## SUMMARY

Natural cell membranes are layered structures whose main components are lipids, proteins, and sugars. The most common phospholipid that builds cell walls is phosphatidylcholine. It is found in every body cell and is essential for proper functioning. The inner membrane is rich in negatively charged phosphatidylserine molecules, and systems modeling biological membranes made of sphingomyelin and phosphatidylserine were used for research purposes. In mammalian cells, including humans, phosphatidylserine constitutes up to 10% of all phospholipids and is particularly abundant in the central nervous system cells. In contrast, sphingomyelin is a particularly important component of red blood cells and some cells in the mammalian eye. Cholesterol, the basic sterol of mammalian cell membranes, was used to build model systems, which, together with sphingomyelin, is the main component of lipid rafts. The choice of lipids for the study was dictated, among others, by their prevalence in cell membranes, contributing to a more faithful representation of natural systems. In addition, erythrocytes isolated from animal blood were used in the research. The primary function of red blood cells is to transport oxygen from the lungs to the tissues via hemoglobin. Their cell membranes are made of cholesterol and phospholipids.

This paper attempts to investigate and explain the effect of biologically active compounds, such as kaempferol and myricetin, on the properties of biological membranes using natural membranes and their model systems. The flavonoid compounds used are characterized by antioxidant and anti-inflammatory properties and anti-cancer. Therefore, they can be used in the food, cosmetic and pharmaceutical industries. Before using preparations based on kaempferol and myricetin, it is necessary to know cell membranes' physicochemical and electrical properties and their interaction with these substances.

The research methodology included determining the physicochemical and electrical properties of monolayers, liposomes, and erythrocytes. The experiments were conducted using the following research techniques: Langmuir method, Brewster angle microscopy, and microelectrophoresis. The essence of the Langmuir technique is the measurement of the dependence of the surface pressure on the area occupied by a single molecule in a monolayer (isotherm $\pi$–A). The KSV NIMA BAM apparatus from Biolin Scientific combined with a Brewster angle microscope was used in the measurements. The microelectrophoresis method allows us to determine the surface charge density on the surface of model cell membranes – liposomes by measuring the electrophoretic mobility. The tests were performed using the Zetasizer Nano ZS apparatus (Malvern Instruments, Malvern, UK). It allows us to obtain data on

the size, electrophoretic mobility, and zeta potential of the studied natural systems and their model counterparts using the Doppler laser microelectrophoresis (LDE) technique. Initially, the dependence of the surface pressure on the area occupied by a single molecule in a monolayer composed of pure substances and mixtures of lipids with kaempferol and myricetin in various molar ratios was investigated using the Langmuir method. In binary monolayers, both substances tend to form complexes in a molar ratio of 1:1. This is dictated by the system desire to achieve equilibrium and, thus, obtain the highest value of the durability constant. The stability constants, specific surfaces, and energies of complex systems formation were determined on this basis. In addition, monolayers made of compounds forming natural biological membranes of erythrocytes were created. In the membranes of normal red blood cells, the ratio of cholesterol to phospholipids is approximately 0:9. The standard model of the outer leaflet of the erythrocyte membrane, composed of phosphatidylcholine and cholesterol and sphingomyelin and cholesterol in a molar ratio of 10:9 was used in the study. The systems were modified with the tested flavonoids. This is a link between artificial and biological systems, increasing the likelihood of the body's positive response when using the active substance. The Langmuir method with Brewster angle microscopy (BAM) was used to visualize the phase changes occurring during monolayer compression. During the real–time observation of the changes at the water/air interface, images were recorded for single–component and mixed monolayers. BAM images confirmed the occurring phase transitions during monolayer compression. Using the microelectrophoresis method, the results of the effect of kaempferol and myricetin on the surface charge density of erythrocyte membranes and membranes formed of phosphatidylcholine, sphingomyelin, and cholesterol in the appropriate molar ratios emitting the composition of the membrane of natural red blood cells, depending on the pH of the environment, were presented. Surface charge plays an important role in understanding the mechanisms of membrane-environment interaction and is highly dependent on pH and membrane composition.

Based on the conducted research, conclusions summarizing the doctoral dissertation were formulated. It was found that kaempferol and myricetin affect natural biological membranes' physicochemical and electrical properties and their models. The presented description of the interaction of the tested biologically active substances with natural membranes and model systems may contribute to their use in the future as therapeutically active substances.

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