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Термопластичний аналіз діаграм стану кріопротекторних розчинів

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Thermoplastic Analysis of State Diagrams of Cryoprotective Solutions

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The study of cluster crystallization phenomenon both for practical cryobiology and for the development of the theory of phase transformations in solutions with weak intermolecular interaction of components is important from the point of view of eliminating contradictions, which arise in attempts to explain experimentally observed regularities of phase transformations in cryoprotective solutions within the limits of classical diagrams of states of the eutectic type. The formulation of the principles of constructing diagrams of the state of cryoprotective solutions with areas of the cluster phase existence acquires special importance and in turn requires the study of the cluster crystallization features along the entire axis of concentrations of the cryoprotective substance CB. However, the methods of differential scanning calorimetry and differential thermal analysis, which are traditional for such studies, do not allow to separate clearly the processes of ordinary crystallization and cluster crystallization, which occurs without breaking hydrogen bonds between water molecules and cryoprotectant at a temperature close to the glass transition temperature Tg. At values lower than a certain characteristic concentration of Cg, such separation is recorded by volume scanning tensodilatometry, however, in the range of concentrations CB > Cg its efficiency decreases.

In this regard, the method of thermomechanical deformation of pre-frozen cryoprotectant solutions was used for the first time to analyze the process of cluster crystallization along the entire axis of CB concentrations. A comparative analysis of the parameters of the thermomechanical curves of frozen aqueous solutions of dimethylsulfoxide (DMSO) and glycerol was carried out, and the relationship between the specified parameters and the kinetics of cluster crystallization of these solutions was established. On the basis of the experimentally obtained thermomechanical curves of frozen DMSO solutions, the possibility of the formation of clusters of two types was shown: on the basis of ice microcrystals and cryoprotective substance microcrystals. The obtained experimental data make it possible to formulate the principles of construction of complete state diagrams for various types of cryoprotective solutions, which will include areas of existence of the cluster phase.

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Оптимізація гіпотермічного зберігання еритроцитів собаки: роль ацетилцистеїну в підвищенні механічної стійкості

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Optimization of Hypothermic Storage of Canine Erythrocytes: the Role of Acetylcysteine in Increasing Mechanical Stability

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In modern veterinary medicine, blood transfusion is an important component of the treatment of dogs in case of severe injuries and chronic diseases. Hypothermic blood storage is becoming increasingly relevant, as this method allows blood to be stored for a long time (Denysova O, 2023). However, during storage, there is a risk of oxidative stress, which can damage red blood cells and affect their mechanical properties, including elasticity and resistance to deformation. It is known that acetylcysteine, as an antioxidant, plays an important role in maintaining the quality and stability of red blood cells during hypothermic storage (Bahoush G., 2024).

The study was aimed to investigate the effect of acetylcysteine on the mechanical properties of dog erythrocyte membranes during hypothermic storage to improve the efficiency and duration of blood storage for further use in transfusion veterinary medicine.

Canine erythrocytes were stored under hypothermia for 35 days in SAGM resuspension solution without (control) and with the addition of acetylcysteine (experiment). The level of erythrocyte hemolysis was determined spectrophotometrically at a wavelength of 543 nm. The osmotic fragility of erythrocytes was determined by placing cells in NaCl solutions of different tonicity and measuring hemolysis. Resistance to mechanical stress was assessed by the level of hemolysis according to the method (Shpakova NM, 2015). All experiments were performed after 7, 14, 21, 28, and 35 days.

On the 28th day of hypothermic storage of canine blood, an increase in hemolysis and an increase in osmotic fragility were observed. However, the use of acetylcysteine caused a significant decrease in hemolysis (by 30%), indicating its ability to prevent damage to red blood cell membranes and preserve their integrity during storage.

During the period from 28 to 35 days of hypothermic storage of dog blood, a decrease in the mechanical stability of cells was detected. However, the addition of an antioxidant led to a 65% increase in red blood cell resistance to mechanical stress compared to the control group.

The obtained results revealed a significant effect of acetylcysteine as a potential antioxidant in hypothermic storage of canine erythrocytes. The antioxidant potential of acetylcysteine is reflected in its ability to neutralize free radicals formed as a result of biomolecule oxidation under the influence of oxidative stress. This process, in turn, is known for its harmful effects on cellular structures, in particular red blood cell membranes, and can lead to their degradation and destruction. Thus, the use of acetylcysteine can improve the quality of red blood cell preservation and contribute to more successful transfusions in veterinary medicine.