ont été étudiés puis testés et optimisés sur des matrices minérales modèles préalablement dopés par des mélanges de biomarqueurs cibles. Ensuite, le nouveau protocole a été testé sur des météorites type chondrites carbonées et comparé à la méthode de référence : H_2O pendant 24 h à 100 °C.

The development of new instruments and associated analytical strategies, such as high-resolution mass spectrometry, is essential to search for bio-signatures in extraterrestrial environments (planets, satellites, asteroids, comets). Their sensitivity would enable us to emphasize, in laboratory or for in-situ experiments, the presence of organic compounds that could have been engaged in prebiotic synthesis pathways.

While the extraction step is commonly recognized as a key point in most analytical studies, this step has rarely been considered in astrobiological research. For instance, no solid/liquid extraction protocol has been selected for future Martian missions so far even though some pre-selected analyzers require liquid samples. Besides in-situ applications, the extraction protocols currently used for laboratory research, which do not take into account the nature of the mineral matrix nor the properties of the molecules, rarely enable quantitative extraction and can even induce biases by modifying the original nature of the detected molecules.

Therefore, the development of new extraction strategies is necessary to obtain representative extracts, compatible with analytical techniques.

In this context, the objective of this project is to develop innovative strategies allowing the extraction of different families of organic molecules (amino acids, nucleobases and peptides) present at ultra-traces in extraterrestrial bodies according to the mineralogy of the samples. For that, carbonaceous chondrite meteorites have been used since they are the closest representation of the extraterrestrial mineral surfaces (Martian surface for example). The strategy focuses on ultrasonic assisted extraction (UAE) [1] for a quantitative extraction of the target compounds. Multiple parameters were studied among which ultrasound frequency, amplitude, pulse and sonication durations [2], solvent nature and ratios then tested and optimized on mineral model matrices that included silica, clays and metal oxides which were doped with organic molecules mixtures prior to extraction. Afterwards, organic molecules were extracted from real meteorite samples using the new protocol and compared to the reference method: aqueous hydrolysis (24 h at 100 °C) [3] through Gaz Chromatography and Liquid Chromatography separations coupled with mass spectroscopy identification and quantification [4].

The new approach will later be adapted to in-situ experiments and validated in instrumental extraction system currently under development. The new extrcation technique developed initially for extraterrestrial bodies could be adapted for other types of mineral samples.

References:

[1] BUCH, A. et al. (2006) *Planet. & Space Sci.*, 54. 15, 1592-1599.
[2] TIMOUMI, R. et al. (2022) *Anal. & Bioanal. Chem*., 1-9.
[3] BURTON, A. S. et al. (2015) *Meteoritics & Planet. Sci.*, 50.3, 470-482.
[4] SERRA, C. et al. (2022) *Talanta*, 243, 123324.

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