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ELECTRO-ANALYTICAL PROPERTIES OF SENSORS FOR DETERMINATION OF VITAMIN B6

One of the main directions of development of modern electro-analytical chemistry is the development of effective methods of research and analysis of organic compounds, in particular – vitamins. This sector of studies has theoretical and practical significance for the further search of the most effective ways of synthesis and analytical determination of these substances.

Vitamin B6, being in the form of the corresponding aldehyde – pyridoxal (Fig. 1), or as a primary amine – pyridoxamine (Fig. 2), or a primary alcohol – pyridoxine (Fig. 3), or its corresponding forms of 5-phosphate derivatives (Fig. 4) can transform from one form to another in living organisms [4].

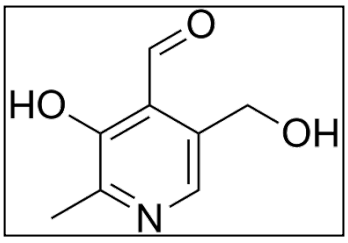

Fig. 1 – Pyridoxal

Vitamin B6 (pyridoxine) is primarily used as a stimulant in metabolism.

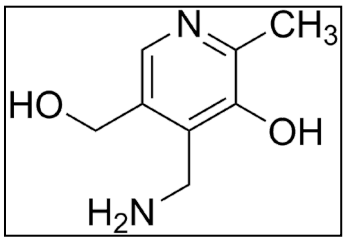

Fig. 2 – Pyridoxamine

Vitamin B6 is a coenzyme of proteins that participate in the conversion of amino acids and regulate the assimilation of proteins.

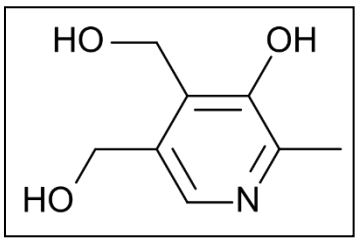

Fig. 3 – Pyridoxine

Pyridoxine participates in the formation of erythrocytes and hemoglobin and ensures a constant supply of glucose to the cell.

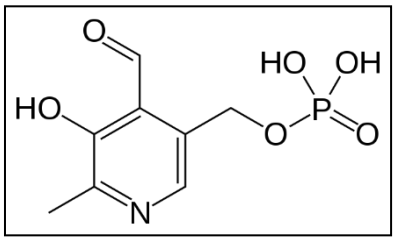

Fig. 4 – Pyridoxine

Without vitamin B6, both normal protein exchange and the exchange of fats and carbohydrates are impossible. Saturation of nerve cells with glucose requires a lot of pyridoxine, so almost half of all pyridoxine in the body is used to release carbohydrates into the blood.

In recent years, the academic literature has described research in the field of voltammetry, aimed at developing methods for the determination of vitamins in various objects using modified electrodes [3].

The working electrodes can be modified in order to improve the analytical signal, detection range, sensitivity and selectivity of the voltammetric method. At the same time, modification of their surface can be carried out both with the help of organic and inorganic substances. Among the latter, hexacyanoferrates of transition metals with catalytic activity are proposed, for example, cuprum hexacyanoferrate (II) [1]. Thus, the application of electrodes made of carbon graphite materials, modified with hexacyanoferrate complexes, can be useful for various vitamins, in particular, for vitamin B6 – pyridoxine [4].

In the academic studies, considerable attention is paid to the voltammetric method of determining vitamin B6 in food and cosmetic industry. This approach can be applied in the determination of vitamin B6 in the extracts of herbal raw materials, food products and biologically active supplements, which, in turn, allows determining the most balanced preparations in terms of vitamins and their dosage, as well as recommending their usage for preventive and therapeutic purposes [5].

The authors [5] describe a voltammetric sensor for the determination of vitamin B6 using a graphite paste electrode, modified with a vanadium salen complex. The limit of detection of vitamin B6 in this way is $3.7 \cdot 10^{-5}$ mol/l. Analytical signal of the vitamin is an anodic peak at a potential of 0.65.

The disadvantage of this method is the error in determining the content of vitamin B6 in the presence of ascorbic acid (vitamin C) and thiamine (vitamin B1) in the sample. An admixture of ascorbic acid in a solution with a concentration of $5 \cdot 10^{-4}$ and $1 \cdot 10^{-3}$ mol/l reduces the signal of vitamin B6 by 3.4% and 27%, respectively, the same concentrations of thiamine reduce the signal by 11% and 29%, respectively. The presence of such interfering effects does not allow the use of this method in the determination of vitamin B6 in biological supplements, as they contain a significant amount of vitamins B1 and C.

The literature also describes [2] a method for the joint determination of vitamins B1 and B6 on a phthalocyanine-modified cobalt carbon-paste electrode. The modified electrode is prepared in the following way. Crushed graphite powder 55% (by mass) is mixed with phthalocyanine (II) 20%, this mixture is homogenized with

the help of mechanical abrasion for 30 minutes. After the mixture has become homogeneous, it is added to 25% paraffin heated to 60-65°C, and the mixture is brought to a homogeneous plastic substance. With the help of vacuuming, air is removed and the plastic tube into which the contact is inserted is filled with mass.

Using differential pulse voltammetry and the above-mentioned modified paste electrode, analytical signals from vitamin B6 and thiamine are obtained at the following potentials of 0.55 V and – 0.13, respectively, during cathodic scanning. Phosphate buffer, pH 7-13, is used as a standard [4].

The disadvantage of the method is the complex scheme of preparation of the modified paste electrode, in particular, mechanical grinding and homogenization of the mixture and subsequent vacuuming, which is impossible without the use of additional equipment.

The reversibility of electrochemical reactions and, therefore, the high sensitivity and reproducibility of voltammetric measurements largely depends on the properties of the indicator electrode. Therefore, much attention is paid to the material of the electrode, the method of its regeneration, the definition of the potential region of polarization, the value of analytical response and the possibility of achieving the specified metrological characteristics [1].

Most often, well-known indicator electrodes made of mercury, carbon materials, gold, silver, platinum metals cannot be used. Electrochemical reactions on such electrodes are often irreversible, complicated by adsorption and high overvoltage.

Therefore, a platinum electrode modified with Co(II) phthalocyanine is used as an indicator electrode. The method of determination consists in taking voltammograms of oxidation of vitamin B6 on a chemically modified electrode. It is important for the determination of pyridoxine to use the differential mode of recording voltammograms [2].

A significant advantage of this type of recording is the possibility of obtaining high peaks, which facilitate the decoding of voltammograms and reduce the error of measuring the signal magnitude [3].

A TA-2 voltammetric analyzer is used with an electrochemical tip connected

to it, consisting of a chemically modified indicator electrode, silver chloride electrodes, comparative and auxiliary electrodes.

Conclusions. The electro-analytical properties of sensors for determining vitamin B6 are usually related to the electrochemical properties of the vitamin itself and the changes that occur on the electrode during interaction with the vitamin. The literature describes the studies in the field of voltammetry aimed at the development of methods for determining vitamins in various objects using modified electrodes. The working electrodes can be modified to improve the analytical signal, detection range, sensitivity and selectivity of the voltammetric method. At the same time, modification of their surface can be carried out both with the help of organic and inorganic substances.

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DEVELOPMENT OF PRODUCTION TECHNOLOGY OF CEREAL BARS OF FUNCTIONAL PURPOSE WITH INCREASED CONTENT OF BIOLOGICALLY ACTIVE SUBSTANCES

Nowadays on the way to proper nutrition people encounter such problems as the quick pace of life and lack of time for healthy eating, which leads to replacing a full meal with irregular snacks, buying unhealthy fast food, various sweets etc. This, in turn, leads to various disorders of the digestive system. An effective mechanism of nutritional correction is enrichment of food products with biologically