Irradiation of DNA-Amino Acid Complexes by Low-Energy (1 and 10 eV) Electrons

Sylwia Ptasińska[1, 2], Thanyawee Pengpan [1], Zejun Li[1], J. Richard Wagner[1] and Léon Sanche[1]

[1] Groupe en Science des Radiations, Faculté de médicine, Université de Sherbrooke, Sherbrooke, Québec, J1H5N4, Canada
[2] Department of Physics and Astronomy, The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom

e-mail: s.ptasinska@open.ac.uk

Biological macromolecules, such as protein or DNA, are known to be very sensitive to ionizing radiation. Ionizing damage can primarily be attributed not only to reactions of water radiolysis products (hydroxyl radicals, solvated electrons, and H-atom), but also to the action of secondary low-energy electrons (LEE). It was demonstrated that direct bombardment of DNA with electrons of 0.5-20 eV contribute significantly to strand breaks in supercoild plasmid DNA [1,2]. However, a study of radiation damage to DNA is not complete without taking into account the presence of its native environment which is essentially composed of water molecules and proteins. DNA-protein complexes have long been known to confer protection of DNA against radiation damage.

The present experiments concern electron interactions with films composed of DNA (synthetic 4-base oligonucleotides and "natural" plasmid DNA) and amino acids. Amino acids, which are the building blocks of proteins, are among the simplest organic molecules of biological relevance and thus serve as convenient model systems in studies of radiation damage.

In the present work lyophilized samples of oligos and the DNA plasmid were irradiated by 1 and 10 eV electrons, respectively. After irradiation, the DNA samples was analyzed by agarose gel electrophoresis for classified as supercoiled and relaxed (circular and linear) form, whereas the fragmentation of short oligos were then analyzed by HPLC.

The adding of amino acids i.e. glycine, histidine, arginine and tryptophan to the DNA solution causes the damage to our samples. However, the degree of protection of DNA by amino acids increased from a molar ratio of amino acid : DNA nucleotide ~ 1:2 depending on the properties (charge, polarity etc) of used amino acids. Moreover a further increase in the amino acid : DNA nucleotide ratio causes additional damage to the DNA. This may be due to the subsequent reaction of radical fragments produced via dissociative electron attachment (DEA) to amino acids. The studies of the total DEA cross section of selected amino acids in the gas phase shown that this process is the most efficient at energies which present experiments were performed, i.e. 1 and 10 eV (and also 6 eV)[3].

References:

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