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Kinetics of transformations of molecular compounds in biological objects under radiation treatment

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Radiation treatment is widely used in the food and agricultural industry to inactivate pathogens and extend product shelf life [1]. Ionizing radiation targets both microorganisms and biomacromolecules (proteins, lipids, carbohydrates, and enzymes), potentially altering product quality attributes, such as flavor, color, and texture [2,3]. The radiolytic oxidation of biomolecules generates reactive compounds that can enhance oxidative damage, with effects that can be either beneficial or detrimental, depending on the intended application [4].
The objective of this study was to investigate radiation-induced molecular transformations in biological samples exposed to 1MeV accelerated electrons and 80 keV X-rays, aiming to establish optimal dose ranges for different product categories. These studies have examined low- and high-molecular-weight compounds, including volatile organic compounds, unsaturated fatty acids, proteins, enzymes and carbohydrates, which are contained in biological objects.
Using HPLC-MS/MS, the study established the dependences of native structure of BSA protein and unsaturated omega-3 fatty acids in model systems on the physical parameters of radiation treatment, using enzymatic hydrolysis. Spectrophotometric and Microscopic methods were employed to evaluate the catalytic activity of the enzyme catalase and the denaturation of starch granules in both model and biological systems after ionizing radiation exposure. Additionally, GC-MS analysis identified volatile organic compounds produced by radiation-induced changes in various biomacromolecules.
Biomacromolecules demonstrate differential radiosensitivity dependent on initial concentration, radiation type, absorbed dose and dose rate. It is shown that different irradiation biomacromolecules exhibit different volatile compound profiles and their radiation-chemical yields. These results may allow to optimize of food irradiation protocols and may also form the basis for the development of biodosimeters for radiation processing control.
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Primary authors: IPATOVA, Victoria (Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University); BLIZNYUK, Ulyana (Physics Department, Lomonosov Moscow State University); BORSHCHEGOVSKAYA, Polina (Physics Department, Lomonosov Moscow State University); BOLOTNIK, Timofey (Chemistry Department, Lomonosov Moscow State University); BRAUN, Arkady (Chemistry Department, Lomonosov Moscow State University); CHERNAYEV, Alexander (Physics Department, Lomonosov Moscow State University); KOZLOVA, Elena (Physics Department, Lomonosov Moscow State University); NIKITCHENKO, Alexander (Physics Department, Lomonosov Moscow State University); OPRUNENKO, Anastasia (Chemistry Department, Lomonosov Moscow State University); RODIN, Igor (Chemistry Department, Lomonosov Moscow State University); YUROV, Dmitry (Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University)

Presenter: IPATOVA, Victoria (Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University)

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