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DIELECTROPHORETIC STUDY OF RADIATION PROTECTION ABILITY OF NANODIAMONDS

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Recently nanodiamonds (ND) were found useful in regenerative medicine, cancer treatment, activation of the intracellular activity and other medical applications. This paper is dedicated to experimental study of influence of ultradispersed ND on red blood cell (RBC) damage in rats exposed to X-ray radiation. The experimental group of 20 rats received 1.0 ml of a diluted suspension of ND once per day with food during 5 days prior to the radiation treatment. The suspension has C=0.01 % of dry weight of ND in saline. The control group of 20 rats has not received ND with food. Therefore, four groups of 10 rats have been studied: with both ND and X-ray (I); with ND without X-ray (II); without ND with X-ray (III); with neither ND nor X-ray (IV). In that way, 20 rats from the groups I and III were treated by X-ray with a dose of 5.8 Gy. Blood samples were collected in 30 days after the irradiation.

The RBC were washed out from blood plasma with saline and then diluted to the standard concentration 35%. The dielectric properties of the RBC have been studied by microwave-dielectrometry at the frequency f=9.2 GHz. This frequency corresponds to the gamma-dispersion range which is determined by mobility of water molecules. Molecules of free water have higher rotational mobility while the water molecules bound by the RBC membranes are bound and form hydration shell over the membrane. The RBC suspension has been placed in a capillary (d=0.4 mm) and located in the resonator of the dielectrometer at a fixed temperature. The real and imaginary parts of the dielectric permittivity of the suspension have been measured. The first value corresponds to physical dielectric permittivity determined by the thickness of the hydration shell and dielectric permittivity of the membrane. The second value is the loss factor, a measure of the dissipative loss associated with the polarizable charges moving in the electric field. The temperatures ranged from T=0 to 50C (T=54C is denaturation temperature for the RBC proteins).

It was shown, X-ray radiation leads to an increase in the static permittivity and decrease in the frequency of the dielectric relaxation of the RBC suspension by 37% with respect to those in intact rats. ND plays a protective role by decreasing the level of dehydration of the RBC membranes produced by X-rays relative to control. Similar changes in the dielectric properties of RBC of patients with different types of cancer before and after treatment have been detected in our previous study. Dielectric properties of suspensions of ND have also been studied at the same frequency. The results indicate that ND can decrease the pathological RBC dehydratation produced by in vivo X-ray radiation.

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