A Radioprotective Effect of Nanoceria (CNPs), Magnetic Flower-Like Iron Oxide Microparticles (FIOMPs), and Vitamins C and E on Irradiated BSA Protein

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Abstract : The reactive oxygen species (ROS) generated by radiation in nuclear diagnostic imaging and radiotherapy could damage the structure of the proteins in noncancerous cells surrounding the tumor. The critical factor in many age-related diseases, such as Alzheimer, Parkinson, or Huntington diseases, is the oxidation of proteins by the ROS as molecular triggers of the given pathologies. Our studies by spectroscopic experiments showed doses close to therapeutic ones (1 to 5 Gy) could lead to changes of secondary and tertiary structures in BSA protein macromolecule as a protein model as well as the aggregation of polypeptide chain but without the fragmentation. For this reason, we investigated the radioprotective effects of natural (vitamin C and E) and synthetic materials (CNPs and FIOMPs) on the structural changes in BSA protein induced by gamma irradiation at a therapeutic dose (3Gy). In the presence of both vitamins and synthetic materials, the spectroscopic studies revealed that irradiated BSA was protected from the structural changes caused by ROS, according to in vitro research. The radioprotective property of CNPs and FIOMPs arises from enzyme mimetic activities (catalase, superoxide dismutase, and peroxidase) and their antioxidant capability against hydroxyl radicals. In the case of FIOMPs, a porous structure also leads to increased ROS recombination with each other in the same radiolytic track and subsequently decreased encounters with BSA. The hydrophilicity of vitamin C resulted in the major scavenging of ROS in the solvent, whereas hydrophobic vitamin E localized on the nonpolar patches of the BSA surface, where it did not only neutralize them thanks to the moderate BSA binding constant but also formed a barrier for diffusing ROS. To the best of our knowledge, there has been a persistent lack of studies investigating the radioactive effect of mentioned materials on proteins. Therefore, the results of our studies can open a new widow for application of these common dietary ingredients and new synthetic NPs in improving the safety of radiotherapy.

Keywords : reactive oxygen species, spectroscopy, bovine serum albumin, gamma radiation, radioprotection
Conference Title : ICBBB 2023 : International Conference on Bioscience, Biotechnology, and Biochemistry
Conference Location : Toronto, Canada
Conference Dates : September 18-19, 2023