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The measurement of the dielectric parameters of blood erythrocytes in cancer patients

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The possibility of using the method of microwave dielectrometry to study the hydration of substances is determined by the fact that the molecules of bound water and the dissolved substance in the centimeter wavelength range are less mobile than the molecules of free water [Development trends in medical science and practice: the experience of countries of Eastern Europe and prospects of Ukraine: monograph/ed.by authors. 2018; 18-37]. Analysis of the dielectric parameters of blood erythrocytes in cancer patients will provide additional information about the state of water directly in the membranes of erythrocytes during a tumor process, which is of interest in connection with the development of physicochemical methods for diagnosing malignant diseases [*AS Cancer Biology*. 2018; 2(10):55-60.]. This paper presents the results of a study of the temperature dependence of the frequency of dielectric relaxation and the degree of hydration of a suspension of erythrocytes and the ghosts of erythrocytes of blood in normal conditions and in malignant tumors in the temperature range of 2-45^{0}C.

The experiments were carried out on the erythrocytes of the blood of donors and oncological patients before the use of antitumor methods of treatment. The group of patients with malignant neoplasms included patients with stage II-III tumors of the following localizations: stomach cancer (n=30), lung cancer (n=30). The control group consisted of 25 healthy donors. The sample preparation procedure was described in detail earlier [*ScienceRise: Medical Science*, 2015; 7/4(12):11-17]. The study of the dielectric characteristics of a suspension of erythrocytes and the ghosts of erythrocytes in the temperature range from 2 to 45 ^{0}C was carried out on a microwave resonator-type dielectrometer at a frequency of 9.2 GHz. The linear form of the dependences of the real (ε′) and imaginary (ε′′) parts of the complex permittivity on the concentration of erythrocytes indicates that the dielectric properties of the solvent do not depend on the concentration of cells. The transition from the quantities (ε') and (ε") directly measured in the experiment to the quantities (ε_s) and (f_d), the static permittivity and the dielectric relaxation frequency of water in solution, was carried out using the Debye equations. Assessment of the hydration was estimated using the formula $\Delta\varepsilon_s = \varepsilon_{sw} - \varepsilon_{ss}$, where $\Delta\varepsilon_s$ is the decrement of the static permittivity of the solution relative to the solvent, and quantities (ε_{sw}) and (ε_{ss}) are the static permittivity's of the solvent and solution, respectively. The results obtained were processed statistically using the software package statistics/w for mathematics.

Temperature-dependent changes in dielectric parameters (f_d) and ($\Delta\varepsilon_s$) of erythrocyte suspension and the ghosts of erythrocytes of blood of cancer patients were found. On the Arrhenius curve which are described of the frequency of dielectric relaxation of the suspension of erythrocytes of blood of patients with malignant tumors in the temperature range of 80 ^{0}C, a break is observed, with an increase in the activation energy from 15.4 kJ/mol to 22.3 kJ/mol. The degree of hydration of the erythrocyte membranes of blood of cancer patients decreases in the temperature range from 2 to 15 ^{0}C and increases in the temperature range of 18-32 ^{0}C.

The observed temperature-dependent changes in the dielectric parameters ($\Delta\varepsilon_s$) and (f_d) of the ghosts of erythrocytes and suspensions of erythrocytes of the blood of patients, together with the related changes in the structural and functional properties of erythrocyte membranes, can be considered as one of the important aspects of the relationship between the organism and the tumor.