POTENTIOMETRIC SENSORS FOR THE DETERMINATION OF B VITAMINS IN FOOD PRODUCTS

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B vitamins play a crucial role in many biochemical processes in the body, including carbohydrate metabolism and nervous system function (thiamine), redox reactions (riboflavin), protein metabolism (pyridoxine), DNA synthesis and hematopoiesis (folic acid), as well as nervous system function and blood formation (cobalamin). The analysis of the quality and safety of food products is fundamental to the sustainable development of food technologies, as well as the living standards of the current generation and the health of our descendants.

Existing methods for determining B vitamins are characterized by relatively high sensitivity but require expensive equipment and highly toxic reagents, which contradicts the modern concept of sustainable development and the principles of green chemistry. Potentiometric sensors are a promising method for analyzing biologically active substances of various origins, including the content of B vitamins in food products, as they provide rapid analysis, high sensitivity, and ease of use. Moreover, potentiometry is an attractive method due to its simplicity, speed, and the possibility of developing portable sensor devices.

The operating principle of the designed potentiometric sensors is based on interactions with the analyzed molecules. The sensitive elements of these sensors include a modified membrane that is selective for a specific vitamin. The polyvinyl chloride (PVC) membrane incorporates adducts of organic dyes and B vitamins.

In the development of potentiometric sensors, the following aspects were considered:

- Selection of a sensitive membrane material (inert polyvinylchloride membrane).
- Optimization of the sensor's operating parameters (pH, ionic strength of the solution, membrane conditioning time).
- Miniaturization of potentiometric sensors through the use of solid-contact electrodes, which enhance the metrological characteristics of the sensors by eliminating the need for an internal solution.
- A medical-grade steel needle was used as the metallic substrate.

Calibration of the developed sensors was conducted in solutions with known vitamin concentrations. The selectivity coefficients of the determined vitamins relative to other components present in analyzed food samples were established. The proposed methodologies were tested on samples of dairy products, cereals, and meat products, and the results were compared with alternative analytical methods.

The constructed potentiometric sensors demonstrated high sensitivity to thiamine, riboflavin, and pyridoxine. The average response time was 1 minute, with a detection limit of 10^{-5} mol/L. The membrane lifespan was 6 months (when stored in a desiccator), and each membrane allowed for 180–200 measurements. High selectivity for B vitamins in the presence of other components was observed. The deviation in vitamin determination did not exceed 5 % compared to alternative methods.

Potentiometric sensors have proven to be effective for determining B vitamins in food products. They can be used for rapid analysis and in automated quality control systems. Future research may focus on miniaturizing sensors and integrating them into portable devices. Promising directions include enhancing membrane stability and integrating sensors into mobile analytical platforms. This study demonstrates the potential of potentiometric sensors for food quality control and opens new opportunities for automating analytical methods in the food industry. Such sensors can be used in laboratory settings as well as integrated into food quality control systems.