Probl Cryobiol Cryomed 2020; 30(3):290
https://doi.org/10.15407/cryo30.03.290

Математичне моделювання зміни форми еритроцитів в умовах ранньої нейропротекції за помірної терапевтичної дії гіпотермії

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Mathematical Modeling of Red Blood Cell Shape Change in Early Neuroprotection with Moderate Therapeutic Effect of Hypothermia

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The worldwide increase in the number of neurological diseases of different etiology stipulates the interest of specialists to this problem and various approaches to its solution. Modern therapy for the treatment of stroke is based on clinical trials of the effects of induced hypothermia in the context of early neuroprotection and prolongation of the therapeutic window for patients [T. Knecht, C. Borlongan, *et al.*, 2018]. The impact of hypothermia on the results of studies after stroke is of great interest, but the interpretation is contradictory as for experimental models and studies in humans. Computer modeling has been increasingly used recently as auxiliary tool for the procedures used to help in planning, evaluating and optimizing the therapy, as well as in minimizing the risks of treatment. To obtain realistic models of therapy it is important to use the adequate mathematical functions, to simulate the temperature dependence of cell properties or to interpolate with basing on tabular data, if necessary.

To study the effect of temperature on the treatment results for ischemic and hemorrhagic stroke after thrombolytic therapy, we analyzed our experimental data [O.M. Morozova, L.V. Batyuk, O.A. Muraveinik, 2019]. A probabilistic mathematical model, allowing the calculation of numerical characteristics of the change of shape and lysis of erythrocytes in neurological disease when adding an inducer to the blood flow, to establish the relationship between the load of cells with thrombolytic agent and the rate of cell lysis within the temperature range (0–20 °C), was designed. Model parameters calculated from the experimental data were as follows: T (temperature), λ (coefficients of thermal conductivity of cells and blood), C (heat capacity) and ρ (cell density), C_k (heat capacity of blood), Q (heat released by metabolic reactions and energy absorption from an external source), rate constants of cell formation and lysis. There was quantified the change of cells size over time and there were obtained the expressions to calculate the erythrocyte lysis characteristics under the conditions of alteplase exposure at different temperatures, namely: average, most likely value, distribution function, probability density, which can be used for assessment of thermodynamic parameters of the process and method for treatment improvement. Numerical estimates of these relationships are possible after proper statistics have been accumulated.

Probl Cryobiol Cryomed 2020; 30(3):290
https://doi.org/10.15407/cryo30.03a.290

Вплив обробки насіння ультранизькими температурами на лабораторну і польову схожість моркви (*Daucus carota* subsp. *sativus*)

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Effect of Ultra-Low Temperature Treatment of Seeds on Laboratory and Field Germination of Carrots (*Daucus Carota* Subsp. *Sativus*)

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The germination of seeds during a long-term storage reduces due to the coagulation and denaturation of proteins, disorder of the integrity of its enzyme complex. The biological shelf life of carrot seeds is no longer than 3 years. Therefore, it is important to develop the methods of presowing treatment of carrot seeds with ultra-low temperatures to improve its quality and extend the shelf life in a viable state.

The aim of this study was to determine the effect of different freezing modes for carrot seeds with a reduced viability on laboratory and field germination rates. We used in our studies the carrot seeds (*Daucus carota* subsp. *sativus*) of Nantska Kharkivska varieties of 2014 and 2017 reproduction. Seed moisture made 7.7–8.9%; with 25 and 70% laboratory germination, respectively. The samples were placed into 1.8 and 15 ml centrifugal polypropylene tubes and cooled down to –70°C at a rate of 1 deg/min or directly immersed into liquid nitrogen, warmed at 22°C. The number of seeds in the variant was 100 with a 6-fold replications. Germination and its energy were determined after 7 and 14 days, respectively.

It has already been found that cooling the carrot seeds (2014) down to –70°C and direct immersion into liquid nitrogen in 1.8 ml containers significantly exceeded the laboratory germination by 5.6% and 5.4%, respectively, and was not statistically different from the control indices for seeds reproduction 2017.

Seeds of both years of reproduction, sown in field after treatment at –70ºC, showed a tendency to stimulate the field germination and increased yield by 6–9%. Carrot roots were characterized with high levels of carotene and sugars and reduced nitrate content.

In liquid-nitrogen-cooled variants, the field germination and root yields were lower than the control values.

Laboratory and field germination rates increased for cooled at temperatures to – 70ºC carrot seeds, as well as the yield and quality of root crops.