cell research

Application of LC-MS/MS-based metabolomic screening in the study of biological response to X-ray and Terahertz radiation

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Metabolites are low-molecular-weight products of biochemical reactions that play a key role in the energy dynamics of living systems and signaling. Metabolomics is a technique for quantitative assessment of small molecules in biological systems. A metabolomic profile reflects the biochemical activity of an organism and is widely used in the study of pathologies, pharmaceutical development and diagnostics.

We have previously developed an approach to metabolomic screening of polar and hydrophobic metabolites using a monolithic organic polymer-based column enables separating metabolites in two chromatographic modes, hydrophilic and reversed-phase chromatography. This approach makes it possible to achieve coverage of a large number of metabolites with different physicochemical properties comparable or superior with methods utilizing commercially available columns with sorbents of various types [1]. Using the approach, metabolomic screening of dried blood spots samples of mice exposed with X-ray was performed, and metabolites that could be considered as potential markers of irradiation exposure and organ tissue damage were detected. Analysis of marker metabolites revealed metabolic pathways altered by radiation exposure.

In another study, we investigated the effects of 2.3 THz radiation [2] on SK-MEL-28 cells using metabolomic and gene network analysis. Forty metabolites, mainly related to purine and pyrimidine pathways, were significantly altered after irradiation, along with lipids like ceramides and phosphatidylcholines. Gene network analysis identified key regulatory enzymes involved in the biosynthesis and degradation of these metabolites. Mitochondrial membrane components, including the respiratory chain complex and ATP synthase complex, responded to THz radiation. We hypothesize that THz radiation causes reversible disruption of the lipid raft structure, which affects the transport of mitochondrial molecules, preserving protein integrity, and potentially explains the high cell survival rate. Our results provide insights into the biological effects of THz radiation and the role of membrane components in cellular responses.

References:
1. N. V. Basov, A. D. Rogachev et al. Talanta, 267 (2024), 125168.
2. Kulipanov G.N. et al. IEEE Trans Terahertz Sci Technol, 5 (2015), № 5.