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REALITIES AND PROSPECTS

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HEALTH
and
BIOSENSORS

Edited by Nadiya Skotna, Svitlana Voloshanska,
Taras Kavetskyy, Oleh Smutok, Mykhailo Gonchar

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Reviewers:

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Arnold Kiv, Doctor of Physical and Mathematical Sciences, Professor, Head of Department of Innovation Technologies, South-Ukrainian K.D. Ushynsky National Pedagogical University.

This research work belongs to a group of authors, contains an in-depth study of the health preservation problem and the use of biosensors for this purpose, fixes the scientific priority, provides society with the primary scientific information on health promotion, the formation of environmental responsibility.

The monograph is intended primarily for scientists and meets by its content and form of publication, but will be interesting for a wide range of public. The clarity of the wording and presentation of the material, the logic of coverage for the basic ideas and concepts in it are of particular importance. Requirements to the essence of the presentation of the material in the sections of the monograph, similar to the requirements of other scientific publications with certain features of their purpose. Moreover, the issues raised in this monograph are still the subject of lively discussion among contemporary domestic and foreign scholars.

We will be glad if the monograph will not leave you indifferent and you will want to share your impressions of it.

CONTENTS

P R E F A C E

In the recent years, there is a growing interest in the world in the development of new highly specific approaches of identifying the key ingredients or metabolites which determine the quality of the product or serve as markers for diseases, the physiological state of a human organism or environmental safety. Among different analytical approaches, a special role is attributed to analytical biotechnology which exploits the principles of biomolecular recognition, highly developed during the evolution. Biosensors are the most novel achievement of analytical biotechnology. Generally, a biosensor is a hybrid device containing two functional parts: a bioelement (biorecognition unit) – an immobilized biologically active material, and a physical transducer (signal converting unit). The biosensor bioelement is usually prepared in the immobilized form and often covered with an outer membrane which either prevents the penetration of interfering substances into a sensitive bioselective layer and transducer surface, or creates a diffusion barrier for the analyte. Such membrane structures increase the stability of the biorecognizing element, enhance its selectivity and provide the diffusion limitations for biochemical reactions.

Nowadays, nanotechnology approaches have been successfully used for improvement of functional properties of the enzymatic sensors. Nanosized materials have unique characteristics: a high sorption capacity, ability of self-assembly and, in some cases, unique catalytic properties. The integration of nanotechnologies seems to be very promising in further development and production of such biosensors due to the unique combination of chemical inertness, surface chemistry, size- and shape-dependent electronic and optical properties.

The main focus of the monograph is dedicated to description of new bio-recognizing objects based on enzymes for analytical purposes coupled with the novel polymer matrixes and nanomaterials for improving the characteristics of amperometric biosensors.

Modern studies of biosensors define them as markers for the establishment of violations for the physiological states in the human body and the diagnosis for certain types of diseases.

This problem is especially relevant for the present, as during the last decade, there are steady negative changes in the population health, in particular in Ukraine, especially pronounced in children and adolescents. The objective and subjective reasons for the sharp decline in the health of our country's citizens are: deep socioeconomic crisis; unfavorable ecological situation; the spread of infectious and parasitic diseases; imperfect structure of health care system; the lack of priorities and motivation to lead a healthy lifestyle as a leading factor in the preservation and strengthening of health, etc.

The health care system in Ukraine is focused on treatment rather than on disease prevention and healthy lifestyle propaganda. Instead, the world scientific community is actively working on issues of preventing the development of diseases and developing methods for their effective early diagnosis. Great expectations are relied on biosensors that will help monitor health indicators, improve the quality of medical analyzes, assess the state of the environment, etc. That is why medical sensors make up the largest part of the biosensor market.

The consideration of medical-biological, environmental and educational aspects of human health and its conservation also possess an important place in the presented monograph.

We hope that the results of the theoretical, methodological and practical studies presented in the proposed collective work of the authors will be interesting both for specialists and for the general public.

Nadiya SKOTNA,
Svitlana VOLOSHANSKA,
Taras KAVETSKYY,
Oleh SMUTOK,
Mykhailo GONCHAR

SECTION I

BIOSENSORS FOR ECOLOGY AND HUMAN HEALTH

Chapter 1. NON-INVASIVE *L*-LACTATE ANALYSIS OF HUMAN LIQUIDS USING A THIRD GENERATION BIOSENSOR BASED ON GOLD NANOLAYER AND FLAVOCYTOCHROME b_2

O. SMUTOK[1,2], T. KAVETSKYY[2,3], Y. KUKHAZH[2], K. ZUBRYTSKA[2], M. KRAVTSIV[2], O. MUSHYNSKA[2], O. NYKOLAISHYN-DYTSO[2], R. SERKIZ[1], S. VOLOSHANSKA[2], M. GONCHAR[1,2]

[1]Institute of Cell Biology, National Academy of Science of Ukraine, 14/16, Drahomanov Str., 79005 Lviv, Ukraine

[2]Drohobych Ivan Franko State Pedagogical University, 24, I. Franko Str., 82100 Drohobych, Ukraine

[3]The John Paul II Catholic University of Lublin, 14, Al. Racławickie, 20-950 Lublin, Poland

e-mail: smutok@cellbiol.lviv.ua

Abstract. *Lactic acid (L-lactate) is among of the most important analytes since it is a universal metabolite of nearly all living organisms. The indication of the L-lactate level is used in clinical diagnostics of hypoxia, lactic acidosis, some acute heart diseases and in drug toxicity tests, as well as for monitoring the athletic performance for evaluation of the best training equipment and regimes during the training of the sportsmen. Therefore, reliable determination of L-lactate is important in clinical diagnostics and sport medicine. The measurement of metabolites in fluid other than blood is becoming increasingly significant because of major demands of non-invasive analysis (safety, rapidity and accuracy). In sensor technology, the most efficient for non-invasive analysis of human fluids seems to be third generation (mediatorless) amperometric biosensors due to no requirement in any exogenous cofactors, toxic electron transfer mediators or using a high working potential.*

The aim of this work is the construction of a third generation (mediatorless) electrochemical biosensor for non-invasive L-lactate analysis of human liquids based on yeast L-lactate: cytochrome c oxidoreductase (EC 1.1.2.3; flavocytochrome b_2, FC b_2) immobilised onto gold nanolayer (nAu). Obtained FC b_2-nAu modified bioelectrodes are characterized by improved analytical parameters compared to the enzyme electrodes obtained without using nAu. The constructed bioelectrodes were adapted for direct non-invasive analysis of human saliva and sweat samples. The obtained results of the real samples analysis of saliva show a high correlation with the reference approaches, as well, literature data.

Keywords: *L-lactate; Human liquids; Non-invasive analysis; Direct electron transfer; Gold nanolayer; Flavocytochrome b_2; Amperometric biosensor.*

Introduction

Lactate, a key metabolite of the anaerobic glycolytic pathway, plays an important role in medicine, in the nutritional sector, as well as in food quality control. A level of *L*-lactate content in human blood is an important clinical indicator of hypoxia, acidosis [14], heart attack [27], level of drug's toxicity [20], and serves as a marker for evaluation of the optimal sportsmen's training [2]. *L*-lactate is also an important biomarker for different types of cancer due to Warburg phenomenon [19]. Moreover, because a lactate threshold can be increased greatly with training monitoring the athletic performance for evaluation of the best training equipment and regimes is very actual [18]. Therefore, reliable determination of *L*-lactate is important in clinical diagnostics and sport medicine.

The measurement of metabolites in fluid other than blood (saliva, urine and sweat) is becoming increasingly significant because of major demands of non-invasive analysis. A non-invasive method of *L*-lactate assay has deprived the risks by handling of blood and the pain of puncturing. Advantages of this analysis are simplicity of sample collection and that samples can be collected more frequently with much less stress on the patient. A tight correlation between the *L*-lactate concentration in sweat and blood was approved many years ago and can form the basis of correct non-invasive analytical approach [1].

Amperometric biosensors offer a sensitive and selective means to monitor organic analytes like *L*-lactate. Biosensor technology made a great progress in the last decades. It involved the development of increasingly selective and sensitive biorecognition elements together with the fabrication of novel transducer materials and matrixes for protein immobilization. Biosensors of the third generation are based on direct electronic coupling of the biorecognition elements to the electrode without assistance of intermediate substances such as substrates/products or artificial mediators in the biosensors of first or second generation, respectively [37; 31]. The first reports on direct electron transfer between redox protein and electrode were provided by Eddowes and Hill [7], and Yeh and Kuwana [43], who independently discovered the ability of cytochrome *c* to directly transfer electrons to gold or tin-doped indium oxide electrodes. Subsequently, it was followed by the discovery that larger redox proteins such as laccase and peroxidise are also able to undergo the direct electron transfer [35; 42]. Since that time, direct electron transfer has been reported for catalase [25], cytochrome P450 [4], hydrogenases [38], bilirubin oxidase [28], ascorbate oxidase [29], succinate dehydrogenase [13], alcohol dehydrogenase [15], fructose dehydrogenase [8] cellobiose dehydrogenase [22] and flavocytochrome b_2 [33]. Most of the enzymes, which are capable of direct electron transfer, contain metals such as iron or copper and have easily accessible active centers. The important factors for efficient electron transfer are orientation of the enzyme structure on the electrode [10] distance and driving force between active center of the enzyme and electrode [9]. However, the high selectivity of many enzymes requires deep embedding of the enzyme prosthetic group in the protein structure and thus prevents such enzymes from direct electron transfer to the electrode due to the fact that the distance between the redox centers of such enzymes and electrode exceeds the distance across which electrons can be efficiently transferred [40]. This limitation can be surmounted by chemical [5] or genetic [21] modification of proteins or reconstitution of the apo-enzymes with relay-cofactor units, immobilized on the electrode surface [39; 16]. The direct contact between enzyme redox center and the electrode can also be improved by incorporation of nanomaterials [41; 26; 24].

The aim of this work is the construction of a novel non-invasive electrochemical biosensor of third generation for *L*-lactate based on yeast *L*-lactate: cytochrome *c* oxidoreductase (EC 1.1.2.3; flavocytochrome b_2, FC b_2) immobilized onto gold nanolayer (nAu). FC b_2 is a tetramer with four identical subunits, each consisting of FMN- and heme-binding domains. The main properties of FC b_2 of thermotolerant yeast *Ogataea (Hansenula) polymorpha* are the selectivity for *L*-lactate, its high stability and ability to direct electron transfer. The developed mediatorless prototype of biosensor was used for direct chronoamperometric analysis of the real samples of saliva and sweat.

Materials and methods

Reagents

L-lactic acid sodium salt, *L*(+)-lactic acid, Triton X-100, H_2O_2, $HAuCl_4$, and EDTA were obtained from Sigma-Aldrich (Buchs, Switzerland). *D*(+)-glucose monohydrate was purchased from J. T. Baker (Deventer, The Netherlands). $(NH_4)_2SO_4$, Na_2HPO_4, KH_2PO_4, $MgSO_4$, $CaCl_2$ were obtained from Merck (Darmstadt, Germany). E-Toyopearl 650M was obtained from Toyo Soda (Tokyo, Japan). The cathodic electrodeposition paint "GY 83-0270 0005" was from BASF

Coatings GmbH (Munster, Germany). All chemicals were of analytical grade and all solutions were prepared using triply-distilled water.

Purification of flavocytochrome b_2 (FC b_2)

L-lactate: cytochrome *c* oxidoreductase (flavocytochrome b_2) (EC 1.1.2.3) was isolated and purified from the recombinant cells of the thermotolerant yeast *Ogataea polymorpha* "tr 1" (*gcr1 catX/prAOX_CYB2*) [6]. The enzyme was isolated by ion-exchange chromatography on DEAE-Toyopearl cellulose 650 M [34]. The enzyme was purified to the specific activity of 22 $U \cdot mg^{-1}$ and stored as a suspension in 70%-saturated ammonium sulphate, pH 7.8 at +4 ^oC before usage.

Apparatus and techniques for biosensor construction

Amperometric biosensors were evaluated using constant-potential amperometry in a three-electrode configuration using 4 mm diameter planar gold electrodes DRP-C220AT from "DropSens" (Llanera, Asturias, Spain).

Amperometric measurements were carried out using a potentiostat CHI 1200A (IJ Cambria Scientific, Burry Port, UK) connected to a personal computer and performed in a batch mode under continuous stirring in a standard 4 ml electrochemical cell at 25 ^oC.

Modification of the surface of gold planar microelectrode by gold nanolayer

In order to improve a direct electron transfer from FC b_2 to electrode surface, the working surface of electrode was modified by gold nanolayer (nAu). The nAu was obtained directly on the electrode surface by reduction of $HAuCl_4$ solution to Au^0. The reaction was performed using 30% H_2O_2 according to Panda and Chattopadhyay [23]. The procedure was as follows: 4 µl 2 mM $HAuCl_4$ was dropped on the top of working electrode; after drying, 4-5 µl 30% H_2O_2 was added.

Prior the modification of the surface the planar gold electrodes were cleaned by 70% ethanol solution. The modification of electrode surface by the nAu was accompanied with changing polished surface structure to scabrous and color from yellow (gold) to high-colored orange (nanogold).

Immobilization of FC b_2 on the nAu-modified planar electrode

Entrapment in a layer of the cathodic electrodeposition polymer CP9: an optimised procedure of FC b_2 immobilization on the top of gold planar electrodes was as follows: 4 µl FC b_2 suspension (10 $U \cdot ml^{-1}$ in 200 mM phosphate buffer (PB), pH 7.8) was dropped on the surface of nAu-modified electrode. After drying for 2 min at room temperature, the enzyme layer was covered with 8 µl 10-fold diluted solution of the cathodic paint GY 83-0270 0005 (pH 5.5). After drying, a well-adhering polymer film was formed.

Physical fixation of the enzyme behind a dialysis membrane: 4 µl FC b_2 suspension (10 $U \cdot ml^{-1}$ in 200 mM PB, pH 7.8) was dropped on the surface of the gold planar electrodes and dried for 2–3 min at room temperature. Then, the electrode was covered with a piece of standard dialysis membrane (with a diameter of about 6 mm). An adhesive membrane with a round hole (with a diameter of about 4 mm) was used for dialysis membrane holding on the electrode surface. The electrodes were rinsed with 20 mM PB, pH 7.8, before using.

Scanning electron and X-ray microanalysis

A Scanning Electron Microscope (SEM-microanalyser REMMA-102-02, Sumy, Ukraine) was used for morphological analyses of the electrodes surface. The special cover film on the samples with a Butvar solution B-98 (Sigma, St. Louis, MO, USA) in 1.5% chloroform was formed using an ultrasound method. The distance from the last lens of the microscope to the sample (WD) ranged from 20.1 mm to 26.1 mm; the accelerator voltage was in the range from 20 kV; zooms were from 10 000.

Atomic force microanalysis

The structure of nAu-modified planar electrodes was studied by atomic force microscope Solver P47-PRO (NT-MDT).

An aliquot of the tested sample was spread on the surface of freshly-cleaved mica, dried and analyzed in air using the tapping mode with a resonance frequency of 160 kHz, scan rate of 1 Hz/s and resolution of 256 × 256 pixels.

Results and discussion

Evaluation and characterization of mediatorless L-lactate-selective bioelectrodes based on flavocytochrome b_2 immobilized onto gold nanolayer

In the yeast, FC b_2 performs the dehydrogenation of *L*-lactate to pyruvate at the presence of cytochrome *c*. In the first step of catalysis, lactate transfers two electrons (hydride) to FMN, which further reduces the heme. Finally, the reduced heme of FC b_2 reduces cytochrome *c*, which finally transfers the redox equivalents to the mitochondrial respiratory chain. For construction of a third generation biosensor, we have used the ability of reduced FC b_2 to undergo the direct electron exchange with the electrode surface [33]. In the absence of redox mediator, the direct electron transfer is possible if the distance between the enzyme active center and the electrode surface is sufficiently short. Because the efficiency of the direct electron transfer between FC b_2 and graphite electrode is comparatively low [33], we suggested that modification of the electrode surface by gold nanolayer may enhance the electron exchange due to size factor. Moreover, the gold nanoparticles could directly transfer the electrons from the enzyme monolayer due to the "correct orientation" of the heme relative to the electrode surface *(Fig. 1)*.

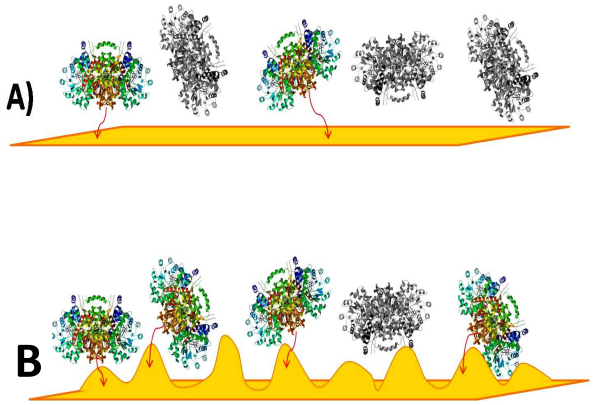


Fig. 1. The general scheme of electron exchange between the FC b_2 active center and electrode surface. A) An inefficient electron transfer. B) An improved electron transfer through gold nanolayer (nAu). The colored images related to the FC b_2 molecules that provide a direct electron transfer, the gray images – the enzyme molecules that do not participate in this process

The gold nanolayer (nAu) was formed on the surface of a commercial 4 mm diameter planar gold electrodes DRP-C220AT "DropSens". The nAu was created directly on the top of working surface of the electrode by the reaction of $HAuCl_4$ with H_2O_2. FC b_2 was immobilised on the top of the formed nAu using the cathodic electrodeposition paint "GY 83-0270 0005" BASF Coatings GmbH (Munster, Germany).

The cyclic voltamperometry was used for characterization of the electroconductivity of the nAu-modified planar gold electrodes DRP-C220AT compared to the same unmodified electrode *(Fig. 2)*.

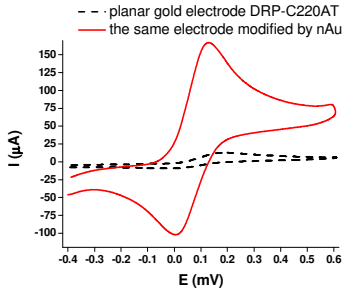
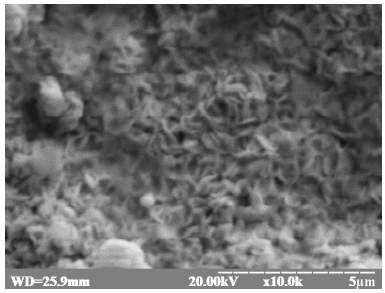


Fig. 2. Cyclic voltamperometry of bare (dash line) and nAu–modified (solid line) gold electrode. Conditions: scan rate 50 mV·s^{-1}, the redox potential is reported vs Ag/AgCl, the electrolyte solution consists of 10 mM potassium ferrocyanide in 100 mM KCl, pH 6.0

The cyclic voltamperometry with using ferri/ferrocyanide redox couple revealed that the modification of the gold electrode by nAu significantly (18-fold) improved the electron transfer *(Fig. 2)*.

To confirm the formation of a gold nanolayer on the surface of the planar electrode, scanning electron microscopy and atomic force microscopy were used *(Fig. 3)*.

(A) 

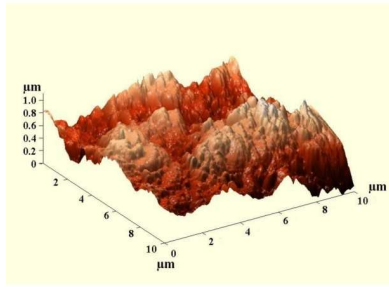
(B) 

Fig. 3. (A) Scanning electron microscopy of the surface of 4 mm gold planar electrode DRP-C220AT "DropSens" after modification by the nAu. Note: WD – distance from the last lens of microscope to the samples (mm); kV – accelerating voltage; x – fold magnification; μm – scale unit. (B) Atomic force microscopy microphotograph of nAu-modified electrode

The results of SEM and AFM imaging clearly demonstrated that due to the formation of nAu the surface of the electrode becomes microcrystalline with clusters of irregular shape of microfibrillar structures *(Fig. 3)*. On the other hand, the formation of nAu was confirmed by X-ray spectral analysis *(Fig. 4)*.

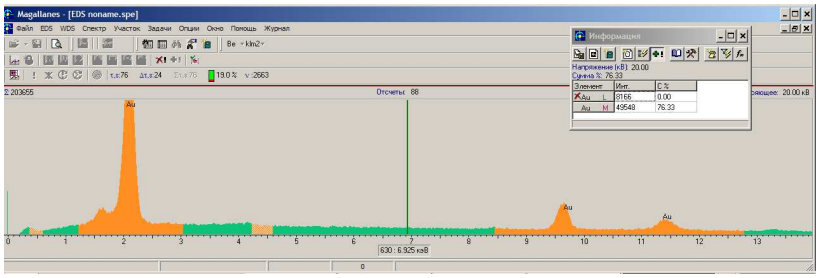


Fig. 4. X-ray spectral analysis of the surface of 4 mm gold planar electrode DRP-C220AT "DropSens" after modification by the nAu

The data of the X-ray spectral analysis of nAu-modified electrode's surface have approved the formation of Au^0 with a typical peak K_α at 2.1 keV *(Fig. 4)*.

FC b_2 with activity of 22 $U \cdot mg^{-1}$ was immobilized on the top of the formed nAu using the cathodic electrodeposition paint GY 83-0270 0005. We have compared the chronoamperometric characteristics of nonmodified and nAu-modified enzyme electrodes, recording their responses to the increased concentrations of *L*-lactate *(Fig. 5)*.

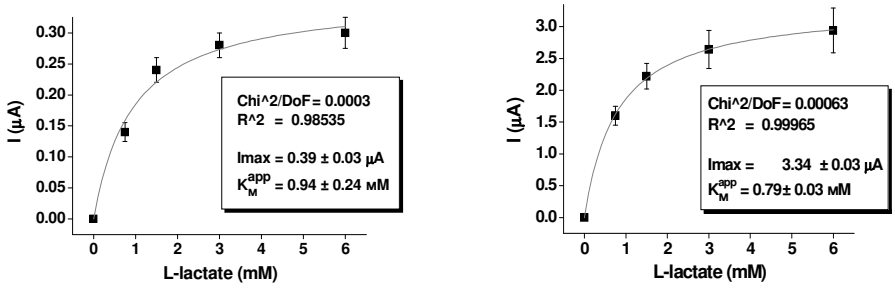


Fig. 5. The calibration curves (obtained from chronoamperometric analysis) upon subsequent additions of L-lactate for non-modified (left) and for nAu-modified (right) 4 mm gold planar enzyme electrodes DRP-C220AT. Conditions: working potential 250 mV vs Ag/AgCl in 20 mM PB, pH 7.8 at room temperature

As shown in *Fig. 5 (left)*, the maximal current at the saturating concentrations of substrate for the bare (non-modified) enzyme electrode was equal to 0.39 ± 0.027 μA. On the other hand, the nAu-modified electrode generated an one-order higher output (up to 3.34 ± 0.03 μA) at the same conditions *(Fig. 5, right)*. The apparent Michael-Menten constants (K_M^{app}) of the first type of bioelectrode derived from the calibration plots were calculated as 0.94 ± 0.243 mM and 0.79 ± 0.03 mM for nAu-modified enzyme electrodes, respectively *(Fig. 5)*. Decreased K_M^{app} to *L*-lactate for nAu-based bioelectrodes system additionally demonstrated a positive impact of nAu on the enzyme-depended catalysis due to the faster reoxidation of FC b_2 resulting from improved direct electron transfer.

The time of response of the nAu-modified bioelectrode is characterized by the following parameters: 50% of the signal is reached for 4.5 seconds and 90% for 10 seconds *(Fig. 6)*.

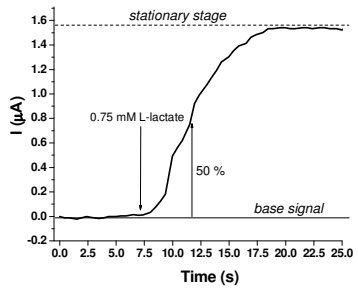


Fig. 6. Chronoamperometric current response of the nAu-modified bioelectrode upon addition of 0.75 mM L-lactate. Conditions: working potential 250 mV vs Ag/AgCl in 20 mM PB, pH 7.8 at room temperature

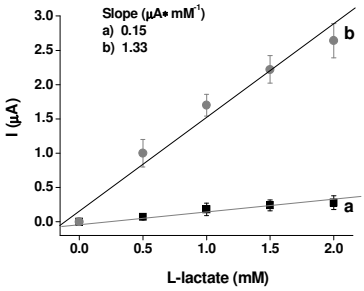


Fig. 7. L-lactate-dependent responses of two types of FC b_2-based electrodes: non-modified (a) and nAu-modified 4 mm gold planar electrode DRP-C220AT (b). Conditions: working potential 250 mV vs Ag/AgCl in 20 mM PB, pH 7.8 at room temperature

The best sensitivity (106 $A \cdot M^{-1} \cdot m^{-2}$) was achieved for the nAu-modified electrode which is approximately one order higher when compared with the non-modified enzyme electrode (11.0 $A \cdot M^{-1} \cdot m^{-2}$) *(Fig. 7)*. The increased sensitivity of the constructed biosensor clearly approved that deposition of Au nanolayer on gold electrode is useful for construction of the third generation biosensors with improved bioanalytical characteristics. The reproducibility of the biosensor signals in the linear range (from 0.03 up to 2.0 mM of *L*-lactate) was calculated as 0.95 % of relative standard deviation. A selectivity of the developed sensor depends only on purity of FC b_2 preparations and was shown to be the same as described by us for the second generation FC b_2-based biosensor [33]. The half-life of the sensor stability was estimated as 34 days of storage at +4 ^{o}C. The developed mediatorless *L*-lactate-selective bioelectrodes were used for construction of prototype of non-invasive biosensor for direct analysis of *L*-lactate in human saliva and sweat.

Construction and validation of non-invasive L-lactate-selective biosensor

Recently, the creation and testing of a non-invasive biosensor chip for determination of *L*-lactate in human sweat has been reported [17]. The principle of the bioelectrode described is the principle of enzymatic oxidation of lactate by lactate oxidase, followed by electron transfer from the reduced enzyme to the surface of electrode through the mediator. The main advantages of the described biochip are the possibility of online monitoring of the lactate content at different loads, wide linearity (up to 20 mM *L*-lactate), a low working potential (50 mV), the flexibility, which reduces the inconvenience of its attachment to the surface of the skin.

We have created a prototype of a mediatorless biosensor for non-invasive quantitative determination of *L*-lactate in sweat and saliva using FC b_2 and nAu-modified planar electrodes DRP-C220AT.

Designing a prototype of *L*-lactate-selective bioelectrode was focused on usage of non-toxic and hypoallergenic compounds. For this purpose, instead of cathodic paint, two membranes were used for immobilization of FC b_2 on the nAu-modified electrode. The dialysis membrane provides an easy penetration of analyte and holding the enzyme; another adhesive membrane was used for fixation of the dialysis membrane on the electrode surface *(Fig. 8)*.

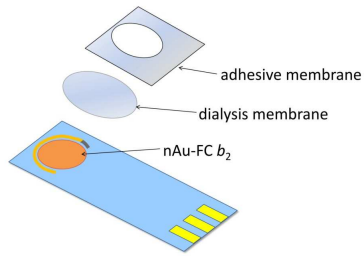


Fig. 8. The scheme of non-invasive L-lactate-selective bioelectrode based on FC b_2 and nAu-modified planar electrodes DRP-C220AT

For non-invasive measurement of *L*-lactate content in sweat *in situ*, the electrode connected through 50 cm flexible adaptor was put to a skin of the forearm. Before analysis (10 min) the skin was washed by distilled water to decrease an impact of microbial contamination. Then, the electrode surface was connected with skin and analysis of *L*-lactate by chronoamperometric mode was started *(Fig. 9, left)*. For non-invasive analysis of lactate content in saliva, the electrode was put under a tongue for 30 s (5 min before the experiment a mouth was washed by distilled water). The increasing of chronoamperometric response due to the enzymatic oxidation of lactate was observed at working potential 250 mV *(Fig. 9, right)*.

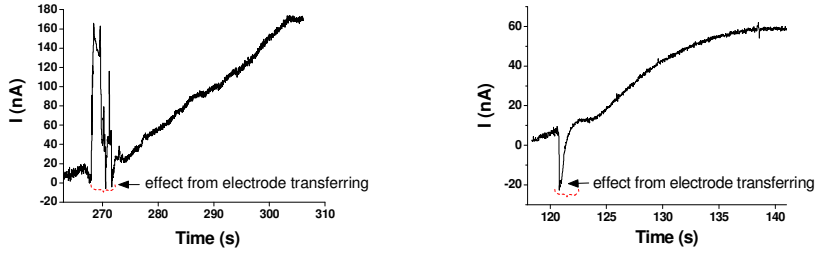


Fig. 9. Chronoamperometric current response during in situ non-invasive analysis of sweat (left) and saliva (right) by a non-invasive L-lactate-selective bioelectrode based on FC b_2 and nAu-modified planar electrode DRP-C220AT.
Conditions: working potential 250 mV vs Ag/AgCl at room temperature

The chronoamperogram of non-invasive determination of the *L*-lactate content in sweat demonstrates the increasing sensor signal up to 170 nA during 35 seconds after transferring the electrode to the investigated skin surface. In the case of saliva analysis, a similar response was equivalent to 50 nA relative to the base signal *(Fig. 9)*. Calibration of the corresponding

bioelectrode by standard *L*-lactate solution was performed to find which concentrations of *L*-lactate correspond to the given values of the chronoamperometric *in situ* currents *(Fig. 10)*.

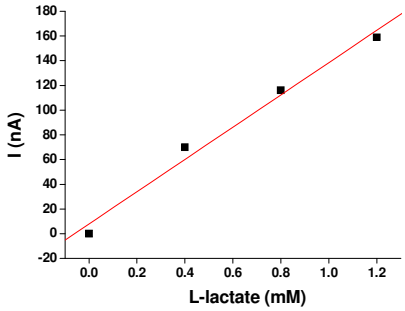


Fig. 10. Calibration curves of chronoamperometric response of a non-invasive L-lactate-selective bioelectrode based on FC b_2 and nAu-modified planar electrodes DRP-C220AT upon addition of standard L-lactate solution. Conditions: working potential 250 mV vs Ag/AgCl in 20 mM PB, pH 7.8 at room temperature

The calibration of the bioelectrode was performed at room temperature in a 50 ml glass microcell, filled with 4 ml 30 mM phosphate buffer, pH 7.8. The bioelectrode was placed in an intensely stirred solution and, after the base signal was set at a working potential of 250 mV, increasing concentrations of the standard *L*-lactate solution were added into the cell *(Fig. 10)*.

Using the interpolation of the current values obtained by chronoamperometric analysis of sweat and saliva on the calibration curve of standart solution of *L*-lactate, it was found that the response of 170 nA corresponds to the concentration higher than 1.2 mM and 50 nA to 0.32 mM *L*-lactate.

For analysis of accuracy of the non-invasive direct *L*-lactate assay, a standard addition mode (SAM), as well as spectrophotometric method [12] were used as the reference approaches. For standard addition mode, chronoamperometric measurement of *L*-lactate content in the collected samples without any treatment (saliva and sweat) by the same electrode was used *(Fig. 11; Table 1)*.

L-lactate content in sweat calculated using standard addition mode was 4.85 ± 0.25 mM and 0.34 ± 0.03 mM of *L*-lactate in saliva *(Fig. 11)*. On the other hand, the results obtained using spectrophotometric method were estimated as 5.0 ± 0.15 mM *L*-lactate for sweat and 0.35 ± 0.03 mM for saliva, respectively *(Table 1)*.

As follows, analytical results obtained by non-invasive *in situ* and reference analysis for human saliva have a high correlation ($0.7 < r < 1$). The reasons for the inconsistency of the results of the determination of *L*-lactate in sweat by the chronoamperometric *in situ* analysis could be explained, probably, by a high sensitivity of the biosensor (linearity maximum about 1.2 mM for *L*-lactate) for sweat samples without dilution.

This disadvantage of the sensor could be eliminated by modifying the operating parameters of bioelectrodes, in particular by decreasing the affinity of the biosensor system to *L*-lactate [6; 32], by expanding the linearity for *L*-lactate determination (by reducing the efficiency of electron transfer in the bioselective membrane) [11] or by decreasing the penetration of the biosensor membrane for substrate. In any way, this hypothesis should be clarified in the future using bioelectrodes with modified parameters.

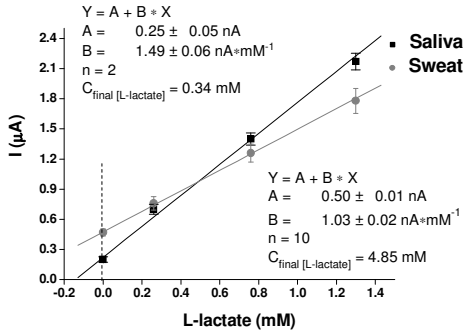


Fig. 11. Calibration curves of chronoamperometric analysis of the collected samples of sweat and saliva by L-lactate-selective bioelectrode using a standard addition method. Conditions: working potential 250 mV vs Ag/AgCl in 20 mM PB, pH 7.8 at room temperature

Table 1

The analysis of the human real samples of sweat and saliva using the *L*-lactate-selective bioelectrode and spectrophotometric method

	Method		
Sample	***Biosensor assay using SAM, mM***	***Spectrophotometric method, mM***	***Developed direct biosensor analysis, mM***
Saliva	0.34 ± 0.03 p > 0.05*	0.35 ± 0.03 p > 0.05*	0.36 ± 0.02
Sweat	4.85 ± 0.25	5.0 ± 0.15	> 1.2

**Difference between current method and the compared methods is statistically insignificant (p > 0.05)*

Conclusions

A new prototype of non-invasive electrochemical biosensor of third generation for analysis of *L*-lactate in human liquids has been constructed. The sensor is based on ability of yeast flavocytochrome b_2 to direct electron transfer onto surface of gold electrode. It was proven that the additional deposition of gold nanolayer (nAu) onto a gold electrode enhanced the direct electron exchange between the enzyme active center and the electrode surface. The comparison of nAu-modified and unmodified FC b_2-based biosensors has shown that the electrode modification by Au-nanoparticles resulted in an 18-fold increase in the amperometric response towards *L*-lactate. The developed mediatorless biosensor had been adapted for non-invasive *in situ* analysis of *L*-lactate in human sweat and saliva. Using three analytical approaches, it has been shown, that *L*-lactate content in saliva sample is in the range of 0.34-0.36 mM.

Unfortunately, the developed prototype of non-invasive *L*-lactate-selective bioelectrode based on FC *b*2 and nAu-modified planar electrodes DRP-C220AT is too sensitive for direct analysis of human sweat without dilution. This should be clarified in the future using bioelectrodes with modified parameters (sensitivity, affinity, layer permeability). However, a new prototype of non-invasive electrochemical biosensor of third generation is supposed to be applied for the determination of saliva lactate level in clinical diagnostics and sport medicine.

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Chapter 2. LACCASE AS A PERSPECTIVE TOOL FOR MONITORING AND DETOXIFICATION OF PHENOLIC ENVIRONMENTAL POLLUTIONS

O. DEMKIV[1,2], O. SMUTOK[1,2], T. KAVETSKYY[2,3], S. BANAH[4], Y. KUKHAZH[2], K. ZUBRYTSKA[2], H. KLEPACH[2], M. GONCHAR[1,2]

[1]Institute of Cell Biology, National Academy of Science of Ukraine, 14/16, Drahomanov Str., 79005 Lviv, Ukraine

[2]Drohobych Ivan Franko State Pedagogical University, 24, I. Franko Str., 82100 Drohobych, Ukraine

[3]The John Paul II Catholic University of Lublin, 14, Al. Racławickie, 20-950 Lublin, Poland

[4]Ivan Franko Lviv National Univesity, 4, Mykhailo Hrushevskyi Str., 79005 Lviv, Ukraine

e-mail: demkiv@yahoo.com

Abstract. *The usage of microbial laccase as a perspective tool for monitoring and detoxication of phenolic environmental pollutions are reviewed. Laccase-based amperometric biosensors and importance of laccases for bioremediation are considered. The most actual application of laccases is summarized. "Green" chemistry and the use of enzymes such as laccase are shown as one of the most promising approaches to reducing the negative technogenic pressure on the environment.*

Keywords: *Laccase; Environmental pollution; Amperometric biosensor; Bioremediation.*

Introduction

Technogenic pressure on the environment significantly affects the pollution of water resources, resulting that the one of the most important problems is the contamination of soil, water and air by toxic chemicals. Due to extremely rapid development of the industrial sphere and wide use of plastic, detergents, pharmaceuticals, pesticides in agriculture, the level of environmental pollution is groving up extremely fast that causes a serious threat to human life and health. Some compounds, such as polycyclic aromatic hydrocarbons, pentachlorophenols, polychlorinated biphenyles, dichlorodiphenyltrichloroethane (DDT), benzene, toluene, ethylbenzene and xylene are accumulated in the environment. These pollutants join to natural water streams along with industrial effluents of chemical-related sector, such as coal refineries, pharmaceutical manufacturing, production of resins, paints, wood processing, textiles, petrochemicals, and pulp, including the manufacturing of phenols cause carcinogenic and mutagenic effects on living organisms [79; 80].

Especially dangerous products of the chemical and pharmaceutical industry are xenobiotics which are classified also as carcinogens that cause disruption of the endocrine system of human and animals. They are a matter of industrial origin in the human body, capable of causing effects similar to the effects of high doses of a natural hormone estrogen [83; 84]. Mimicking estrogen, they adversely affect the function of the endocrine system and able to cause various health defects, affecting synthesis, metabolism and cellular reactions of natural estrogens [85; 3]. Xenoestrogens are a common pollution. They arrive in the surface water with drains of oil, shale, forest-chemical, and cox-chemical industries as well as with drains of hydrolysis industry. For example, xenoestrogen Bisphenol A is a monomer that is used for the manufacture of polycarbonate plastic and epoxy resins, which are raw materials for the production of

packaging materials for food and drinks. As a result of hydrolysis of the ester linkages in these polymers, Bisphenol A is released in the environment, resulting in widespread negative impact on human and animals. A list of substances with an endocrine activity is constantly expanding. It includes chlorine-organic and poly-aromatic compounds, the source of which is a plastic used for packaging of drinking water [63], and some pharmaceutical drugs widely used, such as Ibuprofen, in dangerous concentrations. When using Ibuprofen in the order of hundreds of thousands tons, the anti-inflammatory drug and its metabolites are detected in all samples of wastewater and sea water at a concentration from 0.1 to 20 μg/L [18]. The main sources of substances with xenoestrogenic effect are the wastewater of cities and animal complexes. A high content of estrogens and pharmaceutical drugs is still existed even after treatment of water [105; 106]. Moreover, acumulated in plants polyphenols have become an emerging field of interest in recent decades. A growing body of research indicates that polyphenol consumption may play a vital role in health through the disregulation of metabolism, weight, chronic disease, and cell proliferation [49].

Bioremediation is a key strategy to control the massive presence of chemicals in the environment [93]. Environmental concerns have led to an increased interest in developing green technologies for bioremediation of wastewater pollutants. In this aspect, laccases have emerged as attractive green catalysts due to their applicability in oxidizing broad range of substrates. Enzymatic bioremediation is an alternative approach, because it involves simple protocols, requires low purification costs and has a minimum impact on ecosystem, without producing hazardous by-products unlike inefficient conventional methods.

Laccases (benzenediol: oxygen oxidoreductases; EC1.10.3.2.) are the typical glycoprotein class enzymes of wood decaying fungi and are involved in the degradation of lignin in lignocellulosic substrates of woody tissues. Except fungi, the laccase activity has been found in plants, bacteria and insects that predetermine their significant role for synthetic and mineralization processes in nature. However, majority of laccases characterized so far have been derived from white-rot fungi [29]. Laccase is a part of broad group of enzymes containing copper atoms in the catalytic center and are usually called multicopper oxidases.

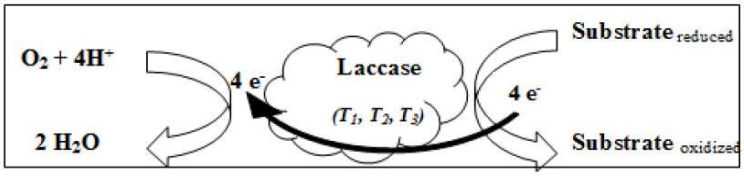

Fig. 1. A typical scheme of laccase reaction [104]

Laccases contain three types of copper atoms, one of which is responsible for their characteristic blue color. This enzyme conjoins the four single electron oxidations of the reducing substrate to the four-electron reductive cleavage of the di-oxygen bond with four copper atoms *(Fig. 1)* [29]. Laccases have a broad substrate specificity to a wide variety of phenolic compounds, including monophenols, di-phenols, polyphenols, methoxy-substituted phenols, and a range of other compounds [99]. Moreover, they are able to oxidising para-phenolic substituted compounds but their affinity is usually higher towards the ortho-phenoles. Literature reports that laccase has been the model catalyst for substrates like aminophenols, methoxyphenols, aromatic amines, and ascorbate, with the concomitant four-electron reduction of oxygen to water [98]. The broad substrate specificity makes laccases interesting "eco-friendly" enzymes with high industrial potential [77].

Due to a broad substrate specificity, and wide reaction capabilities, laccase possess promising applications in bioremediation of soils as well as water [49] and in development of biosensors and biofuel cells [95; 96].

Laccase-based amperometric biosensors

The development of new approaches for monitoring of the dangerous substances in environment is a topical problem to improve human life quality. During the past two decades, bioelectrochemistry has received increased attention. A term "biosensor" couples an integrated biological biorecognition component with an electronic transducer, converting a biochemical signal into a quantifiable electrical response that detects, transmits and records information regarding to biochemical change. They are specific, sensitive, reliable, portable and simple in operation. Laccase does not involve the addition cofactors in electron transfer reactions, so it is promising tool in Biosensorics *(Fig. 2)*.

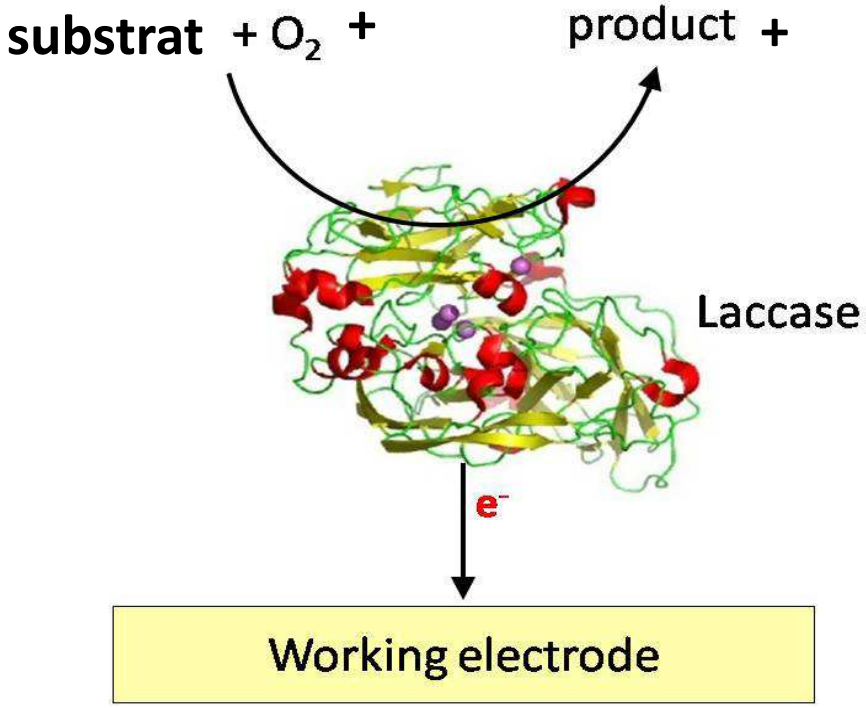

Fig. 2. A typical scheme of direct electron transfer of laccase-based biosensor [40]

Laccase-based biosensors for effective biocatalysis do not require hydrogen peroxide as a co-substrate or any other cofactors, which results in a simple procedure for their application for the quantitative determination of toxic phenolic compounds, azides, pesticides, *etc.* [58; 60; 79].

One of the most important problems of existing biosensor's technologies is the formation of a biorecognition membrane which contains immobilized bioelements, in particular, enzymes. A large number of laccase-based biosensors are described using various methods of immobilization of the enzyme: covalent binding, adsorption, cross-linking and entrapment in the gel [31]. Covalent binding is based on the chemical activation of groups in the support matrix so that they react with functional groups in the biomaterial which are not essential to catalytic activity [33]. The weak point of this method is possible changes in the structure of the enzyme active center [5]. Adsorption is a simple, low cost and fast immobilization method. The

enzyme is bound to a support via ionic interactions or weak forces, such as van der Waals and hydrogen bonds. However, the biological elements immobilized through this method are unstable and can be easily desorbed under operating conditions [10]. Cross-linking uses bifunctional reagents to generate intramolecular bonds between the molecules of the enzyme. However, large quantities of the enzyme are needed, and factors, such as pH and ionic strength, must be controlled [12]. At the entrapment of the biomaterial into a porous solid matrix, the enzyme suffers minimum alteration and this immobilization approach looks most promising in sensor's technologies. The method needs pore-size controlling to reduce diffusional limitation of the substrate to the enzyme. So, the screening of new suitable matrices for an effective laccase immobilization is a crucial part in the construction of the biosensors [21]. For laccase-based bioelectrodes, it has been demonstrated that immobilization of the enzyme has an important effect on the sensitivity of the biosensor [26]. This was recently confirmed using laccase from *Trametes versicolor* and ureasil polymeric matrixes of different structures. It was demonstrated that by changing the structural characteristics of polymer matrixes, it is possible to substantially control the sensitivity of the biosensor [38; 39; 40; 41; 42]. Laccase from *T. versicolor* in the form of crystals bond with cyclodextrin polymers is a highly reactive biofilm in relation to phenols and their derivatives such as 2-aminophenol, guaiacol, catechol, pygrogallol, and ABTS [83]. An effective biosensor with immobilized laccase from *Coriolus versicolor* on N-hydroxy succinimide-based monolayers on the surface of gold was developed. On the basis of glassy carbon electrodes with immobilized laccase from *T. versicolor* using osmium-containing cathode polymer, an ultrasensitive amperometric biosensor was developed to detect catecholamine neurotransmitters, dopamine, adrenaline and norepinephrine [23]. Recently, a new highly sensitive biosensor based on laccase and photocross-linked polymers with different crosslink density as a holding matrix to be suitable for analysis of the quality of drinking water, as well as determination of wastewater pollution has been reported [39].

In recent years, particular interest is focused on the use of nanoscale materials in combination with enzymes for the construction of new bionanomaterials with inproved catalytic properties. This is due to the fact that one of the main features of nanoscale materials is a large surface, a high adsorbtion ability and a unusual chemical activity. This enables the development of bionanoparticles for design of amperometric biosensors with improved operational characteristics [27; 60; 101]. For the nanocarriers, of a great importance is their biocompatibility and the ability to increase the efficiency of the transfer of electrons in the bioselective layer of the biosensor [12; 43; 44; 47; 65; 66; 102; 103; 104]. There are described the use of various types of nanocarriers for laccase: carbon nanomaterials [51], metallic nanoparticles [16; 17; 43], oxides of metals [16], conductive polymers [75], and ionic liquids [25]. The development of biosensors with increased sensitivity to phenolic compounds by the use of carbon nanotubes with uniqal conductive and mechanical properties was confirmed [31]. The other laccase-based biosensors, based on modified carbon nanotubes to detect phenolic compounds and pesticides in beverages, plants, etc. was described [65; 81]. The development of biosensors is widely used graphene, 2D carbon nanomaterial which has unique properties, in comparison with the other carbon nanoforms, fullerenes and carbon nanotubes, was reported [89; 70; 28; 46]. Hovewer, the direct immobilization of enzymes on the surface of graphene is complicated by its strong hydrophobic nature and the presence of only sp2-hybridized carbon atoms [37]. To eliminate this negative effect, it was recently described a sensitive and selective biosensor for catechol analysis where graphene was bound with polymer cellulose microfibers [68]. The catechol analysis in environmental samples is of great importance as it is classified as a toxic contaminant due to its slow biological degradation and high toxicity to human health and ecosystems. It was established that including of the gold nanoparticles with covalent immobilized laccase in the biorecognition layer of bioelectrodes enhanced the sensor sensitivity

in 2–3 fold compared with the control one [39; 43]. Newly it was described an electrochemical biosensor for polyphenols determination based on a nanocomposite film formed by a laccase, immobilized on a electrodeposited gold nanoparticles on the surface of carbon electrode, modified *in situ* with polypyrrole [60]. It was developed laccase-based biosensor for sensitive analysis of pesticide (formethanate) using electrodeposited gold nanoparticles [83]. Using the laccase from *T. versicolor*, immobilized on the surface of a graphite electrode, modified with palladium nanoparticles, a biosensor for the analysis of bisphenol A and ABTS was constructed. The use of nanoparticles affects the properties of the sensor extending the range of its linearity to phenolic compounds [27].

Another principle of electrochemical detection of the dangerous chemicals is based on inhibition of laccase. Such biosensors mainly were used to control the residual levels of pesticides in the environment and food [13]. A biosensor for quantifying carbamates based on laccase inhibition using 4-aminophenol as a substrate has been described. The analysis of carbamate pesticides was carried out using bioelectrodes, based on a carbon paste biofunctionalized with laccase from *T. versicolor* on a film of Prussian Blue, as an electron transfer mediator [65; 66].

Importance of laccases for bioremediation

Bioremediation is the process in which hazardous chemicals can be eliminated using living microorganisms, as well their products like enzymes. Laccases of fungi are of particular interest with regard to potential industrial applications due to their capability to oxidize a wide range of industrially relevant substrates. Certain hazardous compounds such as polycyclic aromatic compounds which arise from utilization of fossil fuels can be degraded by laccases [11]. Phenolic compounds are present in various industrial byproducts, obtained from the conversion of coal, refining of petrol, production of organic chemicals and olive oil production, can be also degraded by laccase [2; 35].

Bioconversion of 2,4,6-trichlorophenol to 2,6-dichloro-1,4-hydroquinone and 2,6-dichloro-1,4-benzoquione can be accomplished by laccase [49]. Chlorinated phenols are major industrial and agricultural xenobiotics that pollute soil and ground water. The transformation of one or a mixture of several chlorinated phenols by a laccase from the fungus *T. villosa* was studied. Generally, if more than one phenol was added, the transformation of chlorinated phenols decreased, and if the concentration of the laccase was increased, the transformation of the phenols was enhanced. However, in spite of some limitations, the application of laccase to decontaminate wastewater, polluted with chlorinated phenols, appears feasible [8]. Laccase can be used to reduce the content of halogenated organic pesticides present in the soil [61] or removal of phenolic compounds produced by olive oil mills [6; 7]. In addition, laccase is used to discolor drains of hydrolysis productions and sewage containing molasses [64].

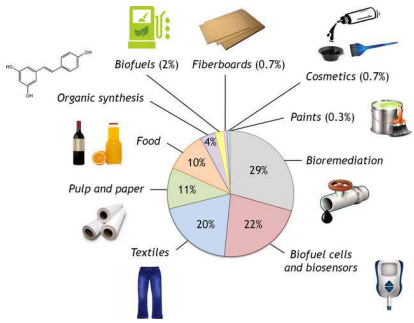

Fig. 3. Application of laccases in different industrial and technological branches [103; 104]

The main areas of bioremediation by laccase are degradation, discoloration or detoxification of dyes during wastewater treatment of industrial enterprises [97; 99; 102; 103; 104; 105]. The textile industry accounts for two-thirds of the total dyestuff market and consumes large volumes of water and chemicals for wet processing of textiles [7]. The chemical reagents used are very diverse in chemical composition, ranging from inorganic compounds to polymers and organic products [108]. Due to their chemical structure dyes are resistant to fading on exposure to light, water, and different chemicals and most of them are difficult to decolourise due to their synthetic origin. The use of laccases in the textile industry is growing very fast since. Besides decolorizing textile effluents as commented above, laccase is used to bleach textiles and even to synthesize dyes [74]. Nowaday urgent requirement is the development of approaches for the removal of dyes from industrial effluents [99] because they exept pollution of the environment, also affect to the life of wetland biotopes, preventing the penetration of sunlight, which complicates photosynthesis and promotes eutrophication (enrichment of water bodies with nutrient elements, accompanied by the destruction of their productivity) [74]. The use of *Flavodon flavus* fungi synthesizing laccase for the discoloration of synthetic dyes such as trimethyltin chloride (Azur 1) and Diamond Blue in a low nitrogen medium was described [91; 92; 1]. The partial discoloration of azo-dyes and the complete discoloration of triphenylmethane dyes (bromophenol blue and malachite green) using cultures of *Pycnoporus sanguineus* was also demonstrated. The capability of laccase from *Trametes hirsuta* to degradation of triarylmethane, indigoid, azo- and atrachinotic derivates [7; 104], as well the other 23 industrial dyes was confirmed [105]. An effective repeated use of laccase, immobilized in alginate-gelatin gel using ethylene glycol, for enzymatic discoloration of dyes was demonstrated [72]. Given that the mostly of modern chemical processes used to remove dye are expensive and ineffective [94], and laccases, mainly synthesizing as extracellular enzymes by microorganisms and mushrooms, have enormous potential for developing inexpensive and effective approaches for the degradation of different types of dyes [32; 34; 20; 82]. Fungal laccases can oxidize non-phenolic steroids of androstane and pregnane with the formation of intermediate products. These steroids intermediates show a promising potential for pharmaceutical applications. For instance, 7-Ketodehydroepiandrosterone provides support of immunomodulatory activities, enhancement of cognition, memory storage and retrieval, and weight management [88]. The data on laccase action on steroids mainly concern the dimerization, or polymerization of phenolic steroid hormones, such as estradiol, estrone, ethynilestradiol, and their derivatives. These reactions can be exploited for the removal of estrogens, which are the endocrine disrupting steroids, from the wastewaters.

Laccases are widely used for efficient degradation of aromatic and phenolic pollutants from industrial wastewater, as well from contaminated natural streams and ground water [62; 67]. An enzyme bioreactor for the effective (42–90%) removing various phenolic xenobiotics from aqueous solutions based on the use of two enzymes – laccase and tyrosinase, immobilized on polyvinylpolypyrrolidone was reported [45]. The possibility of re-usage of laccase immobilized in an organic gel for the degradation of xenobiotics in sewage waters was proved [19]. Also, the efficacy of using laccase from *T. versicolor* to effectively remove bisphenol A and sodium diclofenac from urban sewage was recently demonstrated [4].

The mechanisms of bioremediation by laccase involve enzymatic oxidation of pollutants to free radicals or quinones, which are subsequently polymerizable [62]. These polymer fragments have a rather high molecular weight, which makes it easy to remove them by filtration. The reaction of polymerization has also contributed to effectivity of bioremediation, since it neutralizes the harmful effects of the pollutants making them non-toxic [9]. It was shown that the use of electron transfer mediators such as 2,2-azinobis derivates (3-ethylbenzothiazolin-6-sulfonate) and 1-hydroxybenzotriazole greatly increases the oxidation

efficiency of non-phenolic compounds by laccase [20; 82]. The xenobiotics oxidation is a two-stage process in which the enzyme initially catalyzes the oxidation of the primary substrate, and then the oxidized mediator oxidizes the secondary substrate (alkene) to the corresponding ketone or aldehyde. The unique laccase properties for the partial or complete splitting of organic aromatic substances, that can be further mineralized by other microbial cells, are the basis of its bioremediation importance. Thus, in addition to the oxidation of toxic substrates, laccase can also immobilize soil pollutants by their addition to humic compounds (a process similar to synthesis of humic acid in soils). It makes the process of bioremediation a cost-effective, energy-efficient and enviroment-friendly [97; 102; 103; 104].

Conclusions

To summarize, it should be noted that the biosphere of the modern world is constantly threatened by the ever-increasing levels of environmental pollution. To protect the environment, there are different approaches that are often ineffective.

"Green" chemistry and the use of enzymes such as laccase are one of the most promising approaches to reducing these negative environmental effects. Due to its unique characteristics, laccase attracts special attention to researchers around the world.

The biotechnology application of laccase is gowing up quickly since the discovery of this enzyme by G. Bertrandin in 1894 in the sap of the Japanese lacquer tree, where it helps to form lacquer, hence the name laccase.

The enzyme has been widely used in the pharmaceutical, pulp and paper, textile, food, chemical and petrochemical industries. However, the most actual application of laccases seems to be bioremediation of a wide range of toxic chemicals, as well as monitoring the level of environmental pollution.

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Chapter 3. AMPEROMETRIC DETECTION OF MANGANESE IONS USING RECOMBINANT APO-ARGINASE

N. STASYUK[1], G. GAYDA[1], O. SMUTOK[1,2], A. ZAKALSKIY[1,3], O. ZAKALSKA[1], M. GONCHAR[1,2]

[1]Institute of Cell Biology, National Academy of Science of Ukraine, 14/16, Drahomanov Str., 79005 Lviv, Ukraine

[2]Drohobych Ivan Franko State Pedagogical University, 24, I. Franko Str., 82100 Drohobych, Ukraine

[3]Lviv State University of Physical Culture, 11, Kostiushko Str., 79000 Lviv, Ukraine

e-mail: stasuk_natalia@ukr.net

Abstract. *Transition metals are widely used in industry (including military) and in scientific research. However, they are a serious threat to the working staff and environment due to a high toxicity and even carcinogenicity, related with their ability to react with biologically active compounds (proteins, DNA, RNA, etc.) and generation of reactive oxygen and nitrogen species in living organisms. To ensure the people's health, monitoring toxic metals' content in the environment and in human body is very important. A novel manganese(II)-sensitive amperometric bi-enzyme biosensor based on of recombinant human apo-arginase isolated from the gene-engineered strain of methylotrophic yeast Hansenula polymorpha and commercial urease has been described. The biosensing layer with urease and apo-arginase was placed onto platinum electrode covered by a polyaniline-Nafion (PANi-Nafion) film. The developed sensor has a high sensitivity to Mn^{2+} ions (8450 ± 45 $A \cdot M^{-1} \cdot m^{-2}$) with the apparent Michaelis-Menten constant derived from Mn^{2+} ions calibration curve of 8.5 ± 1.2 μM. A linear concentration range was observed from 1 μM to 6 μM Mn^{2+}, a detection limit being of 0.1 μM and a response time – 1.5 min. The proposed method of assay of Mn^{2+} ions seems to be a helpful tool for clinical diagnostics, food industry and environmental control service.*

Keywords: *Amperometric biosensor; Manganese(II) ions detection; Polyaniline; Nafion; Recombinant arginase I; Apo-enzyme; Holoenzyme; Urease.*

Introduction

Heavy and transient metals toxicity has proven to be a significant threat for the environment and there are several health risks associated with it. The toxic effects of these metals, even though they do not have any biological role, remain present in some or the other form harmful for the human body and its proper functioning [14]. The importance of monitoring ions of heavy and transition metals spans all areas of science and technology. A system that can provide selective detection of these ions in aqueous solutions will find numerous applications in such fields as environmental monitoring, biomedical research, clinical chemistry and pharmacology. Ions of some transition metals in trace quantities are essential mineral components for the human body and all other living organisms, but they exhibit the high level of toxicity at increased concentrations [26; 39]. Manganese (Mn) is considered as the most abundant trace element in the biosphere, being widely distributed in soil, sediment, water and live organisms [4; 12; 25; 41]. In human, chronic manganese excess affects the central nervous system, with the symptoms resembling those of Parkinson's disease and autism [3; 9; 19; 27]. The mean total content of Mn in human adult is about 15 mg (typically bound with nucleic acids), and the requirement of this element is about 2–5 mg/day. Mn acts as an activator of enzymes and as a component of metalloenzymes, taking part in oxidative phosphorylation, fatty acids and cholesterol metabolism, mucopolysaccharide metabolism, and urea cycle [25].

Besides medicine, monitoring content of toxic metals is necessary also under the development of bioreactors for removal of these pollutants from soil, water and wastewater. Thus, monitoring content of Mn^{2+} ions represents a helpful tool for clinical diagnostics, food industry and environmental control service. The analysis of the localization and distribution of essential and beneficial metals (including Mn) in biological tissues and liquids (e.g., blood and urine) is a challenging task for medicine and other life sciences. Blood level as well as urinary excretion rates of metal ions are reliable biomarkers for systemic exposure to the corresponding compounds [3; 22; 26]. Analysis of literature data suggests that a majority of known physico-chemical methods of metal ions assay, including Mn^{2+}, has a number of disadvantages, such as a low sensitivity and selectivity, high costs and complexity of the equipment and analysis procedure. Thus, further development of novel valid methods of quantitative analysis of metal ions for clinical diagnostics and industry is an important task of analytical chemistry and biotechnology.

Many instrument-based techniques have been applied for quantitative analysis of metal ions. Analytical methods such as high performance liquid chromatography (HPLC), gas chromatography, atomic absorption and emission spectroscopy, mass spectrometry (MS) are currently and widely used [15; 32]. The classical approaches of spectrophotometry and fluorometry, especially in combination with micro- and nanotechnologies [4; 5; 10; 24; 30; 38], are very popular too.

Over the past years, the development and application of different MS-imaging techniques for metal ions analysis, including laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), has been rapidly growing in the life sciences in order to investigate the uptake and the transport of both essential and toxic metals in cells and tissues [15].

Even if the high-tech analytical techniques for imaging of heavy and transition metal are highly sensitive and accurate, they are, however, time-consuming, expensive, require special skills and show limited capability for real-time measurements in biological samples.

As an attractive choice to the mentioned above methods, the electrochemical analytical approaches are also extensively used for metal ions assay. Highly specific, sensitive, simple, fast and cheap biosensors based on electrochemical transducers (amperometric and conductometric electrodes, potentiometric pH-sensitive field effect transistors) and different biorecognition molecules as sensitive elements were developed for inhibitory analysis of heavy metals ions. Different microbial cells [13], enzymes [6; 21], DNA and antibodies [1; 11; 16; 32; 40; 44] as well as biomimetics (molecularly imprinted polymers) [8; 31] were used as bioelements. These analytical devices are promising tools for needs of health care, environmental control, biotechnology, agriculture and food industries. Improvement of their analytical characteristics (*e.g.,* sensitivity, selectivity, stability, *etc.*) can be achieved by using negatively or positively charged additional semi-permeable membranes, micro- and nanomaterials of different origin, genetically modified enzymes [31].

Being rather inexpensive and portable, bio- and chemosensors are promising for real-time measuring for online and continuous analysis of natural samples for detection of metal ions. The number of chemosensors, namely, based on platinum nanoparticles and 3,3,5,5-tetramethylbenzidine as chromogen with fiber optic detection as well as based on gold clusters [8], other nanoparticles and fluorescence graphene-based quantum dots were proposed in recent years [2; 7; 17; 23; 45].

Promising tools for elaboration of such methods are presented by metal-ion-dependent enzymes [21] and catalytic nucleic acids – DNA-zymes or RNA-zymes [1; 11; 16; 40; 44].

The use of functional nucleic acids as bioelements for the lab-on-a-chip (LOC) biosensors for detection of heavy metal ions has made a great step forward in recent years. A number of metal-ion-dependent DNA-zymes and metal-ion-binding DNA structures have been obtained

through combinatorial selection and rational design [32]. These molecules have been used as bioselective elements of sensors with fluorescent, colorimetric, electrochemical, and surface Raman detection of correspondent metal ions. For selective sensing metal ions in complex biological samples and live cells, a facile and stable biosensor based on non-biological enantiomer (L-DNAzyme) was proposed by Cui et al. [11]. With its highly sensitivity (with a detection limit down to 11 ppt) and selectivity (up to millions-fold) toward specific metal ions, these sensors seem to be promising for on-site and real-time environmental monitoring, point-of-care medical diagnostics and for in situ cellular imaging [43].

Enzymatic methods for metal ions estimation usually are based on its inhibitory influence on enzymatic activity [18; 28]. Unfortunately, such indirect approach is not selective and is complicated in performance.

So, analysis of literature data suggests that a majority of known physico-chemical methods of metal ions assay has a number of disadvantages, such as a low sensitivity and selectivity, high costs and complexity of the equipment. To ensure the people's health, monitoring toxic metals' content in the environment and in human body is very important. In current paper, we demonstrate the possibility to use apo-enzyme of Mn^{2+}-dependent arginase as a Mn^{2+}-recognizing bioelement of the corresponding amperometric biosensor. For this aim, the ammonium-selective PANi-Nafion film has been used in conjunction with urease-containing layer.

Materials and methods

Reagents and Materials

Urease (EC 3.5.1.5, type IX from Jack Beans, 26100 $U \cdot g^{-1}$), 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid (Hepes), sodium ethylenediaminetetraacetate (EDTA), $MnCl_2$, NaCl, aniline (99%), 5% Nafion® perfluorinated resin solution, chloroform and Butvar solution B-98 were purchased from Sigma-Aldrich. L-arginine was obtained from Merck (Darmstadt, Germany), cathodic polymer GY 83-0270 0005 was obtained from BASF Farben und Lacke, Germany. All buffers and standard solutions were prepared using the water purified by the Milli-Q system (Millipore).

Arginase isolation

Recombinant human arginase I (further – arginase) has been expressed in *Saccharomyces cerevisiae* yeast cells under the control of the inducible *CUP1* promoter. Isolation and purification of $(His)_6$-tagged arginase from cell-free extract of cultivated cells using affinity chromatography on Ni-NTA sorbent was performed as described by us earlier [33; 42]. Arginase activity was determined as the rate of urea production ($\mu mole \cdot min^{-1} \cdot mg^{-1}$ of protein), using as substrate mixture containing 100 mM Arg , 2 mM $MnCl_2$ in 20 mM Tris-sulfate buffer, pH 9.5.

Preparation of apo-enzyme of arginase (apo-arginase)

The apo-arginase was prepared by dialysis of the purified arginase for 48 h against several changes of 50 mM sodium-phosphate buffer (PB), at pH 8.0, containing 50 mM NaCl and 20 mM EDTA. EDTA was removed from the resulting apo-enzyme solution by three steps of dialysis against PB, containing 1M NaCl and Chelex ($0.05\ g \cdot mL^{-1}$), and finally by two dialysis against PB with 50 mM NaCl and Chelex ($0.05\ g \cdot mL^{-1}$) [34].

Mn^{2+}-sensitive bioelectrode construction and amperometric measurements

To construct a bi-enzymatic layer sensitive to Mn^{2+}, urease and apo-arginase were dropped on the surface of the PANi-Nafion/Pt electrode and covered with a commercial cathodic polymer GY 83-0270 0005 [36]. The optimal enzymes/polymer proportion was chosen experimentally. The calibration was performed by the stepwise addition of a standard analyte solution.

Apparatus

A three-electrode system was used for the electropolimerization of aniline and electrochemical studies. A piece of Pt wire and an Ag/AgCI/3M KCI electrode were used as the counter and reference electrodes, respectively. A platinum rod electrode (ALS Co., Tokyo, Japan) was

applied as a working electrode (3.0 mm diameter). Amperometric measurements were carried out with a potentiostat CHI 1200A (IJ Cambria Scientific, Burry Port, UK) and performed in batch mode under continuous stirring in a standard 40 ml cell at room temperature.

Scanning electron microscopy (SEM)

A Scanning Electron Microscope (SEM-microanalyser REMMA-102-02, Sumy, Ukraine) was used for morphological analyses of the electrodes surface. The special cover film on the samples with a Butvar solution B-98 (Sigma, St. Louis, MO, USA) in 1.5% chloroform was formed using an ultrasound method. The distance from the last lens of the microscope to the sample (WD) ranged from 20.1 mm to 26.1 mm; the accelerator voltage was in the range from 20 kV; zooms were from 10 000.

Atomic force microanalysis (AFM)

Atomic Force Microscope (AFM-microanalyser Solver P47-PRO, NT-MDT, Netherlands) was used for morphological analyses of the PANi film on the surface of a Pt electrode. An aliquot of the tested sample was spread on the surface of freshly-cleaved mica, dried and analyzed in air using the tapping mode with a resonance frequency of 160 kHz, scan rate of 1 Hz/s and resolution of 256 × 256 pixels.

***Results* and discussion**

Analysis of the influence of metal ions toward arginase activity

Native human liver arginase consists of 3 identical subunits with manganese(II) ions in active centre. It is worth mentioning that during the procedure of arginase obtaining from yeast cells we did not add Mn^{2+} ions in buffers: neither under cells disruption nor during chromatographic fractionation of cell-free extract. Thus the obtained enzyme preparation may be named "semi-holoarginase". The purified recombinant holoarginase was shown to have optimal pH 9.0–9.5 and optimal temperature for its activity 37–42 °C [33]. *Fig. 1* demonstrates the results of screening of metal ions as effectors of enzymatic activity. "Semi-holoarginase" was incubated in Hepes buffer, pH 7.5 (HB) in the presence of 1 μM or 10 μM metal ions during 10 min at 37 °C then enzymatic activity was determined at standard conditions. As control (100% of activity), enzyme with HB instead metal ions was used. It is worth to emphasize that using lower metal ions concentrations (1 μM versus 10 μM) is more informative to assess cofactor of the tested ions. Thus, Mn^{2+} has the most expressed cofactor activity.

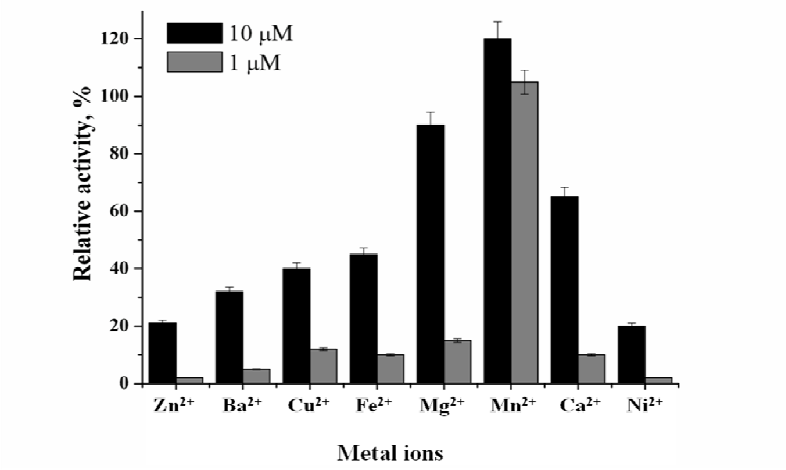


Fig. 1. The influence of metal ions on arginase activity

Reconstruction of apo-arginase to holoenzyme

To appreciate the ability of enzyme for metal-binding reactions in biosensor analysis, apo-enzyme of arginase (apo-arginase), obtained as described in 2.3, was used in experiments with Mn^{2+}. Characteristics of the process of arginase-holoenzyme reconstruction in the presence of Mn^{2+} ions under different conditions of procedure are demonstrated in *Fig. 2*. It was shown that this reaction is strongly dependent on pH and temperature.

The results presented in *Fig. 2, B* demonstrate that Mn^{2+} ions activate apo-arginase at a low concentration (about 0.2 μM) at optimal conditions for arginase activity: pH 9.5 and temperature 56 °C [36]. The highest enzymatic activity was shown to achieve at 2 μM Mn^{2+} at optimal conditions *(Fig. 2, B)* or at 20 μM Mn^{2+} at lower pH and temperature *(Fig. 2, A)*. It is worth mentioning that holoenzyme could be reactivated at optimal conditions with a yield of 60% compared to an expected value. Thus, the described experiments have proved the ability of apo-arginase to be a prospective manganese-sensitive bioelement in biosensor analysis.

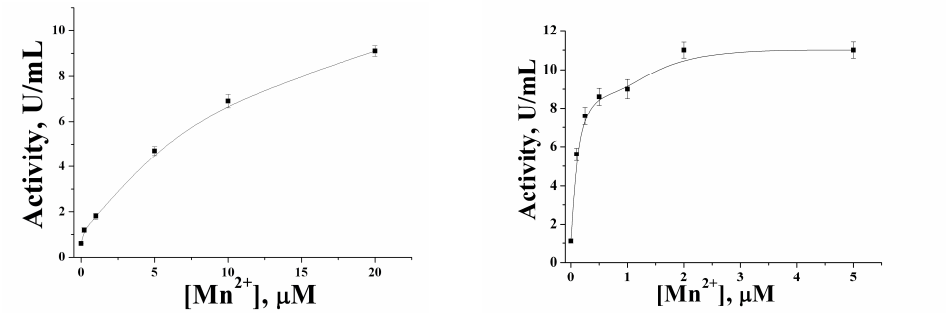


Fig. 2. The dependence of arginase activity on the concentration of Mn^{2+} and conditions of reconstruction: (A) – pH 7.5, 30 min, 37 °C; (B) – pH 9.5, 10 min, 56 °C

Construction and characterization of a manganese-sensitive biosensor

The main principle of Mn^{2+} biosensor analysis using apo-arginase

The apo-enzyme of arginase (apo-agrinase) was used as a Mn^{2+}-recognizing bioelement for construction of amperometric biosensor. For this aim, the ammonium-selective PANi-Nafion film has been used in conjunction with urease-containing layer. Binding of Mn^{2+} with the immobilized apo-arginase induces reconstruction of the holoenzyme (holo-arginase) followed by generation of ammonium ions from Arg in arginase-urease catalysed reactions. The resulting NH_4^+ ions diffuse further to the PANi-Nafion film and trigger the reduction of PANi on the Pt electrode. The last product is monitored at the working potential of – 200 mV. The schematic diagram of the bioselective membrane of amperometric biosensor is shown in *Fig. 3*.

Formation and characterization of PANi-Nafion-modified Pt electrode

To construct the PANi-Nafion-based ammonium sensitive electrode, the 3.0 mm Pt electrode was covered with Nafion as described in detail in our previous paper [36]. The PANi film was formed on the surface of Nafion/Pt rod electrode by 11 cycles of electrodeposition, Sulfonate groups of immobilized Nafion serve as a compensator of a positive charge generated during the anodic polymerization of PANi. Electrochemical and morphological characteristics of the PANi film, formed by the potentiodynamic mode in the aniline-containing solution, as well as mechanisms of electron transfer in the proposed system, were described earlier [35]. Morphological properties presented in *Fig. 4* were shown to be typical for the PANi films.

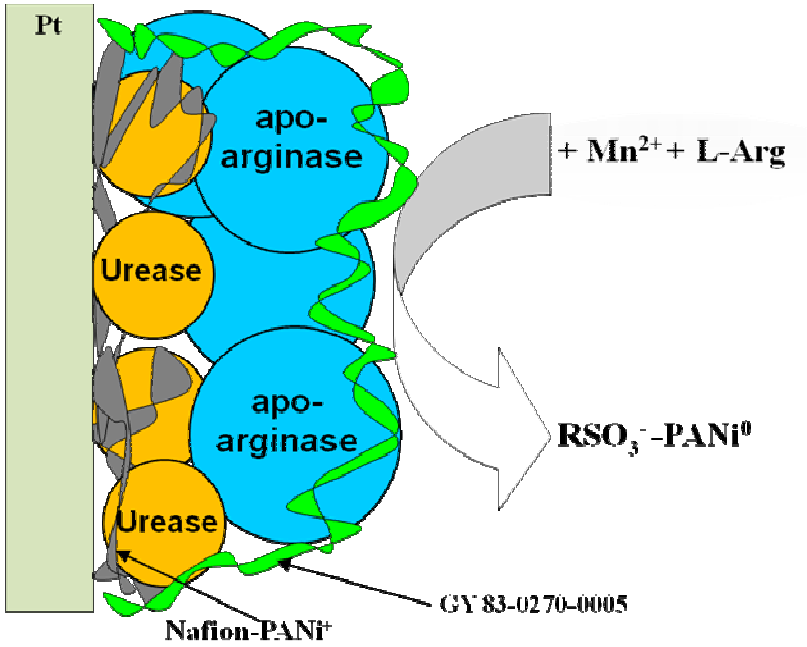
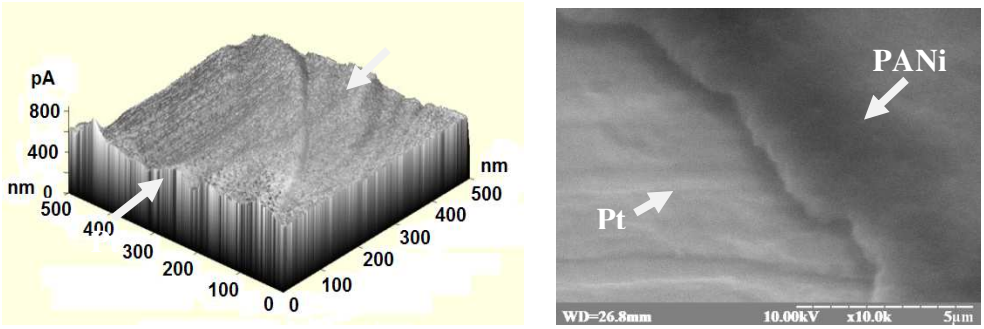


Fig. 3. Principal scheme of Mn^{2+} assay by the bi-enzyme PANi-Nafion/Pt electrode. $PANi^0$ – reduced form of PANi; RSO_3^- – a skeleton of Nafion



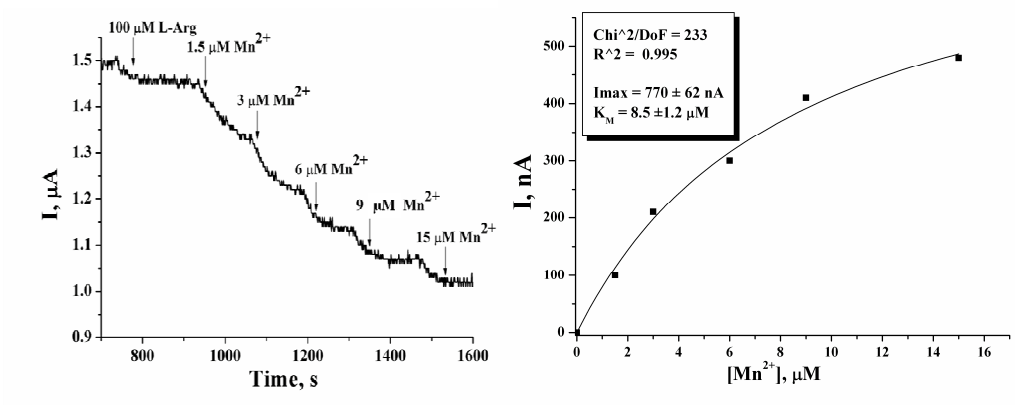
(A) ***(B)***

Fig. 4. Structure and thickness of the PANi film on the Pt electrode characterized with AFM and SEM: (A) AFM microphotograph, resonance frequency of 160 kHz, scan rate of 1 Hz/s and resolution of 256 × 256 pixels; (B) SEM image, WD – distance from the last lens of microscope to the samples (mm); kV – accelerating voltage; x – fold magnification; µm – scale unit

The surface of the Pt-rod electrode after 11 cycles of aniline electrodeposition became of a dark-green color due to the PANi film formation. The morphology of the PANi film *(Fig. 4, A, B)* was almost smooth and the structure of the surface was homogeneous.

Construction and evaluation of Mn^{2+}-sensitive apo-arginase-based bioelectrode

To construct a bi-enzymatic layer, sensitive to Mn^{2+}, urease and apo-arginase were dropped on the surface of the PANi-Nafion/Pt electrode and covered with a commercial cathodic polymer GY 83-0270 0005. The optimal enzymes' proportions were chosen empirically. The calibration was performed by the stepwise addition of a standard analyte solution. The corresponding chronoamperogram and calibration curve for Mn^{2+} biosensor are shown in *Fig. 5*.



(A) *(B)*

Fig. 5. Amperometric response on Mn^{2+} of the developed bi-enzyme PANi-Nafion/Pt electrode: chronoamperogramm (A) and calibration curve (B). Conditions: −200 mV vs Ag/AgCl electrode, pH 10.5 at 22 °C

An amperometric response on $MnCl_2$ of the developed bi-enzyme electrode was tested in the range of manganese ions concentration from 1.5 to 15 μM *(Fig. 5, A)*. The dynamic range was linear between 1 μM to 6 μM $MnCl_2$. The K_M^{app} derived from the calibration curve was shown to be 8.5 ± 1.2 mM μM for Mn^{2+}. The maximal detected signal was found as 770 ± 62 nA *(Fig. 5, B)*. The sensitivity was calculated as 8450 ± 45 $A \cdot M^{-1} \cdot m^{-2}$), and LOD is of 0.1 μM. The full reconstruction time of arginase holoenzyme immobilized on the top of working electrode was about 2.5 min that highly correlates with the results of enzyme reconstruction in solution (2 min). The prolonged time of reconstruction of immobilized arginase can be explained by difficulties for diffusion of Mn^{2+} ions through polymer film. So, the obtained results clearly prove a possibility of using the apo-enzyme of recombinant human liver arginase I for construction of Mn^{2+}-sensitive biosensor and analysis of Mn^{2+}.

Conclusions

A novel manganese(II)-sensitive amperometric bi-enzyme biosensor based on recombinant human apo-arginase I and commercial urease was proposed. The biosensing layer with urease and apo-arginase was placed onto a polyaniline-Nafion composite platinum electrode. The developed sensor revealed a high sensitivity to Mn^{2+} ions – 8450 ± 45 $A \cdot M^{-1} \cdot m^{-2}$ with the apparent Michaelis-Menten constant derived from Mn^{2+} ions calibration curve of 8.5 ± 1.2 μM. A linear concentration range was observed from 1 μM to 6 μM Mn^{2+}, a limit of detection being of 0.1 μM and a response time 1.5 min. The developed sensor revealed a high sensitivity to Mn^{2+} ions and a low detection limit.

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Chapter 4. NOVEL POLYMER MATRIXES FOR CONSTRUCTION OF LACCASE-BASED AMPEROMETRIC BIOSENSORS AS PROBED BY POSITRONS AND SWELLING

T. KAVETSKYY[1,2], Y. KUKHAZH[1], K. ZUBRYTSKA[1], M. STARCHEVSKYY[1], O. ŠAUŠA[3], H. ŠVAJDLENKOVÁ[4], O. SMUTOK[1,5], O. DEMKIV[1,5], M. GONCHAR[1,5]

[1]Drohobych Ivan Franko State Pedagogical University, 24, I. Franko Str., 82100 Drohobych, Ukraine

[2]The John Paul II Catholic University of Lublin, 14, Al. Racławickie, 20-950 Lublin, Poland

[3]Institute of Physics, Slovak Academy of Sciences, 9, Dúbravská cesta, 845 11 Bratislava, Slovakia

[4]Polymer Institute, Slovak Academy of Sciences, 9, Dúbravská cesta, 845 41 Bratislava, Slovakia

[5]Institute of Cell Biology, National Academy of Science of Ukraine, 14/16, Drahomanov Str., 79005 Lviv, Ukraine

e-mail: kavetskyy@yahoo.com

Abstract. *Laccase-based amperometric enzyme biosensors of the third generation for analysis of phenol derivates were constructed using the ureasil-based and photocross-linked polymers as a holding matrix. The knowledge of the properties of the microstructure of such polymer materials is important in terms of optimizing the regulated properties of the amperometric biosensors. Positron annihilation lifetime spectroscopy is known as a progressive method for microstructural analysis of macromolecular structures. A swelling test provides information about a crosslink density and flexibility of polymer network. Combination of these both methods allowed to get information about network properties of the polymer matrixes and the results obtained were further compared with sensitivity of bioelectrodes constructed using the polymer matrixes. A role of free-volume and crosslink density in the host polymer matrixes used for improvement of operational parameters of laccase-based amperometric biosensors was established.*

Keywords: *Organic-inorganic ureasil polymer; Photo-crosslinked polymer; Positron annihilation; Swelling; Free volume; Laccase; Amperometric biosensor.*

Introduction

Technogenic pressure on the environment significantly affects the pollution of water resources. The one of the most dangerous pollutants of wastewater are xenoestrogens. They are a matter of industrial origin in the human body, capable of causing effects similar to the effects of high doses of a natural hormone estrogen [6; 18]. Mimicking estrogen, they adversely affect the function of the endocrine system and able to cause various health defects, affecting synthesis, metabolism and cellular reactions of natural estrogens [19; 1; 17; 24]. Xenoestrogens are a common pollution. They arrive in the surface water with drains of oil, shale, forest-chemical, and cox-chemical industries as well as with drains of hydrolysis industry. For example, xenoestrogen Bisphenol A is a monomer that is used for the manufacture of polycarbonate plastic and epoxy resins, which are raw materials for the production of packaging materials for food and drinks. World market of Bisphenol A is over 6.4 billion pounds per year, and thus, it is one of the chemicals with the highest volume of production all over the world [20]. As a result of hydrolysis of the ester linkages in these polymers, Bisphenol A is released in the environment, resulting in widespread negative impact on human and animals.

A list of substances with an endocrine activity is constantly expanding. It includes chlorine-organic and poly-aromatic compounds, the source of which is a plastic used for packaging of drinking water [16], and some pharmaceutical drugs widely used, such as Ibuprofen, in dangerous concentrations. When using Ibuprofen in the order of hundreds of thousands of tons (Germany), the anti-inflammatory drug and its metabolites are detected in all samples of wastewater and sea water at a concentration from 0.1 to 20 μg/L [5]. The main sources of substances with xenoestrogenic effect are the wastewater of cities and animal complexes. A high content of estrogens and pharmaceutical drugs is still existed even after treatment of water [26]. Xenoestrogens, classified as carcinogens, are toxic to healthy compounds that cause disruption of the endocrine system of human and animals. The development of new approaches for monitoring of these dangerous substances coming from the wastewater is a topical problem to improve human life first of all. One of such innovations is creation of highly sensitive biosensors for analysis of the level of wastewater pollution.

The commercial laccase can be used in the role of catalytic bioselective element of amperometric biosensor sensitive to different aromatic phenols and amines as a part of the project. Laccase (EC 1.10.3.2 *p*-diphenol: benzenediol oxygen oxidoreductase from *Trametes versicolor*) is a copper containing enzyme which is able to catalyze the oxidation of several phenolic compounds and aromatic amines [8]. In a typical laccase reaction, a phenolic substrate is exposed to a single electronic oxidation with the formation of aril radical that in the next stage of the enzymatic reaction is converted into a quinone. Laccase does not need a hydrogen peroxide in the role of co-substrate or additional cofactors for fermentation reaction that makes it an extremely perspective in fabrication of biosensors for monitoring an amount of phenol containing compounds, including some xenoestrogens. Concerning the laccase application for the targeted oxidation of phenolics, the development of biocatalysts application which are stable under environmental condition is a critical issue, which is currently addressed by many work initiatives at EU level, e.g. Knowledge Based Bio Economy (KBBE) programme. Moreover, efficiency of usage laccase form *Trametes versicolor* for effectively removal of C-bisphenol A and C-sodium diclofenac from secondary effluent from a municipal wastewater was demonstrated recently [2].

Recently, innovative amperometric biosensors for monitoring the level of wastewater pollution have been constructed [14] on the surface of the gold planar electrodes C220AT "DropSens" by using the organic-inorganic ureasil-based composites as host polymer matrices and immobilized commercial laccase from *Trametes versicolor*. In fact, urea-silicates or ureasils are well-known as representatives of organic-inorganic hybrid polymer materials successfully examined as dispersion media for luminescent Eu^{3+} salts [21], ion conducting Li^{+} salts [25], organic dyes [22], semiconductor and metal nanoparticles [12; 10; 4; 3], and, for the first time, the ureasil-based composites were tested for immobilization of laccase and construction of biosensors [14]. It has been found that the biosensor based on the ureasil-chalcogenide glass composite was characterized by very high sensitivity to be 38.3 times higher in compare with pure ureasil. On the other hand, application of the ureasil-chalcogenide glass composite with incorporated silver nanoparticles synthesized by high-dose 30 keV Ag^{+} ion implantation results in decreasing the biosensor sensitivity up to 2390 times. The results obtained indicated a well expressed influence on the sensor's characteristics of the constructed biosensor by organic-inorganic ureasil-based matrixes and silver nanoparticles. Laccase-based amperometric enzyme biosensors of the third generation for analysis of phenol derivates have also been constructed [13] using graphite rods (type RW001) as working electrodes and the photocross-linked polymers as a matrix. Such matrix consisted of epoxidized linseed oil (ELO), bisphenol A diglycidyl ether (RD) as reactive diluent and 50% mixture of triarylsulfonium hexafluorophosphate in propylene carbonate (PI) as photoinitiator.

The synthesis was made by the reaction of ELO and 10 mol.% or 30 mol.% of RD, using 3 mol.% of PI (ELO/10RD and ELO/30RD, respectively). The holding matrixes were used for an immobilization of commercial laccase from the fungus *Trametes versicolor.*

In the present work, the results obtained with help of positron annihilation lifetime spectroscopy (PALS) and swelling test are presented for the ureasil-based and photocross-linked polymers used for construction of laccase-based amperometric biosensors. A correlation between the constructed biosensor parameters and microscopical free volume of the biosensor holding matrixes was established.

Experimental

The pure organic-inorganic hybrid ureasil matrix was synthesized as follows [10; 12]: O,O'-bis(2-aminopropyl)-polypropylene glycol-block-polyethylene glycol-block-polypropylene glycol-500 (Jeffamine ED-600) was dried under vacuum for 30 minutes; 3-isocyanatepropyltriethoxysilane (ICPTES), tetraethoxysilane (TEOS, 98%) and n-butyl amine was used as received; Jeffamine and ICPTES were mixed in a stoichiometric ratio of 1 : 2 in order to obtain a liquid ureasilicate monomer; thereafter, TEOS (1.12 mmol) and n-butylamine were added to the mixture, which was kept under stirring for more than 20 min. The mixture was then transferred into a plastic Petri dish and jellified under appropriate conditions; the obtained gels were heated in a vacuum furnace at 333 K at ambient conditions; and a non-rigid, homogeneous and highly transparent xerogel in form of a disk with a diameter of 40 mm and a thickness of 0.25 mm was obtained within 1 day.

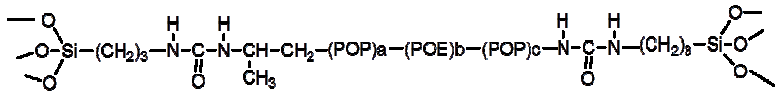
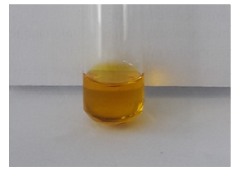
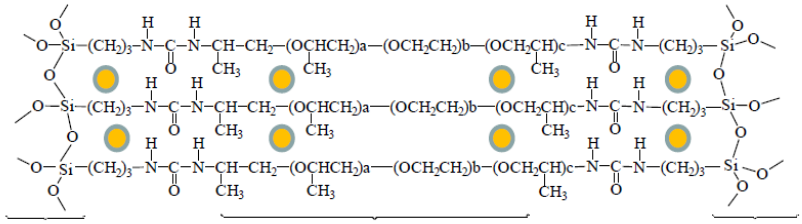
At the same time, the organic-inorganic hybrid ureasil matrix with chalcogenide clusters represented by ureasil-chalcogenide glass As_2S_3 composite was synthesized as follows [10; 12]: the As_2S_3 ingots were synthesized by melt quenching method from As (5N) and S (5N) in sealed quartz ampoules at 923 K; the melt was quenched to room temperature, and the obtained glassy samples were finely grounded in powder form and dissolved in an organic solvent (3 ml n-butylamine) to the 0.4 M concentration; and the ureasil/As_2S_3 composite was obtained by mixing the ureasilicate monomer with the solution of chalcogenide clusters. The stiff gel was obtained as described above. Chemical structures of the ureasil polymers used in the research are shown in *Table 1*.

The photocross-linked polymers ELO/RD was synthesized by the reaction of ELO (epoxidized linseed oil, having an average number of 6 epoxy groups per molecule) and RD (bisphenol A diglycidyl ether), using PI (50% mixture of triarylsulfonium hexafluorophosphate in propylene carbonate) as photoinitiator [13]. Chemical structures of the photocross-linked polymers used in the research are shown in *Table 2*.

The positron annihilation spectroscopy is suitable for characterizing the microstructure of investigated materials [9] on the atomic and molecular scale. The measurements of positron and positronium lifetime by the positron annihilation lifetime spectroscopy (PALS) spectrometer with the time resolution FWHM of ~220–320 ps cover the time range from 1 up to 142 ns in vacuum. For the investigated samples, the PAL spectra were measured by the fast-fast coincidence spectrometer with a time resolution of 320 ps (the instrumental resolution function was calculated from lifetime spectra of an Al defect-free sample). The sandwich arrangement of sample-source (radioactive positron ^{22}Na source with an activity of 0.8 MBq) was used between two identical samples. The PAL spectra were analyzed by the LT program. Three component fitting procedure for PALS data treatment were applied and long-lived lifetime component $\tau_{o\text{-Ps}}$ and its intensity $I_{o\text{-Ps}}$, ascribing to the *ortho*-positronium (*o*-Ps) pick-off annihilation in free-volume spaces, were taken into account for analysis. Temperature measurements of the samples were performed in the range of 15-350 K using a helium closed-cycle refrigerator Janis CCS-450 system with a temperature stability of 0.2 K. From the lifetimes the free-volume pore sizes [23; 7] as well as their thermal expansion characteristics were determined.

Table 1

Chemical structures of the ureasil polymers used in the research

Samples	Materials and Formula
Ureasil	**Initial components:** - 3-(Triethoxysilyl)propyl isocyanate (ICPTES); - O,O′-Bis(2-aminopropyl) polypropylene glycol-block-polyethylene glycol-block-polypropylene glycol (Jeffamine ED-600).  a + c = 2.5, b = 8
Ureasil/As_2S_3 composite	**Initial components:** • Triethoxy (3-isocyanatopropyl)silane (ICPTES); • O,O′-Bis(2-aminopropyl) polypropylene glycol-block-polyethylene glycol-block-polypropylene glycol (Jeffamine ED-600); • As_2S_3, dispersed in butylamine ($CH_3(CH_2)_3NH_2$).  Colloidal solution of As_2S_3 in butylamine.  Stiff, rigid block — Soft, rubbery block — Stiff, rigid block

The images of investigated ureasil samples used for the research are shown in *Fig. 1*.

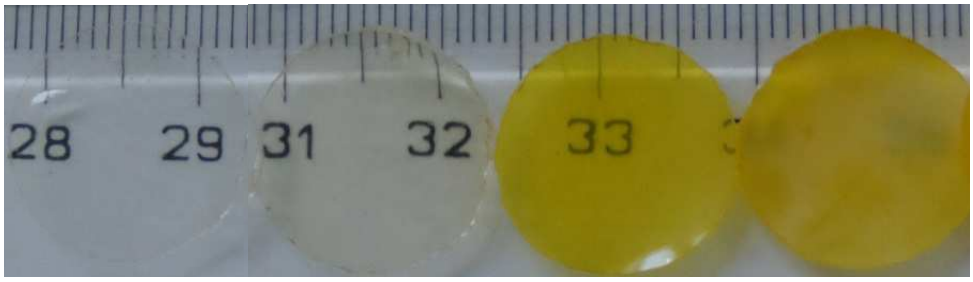
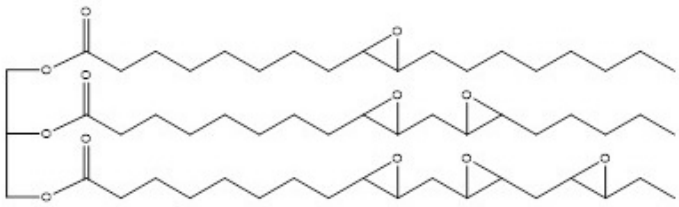
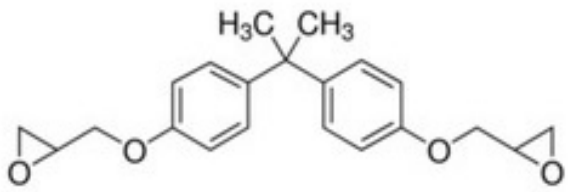
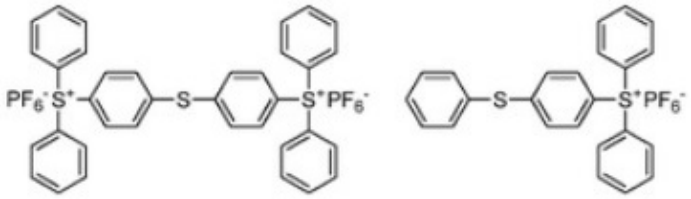


Fig. 1. Images of the investigated ureasil polymers used for the research [11]: 1 – ureasil fresh (2 months after preparation): 'K0-fresh'; 2 – ureasil aged (1 year after preparation): 'K0-aged'; 3 – ureasil/As_2S_3 fresh (2 months after preparation): 'K4-fresh'; 4 – ureasil/As_2S_3 aged (1 year after preparation): 'K4-aged'

Table 2

Chemical structures of the photocross-linked polymers used in the research

Sample	Materials	Formula
ELO/RD	Epoxidized linseed oil	
	Bisphenol A diglycidyl ether	
	Triarylsulfonium hexafluoroantim onate salts (photoinitiator)	

The spherical void size r_h was determined from the *ortho*-positronium (*o*-Ps) lifetime in the simple approach by the semi-empirical relation Eq. 1 [7], where $\Delta R = 0.166$ nm is the empirical constant:

$$\tau_{o-Ps} = 0.5 \left\{ 1 - \frac{r_h}{(r_h + \Delta R)} + \left(\frac{1}{(2\pi)} \right) \sin \left[\frac{2\pi r_h}{(r_h + \Delta R)} \right] \right\}^{-1} \tag{1}$$

The corresponding hole volume V_h is given by equation:

$$V_h = \frac{4}{3} \pi r_h^3 \tag{2}$$

The important characteristics as glass transition temperatures T_g (or temperatures of crystallization in some cases) and the coefficients for the thermal expansion of free-volume holes, $\alpha_F = 1/V_h(T_g^{PALS})(\Delta V_h/\Delta T)$ below (α_{F1}) and above (α_{F2}) T_g from $V_h(T)$ dependences were revealed.

Swelling method is suitable technique for the characterization of crosslinked systems. In the swelling experiment, the samples were immersed in suitable solvents at room temperature and weighted the initial weight (m_0) and final weight ($m_{swollen}$) after 8 days. Then the samples were dried at 333 K in argon atmosphere by using TGA method for obtaining the weight of dry sample (m_{dry}). The percent equilibrium mass swelling (S), the molecular weight between two crosslink points, M_c, was estimated by the Flory-Rehner equation as shown in [11]. The density of the investigated polymeric samples, ρ_p, was estimated by the gravimetric method (Archimedean principle).

Results and discussion

Figure 2 shows the *o*-Ps lifetimes and their relative intensities for the investigated pure ureasil samples as a function of temperature in the range of 15-350 K [11]. The temperature where the free volume (*o*-Ps lifetime) changes slope is assigned as a glass transition temperature T_{g1}. The determined values of hole volume V_h (Eq. 2) at the glass transition temperature (T_{g1}) and the coefficients for the thermal expansion of free-volume holes α_{F1}, α_{F2} below and above T_{g1}, respectively, are gathered in *Table 3*. The lower temperature at which the slope of the $V_h(T)$ also changes in some cases is designated as T_{g2}.

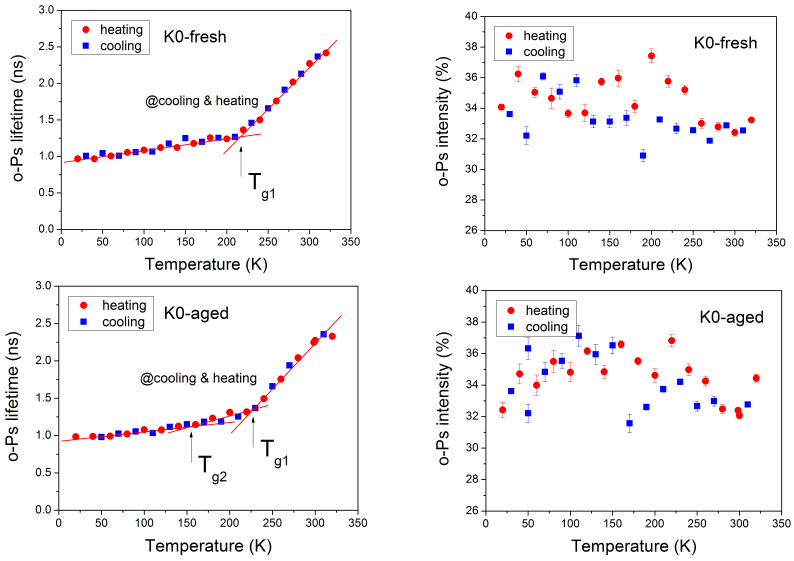


Fig. 2. o-Ps lifetime τ_3 (left) and intensity I_3 (right) as a function of temperature for the pure ureasil (K0) samples of this study. The error bars are within the size of the symbol. The solid lines are drawn as a guide for the eye. The samples are marked as shown in Fig. 1. Adapted from [11]

Figure 3 shows the *o*-Ps lifetimes and their relative intensities for the investigated ureasil/As_2S_3 composite samples as a function of temperature in the range of 15–350 K [11]. Both T_{g1} and T_{g2} are detected for ureasil-based composites. In addition, it is found that the changes in hole volume depend on cooling or heating rate in the case of aged ureasil/As_2S_3 samples (K4-aged).

The differences in network behavior for the aged samples and the effect of chalcogenide (As_2S_3) particles on the free volume of ureasil network are clearly observed, but further

research is still needed to resolve the nature of double T_g values. Comparing the results presented in Table 3, it is seen that the largest changes in microscopical free volume characteristics represented by α_{F1} and α_{F2} are observed for the fresh ureasil/As_2S_3 sample (K4-fresh).

Figure 4 shows the swelling data for the investigated ureasil polymers [11]. Note, for the K4-fresh sample the largest changes in the swelling test parameters are also observed *(Table 4)*. It is interesting to report here that the amperometric laccase-based biosensor constructed using K4-fresh polymer was characterized by the highest sensitivity compared with the pure K0-fresh one [15].

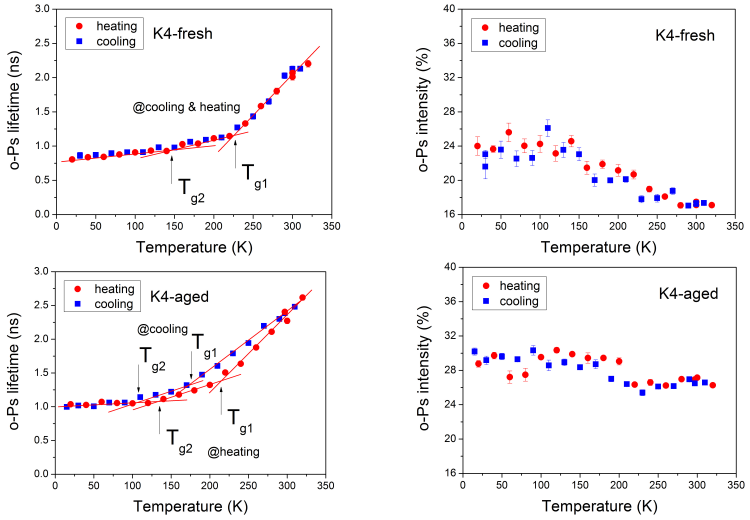


Fig. 3. o-Ps lifetime τ_3 (left) and intensity I_3 (right) as a function of temperature for the ureasil/As_2S_3 samples of this study. The error bars are within the size of the symbol. The solid lines are drawn as a guide for the eye. The samples are marked as shown in Fig. 1. Adapted from [11]

Table 3

Free-volume (V_{h1}) at glass transition temperature (T_{g1}), T_{g1}, lower temperature at which $V_h(T)$ changes the slope (T_{g2}) and the coefficients for the thermal expansion of free-volume holes α_{F1}, α_{F2} below and above T_{g1}, respectively, for the investigated ureasil polymers [11]. The samples are marked as shown in Fig. 1

Sample	V_{h1} (nm^3)	T_{g1} (K)	T_{g2} (K)	α_{F1} ($T < Tg1$) (10^{-4} K^{-1})	α_{F2} ($T > Tg1$) (10^{-4} K^{-1})
K0-fresh (cooling & heating)	0.123 ± 0.002	216 ± 13	-	25 ± 3	286 ± 21
K0-aged (cooling & heating)	0.123 ± 0.003	230 ± 19	166 ± 89	53 ± 22	273 ± 99
K4-fresh (cooling & heating)	0.104 ± 0.001	227 ± 18	126 ± 38	48 ± 10	344 ± 63
K4-aged (cooling)	0.134 ± 0.001	178 ± 19	88 ± 58	46 ± 17	206 ± 56
K4-aged (heating)	0.123 ± 0.004	228 ± 38	130 ± 38	56 ± 22	237 ± 84

Table 4

Bulk density of the polymeric sample (ρ_p), molecular weight between two crosslink points (M_c) and comparative analysis of crosslinking density or swellability for the investigated polymers [11]. The samples are marked as shown in Fig. 1

Sample	ρ_p (g/cm^3)	M_c	Comparative analysis
K0-fresh	1.1778 ± 0.0021	92.47	lower crosslinking density, higher swellability
K0-aged	1.1814 ± 0.0012	44.0	the highest crosslinking density, the lowest swellability
K4-fresh	1.2015 ± 0.007	99.22	the lowest crosslinking density, the highest swellability
K4-aged	1.2170 ± 0.003	76.52	higher crosslinking density, lower swellability

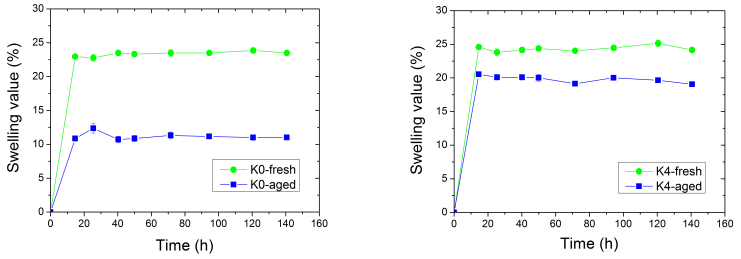


Fig. 4. The swelling values as a function of time for the pure ureasil (K0) samples (left) and the ureasil/As_2S_3 composite (K4) samples (right) of this study in EtOH at room temperature. The samples are marked as shown in Fig. 1. Adapted from [11]

Figure 5 shows the hole volume V_h calculated from *o*-Ps lifetimes and the *o*-Ps relative intensities for the investigated photocross-linked polymers ELO/10RD and ELO/30RD as a function of temperature in the range of 15-350 K [13]. In both polymers, the changes in hole volume depend on cooling or heating rate.

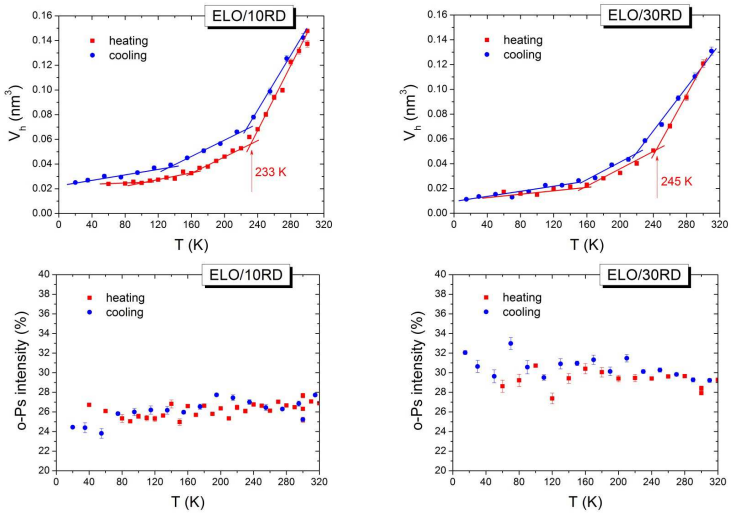


Fig. 5. Hole volume and o-Ps intensity temperature dependences for the photocross-linked polymers ELO/10RD (left) and ELO/30RD (right) in the heating and cooling cycles. Adapted from [13]

It can be noted that the average sizes of free-volume holes in the polymer ELO/10RD are larger than that of ELO/30RD. Also, the polymer ELO/10RD compared to the polymer ELO/30RD has the larger difference in the coefficients for the thermal expansion of free-volume holes in the regions below and above T_g *(Table 5)* [13].

Figure 6 shows the results of swelling test for the polymers ELO/10RD and ELO/30RD in the solvents EtOH and H_2O [13]. The polymer ELO/10RD compared to the polymer ELO/30RD has the higher crosslink density or lower swellability *(Table 5)*. Like to previous case with ureasil polymers, it is interesting again to mention that the amperometric laccase-based biosensor constructed using ELO/10RD polymer shows the improved biosensor's parameters compared to ELO/30RD [13].

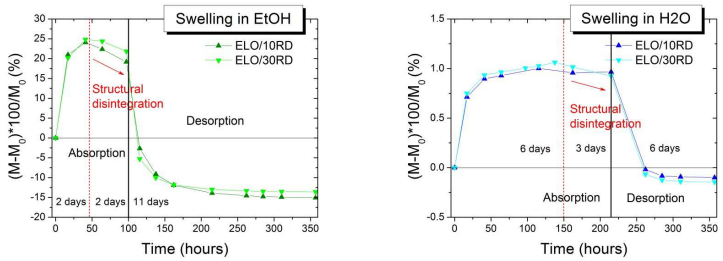


Fig. 6. The absorption and desorption of EtOH (left) and H_2O (right) of the polymers ELO/10RD and ELO/30RD during 15 days. Adapted from [13]

Table 5

Hole volume V_h at T_g, swellability S in EtOH, and slopes α_{F1}, α_{F2} of the $V_h(T)$ dependences in the regions below and above T_g, respectively, as well as their differences (values for heating and cooling cycles are in the top and bottom part of the boxes, respectively) [13]

Polymers	V_h (nm^3)	T_g (K)	S (%)	α_{F1} (10^{-4} K^{-1})	α_{F2} (10^{-4} K^{-1})	$\alpha_{F2}-\alpha_{F1}$ (10^{-4} K^{-1})
ELO/10RD	0.057 ± 0.002 0.068 ± 0.002	233	24.09	3.53 ± 0.30 3.31 ± 0.32	13.02 ± 0.60 11.16 ± 0.55	9.49 ± 0.67 7.85 ± 0.64
ELO/30RD	0.051 ± 0.002 0.049 ± 0.002	245	24.81	3.47 ± 0.33 3.87 ± 0.83	12.42 ± 0.64 8.96 ± 0.48	8.95 ± 0.72 5.09 ± 0.96

Therefore, for different kind of polymers used in this study, a correlation between the constructed biosensor parameters and microscopical free volume of the biosensor holding matrixes was established. It is foreseen that a change in microscopical free-volume below and above T_g represented by ($\alpha_{F2}-\alpha_{F1}$) in polymer matrix should be further tested as a possible control parameter for controlling the functionality of amperometric enzyme biosensor based on the polymer matrix.

Conclusions

Development of advanced materials for construction of biosensor with improved operational parameters is an important field in the novel sensor technologies. Novel polymer matrixes based on the organic-inorganic ureasil and ureasil/As_2S_3 composite were tested for immobilization of commercial microbial laccase and construction of amperometric biosensors [11].

A very high sensitivity of biosensor with ureasil/As_2S_3 composite was established and the positive effect of chalcogenide microparticles on the biosensor's parameters was observed.

It was also established that the network properties of polymer matrix play a significant role for improvement of amperometric enzymatic biosensor but further research is still needed to understand better the results obtained [15].

In the next step, the amperometric enzyme biosensors using photocross-linked polymers ELO/10RD and ELO/30RD as holding matrixes and immobilized commercial laccase from *Trametes versicolor* have been constructed on the surface of the graphite rods as working electrodes [13]. It has been established that the application of the photocross-linked polymer ELO/10RD which is characterized by the higher crosslink density and larger free volume holes with their lower concentration and the larger change in microscopical free-volume below and above T_g compared to the polymer ELO/30RD results in the improvement of the laccase-based amperometric biosensor.

The larger change in microscopical free-volume below and above T_g was also detected for K4-fresh ureasil polymer which showed the most improved sensitivity of biosensor compared to K0-fresh ureasil used [15].

A change in microscopical free-volume below and above T_g represented by $(\alpha_{F2}-\alpha_{F1})$ in polymer matrix should be further tested as a possible control parameter for controlling the functionality of amperometric enzyme biosensor based on the polymer matrix. However, further research is still needed to prove the above correlation for other polymers with different crosslink density and/or morphology as well as to compare the operational parameters of the constructed biosensors with similar analogues known in literature.

Acknowledgments

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SECTION II

BIOMEDICAL AND ENVIRONMENTAL ASPECTS OF HUMAN HEALTH

Chapter 5. CHARACTERISTICS OF THE PROFESSION OF A PARAMEDIC IN POLAND

W. WANOT[1], B. WANOT[2]
[1]Faculty of Pedagogy and Psychology,
University of Silesia in Katowice,
12, Bankowa Str., 40-007 Katowice, Poland
e-mail: bbwjtk@gmail.com
[2]Institute of Physical Education, Tourism and Physiotherapy,
Jan Długosz University in Częstochowa,
4/8, Jerzego Waszyngtona Str., 42-200 Częstochowa, Poland
e-mail: bartoszwanot@interia.pl

Abstract. *Under the Act of October 20, 2006 on State Medical Rescue, the profession of a paramedic can be performed by any person who meets the following criteria: (1) Has complete legal capacity; (2) Obtained a diploma in the field of emergency medical services at a higher vocational school in the country or abroad; (3) Obtained the title of a paramedic in post-graduation school before year 2006. The main task of a paramedic is to quickly help in the sudden danger of life and health in accidents, diseases and catastrophes. In the work of a paramedic, experience is one of the most important areas, as it leads to professional and effective help to others. The specifics of working as a paramedic requires not only theoretical knowledge and practical skills in the field of emergency medicine, but also psychological predispositions and specific personality traits. The most common features manifested by paramedics are: resistance to stress, ability to work and interact with different people, ambition, resistance to pain and harm of others, self-confidence, ability to work in crowd, self-control and determination. It is the decision-making and situations that threaten life and health, as well as providing help in the event of disasters, lead to stress in paramedics. A stressful situation concerns paramedics and patients, therefore the rescuers' knowledge of this phenomenon is necessary.*

Keywords: *Paramedic; State Medical Rescue; Rescue activities; Medical Emergency Teams; Rescue operation; Stress.*

Wstęp

Zawód ratownika medycznego jest obok lekarza i pielęgniarki jest kluczowy dla utrzymania zdrowia oraz zachowania życia przez chorych. Ich wiedza i doświadczenie często ma decydujące znaczenie dla przeżycia ludzi w stanie nagłych zachorowań oraz wypadków. Jednak praca ratowników jest zdeterminowana sposobem organizacji systemu ratownictwa medycznego. Warto zatem przybliżyć pracę ratowników medycznych, ich uprawnienia, specyfikę oraz organizacje pracy jak również związane z nią zagrożenia.

Model zawodu ratownika medycznego

Na podstawie ustawy z dnia 20 października 2006 o Państwowym Ratownictwie Medycznym zawód ratownika medycznego może wykonywać każda osoba, która spełnia następujące kryteria:

- Posiada zupełną zdolność do czynności prawnych;
- Uzyskała dyplom w zakresie ratownictwa medycznego w wyższej szkole zawodowej w kraju lub za granicą;
- Uzyskała w szkole policealnej tytuł ratownika medycznego przed 2006 rokiem.

Dwie powyższe drogi prowadzące do osiągnięcia uprawnień ratownika medycznego są równorzędne pod względem wykonywanych później czynności w pracy zawodowej [1].

Najogólniej mówiąc, ratownik medyczny jest uprawniony do udzielania świadczeń zdrowotnych, będąc zatrudnionym w zakładzie opieki. Głównym zadaniem ratownika jest szybka pomoc w stanie nagłego zagrożenia życia i zdrowia w wypadkach, chorobach i katastrofach. Ratownik medyczny udziela pierwszej pomocy i, w razie potrzeby, transportuje pacjenta do szpitala.

Ratowników zatrudniają jednostki ratowniczo-gaśnicze Państwowej Straży Pożarnej oraz stowarzyszenia i organizacje takie jak: GOPR, WOPR, TOPR, OSP, PCK. Poza medycznymi czynnościami ratunkowymi i zabezpieczeniem miejsca wypadku lub katastrofy oraz transportem poszkodowanych ratownik medyczny uprawniony jest do organizowania i prowadzenie pokazów i szkoleń w zakresie udzielania pierwszej pomocy [1; 2].

Zgodnie z rozporządzeniem Ministra Zdrowia z dnia 29 grudnia 2006 roku oraz z dnia 20 kwietnia 2016 roku, do szczegółowych czynności ratunkowych podejmowanych przez ratownika medycznego należą:

- Podjęcie decyzji o podjęciu czynności ratunkowych bądź odstąpieniu od nich na podstawie oceny stanu pacjenta.
- Ułożenie poszkodowanego we właściwiej pozycji dla jego stanu i poniesionych obrażeń.
- Wykonanie resuscytacji krążeniowo-oddechowej u dorosłych i dzieci, na poziomie podstawowym jak i zaawansowanym.
- Bezprzyrządowe i przyrządowe udrażnianie dróg oddechowych.
- Odsysanie dróg oddechowych.
- Wspomaganie oddechu, wentylacja zastępcza powietrzem lub tlenem, tlenoterapia bierna.
- Intubacja dotchawiczna w nagłym zatrzymaniu krążenia, bez użycia środków zwiotczających.
- Defibrylacja ręczna w oparciu o EKG; defibrylacja zautomatyzowana.
- Wykonanie EKG.
- Monitorowanie czynności układów: oddechowego i krążenia.
- Koniulacja żył obwodowych kończyn i żyły szyjnej zewnętrznej.
- Dojście doszpikowe z użyciem gotowego zestawu.
- Podawanie leków na różne sposoby z użyciem gotowego zestawu (lista leków poniżej).
- Odbarczanie odmy prężnej poprzez nakłucie jamy opłucnowej.
- Pobieranie krwi.
- Oznaczanie poziomu parametrów krytycznych.
- Opatrywanie ran i tamowanie krwotoków.
- Unieruchamianie skręceń, zwichnięć oraz złamań.
- Unieruchamianie kręgosłupa w szczególności odcinka szyjnego.
- Odebranie nagłego porodu.
- Segregacja medyczna.
- Wykonywanie działań zabezpieczających minimalizujących skutki zdrowotne zdarzenia.
- Opieka medyczna i przygotowanie pacjenta w czasie transportu.

Ratownik medyczny upoważniony jest także do podawania leków takich jak: Acetylsalicylic acid, Amiodarone, Atropinum sulfuricum, Clemastine, Diazepam, Epinephrine bitartrate, Flumazenil, Furosemide, Glucagon hydrochloride, Glucosum, Glyceryl trinitrate, Hydrocortisone, Magnesii sulfuricum, Ketoprofen, Lignocainum hydrochloricum, Midazolam, Metociopramidum, Morphine sulphate, Naloxonum hydrochloricum, Natrium chloratum, Płyn

fizjologiczny, Salbutamol, Solutio Ringeri i tlen. Sposób podawania leków może być drogą dożylną, doodbytniczą, dotchawiczną, doustną, wziewną oraz doszpikową. Niektóre leki ratownik medyczny może podać po uprzedniej konsultacji z lekarzem.

Dodatkowe czynności ratunkowe ratownik medyczny może wykonać pod nadzorem lekarza. A są to:

- Intubacja dotchawiczna z użyciem środków zwiotczających.
- Kardiowersja elektryczna i elektrostymulacja zewnętrzna.
- Asystowanie przy drobnych zabiegach chirurgicznych.
- Cewnikowanie
- Płukanie żołądka i umieszczanie sondy żołądkowej
- Podawanie leków

Powyżej zawarte zostały informacje o zawodzie ratownika. Dwadzieścia lat temu nie było jasne, kim jest ratownik medyczny i jakie stanowisko powinien zajmować w służbie zdrowia. Bardzo ważne zatem dla ratownictwa medycznego było ustawowe skonkretyzowanie jego zawodu i szczegółowe ustalenie zakresu czynności, które może wykonywać wykwalifikowany ratownik [3; 4].

Ratownicy medyczni – grupa społeczna

Doświadczenie w pracy i kontakt z wieloma ratownikami medycznymi sprawia, że osoba w tej grupie wyznaje pewne określone wartości, wyróżnia się konkretnymi cechami charakteru, umiejętnościami zawodowymi i reprezentuje pewien styl charakteryzujący ratownika medycznego. Pracę ratowników medycznych jako grupę społeczną opisuje Przemysław Wołoszyn, na podstawie swojej pracy w pogotowiu, badań socjologicznych, wywiadów z pracownikami służby zdrowia i obserwacji. Niniejsza część pracy została zredagowana w oparciu o pozycje tego autora.

W pracy ratownika medycznego jedną z najważniejszych sfer jest doświadczenie, gdyż prowadzi do fachowej i skutecznej pomocy innym. Starsi ratownicy są zdania, że doświadczenie należy zdobywać już w czasie nauki. Ważna jest także ciągłość w kontakcie z zawodem gwarantująca sprawne działanie. Doświadczenie najlepiej zdobywać pracując w różnego rodzaju karetkach i w różnych zespołach ratunkowych. Sama wiedza teoretyczna jest jedynie podstawą do pracy. Zajęcie stanowiska pracy i uznanie wynika z posiadanych umiejętności praktycznych przejawiających się w sprawnym niesieniu pomocy. Duże zdolności i wprawa w wykonywaniu czynności ratunkowych pozwalają na objęcie ważniejszego stanowiska w hierarchii pogotowia. Z najbardziej doświadczonymi i umiejętnymi ratownikami dyrekcja konsultuje pomysły i decyzje, licząc się z ich zdaniem.

Specyfika pracy na stanowisku ratownika medycznego wymaga nie tylko wiedzy teoretycznej i umiejętności praktycznych z zakresu medycyny ratunkowej, ale także predyspozycji psychicznych i konkretnych cech osobowości. Najczęstszymi cechami przejawianymi przez ratowników medycznych są: odporność na stres, umiejętność pracy i współdziałania z różnymi osobami, ambicja, odporność na ból i krzywdę innych, pewność siebie, umiejętność pracy w tłumie, opanowanie i zdecydowanie. Ratownik medyczny oswaja się z trudnymi i stresującymi sytuacjami podczas swojej pracy, a motywacje do działania czer pie z dużej ilości bodźców w trakcie pracy.

Modelowy ratownik medyczny wg Przemysława Wołoszyna nie powinien być kobietą. Co prawda coraz więcej kobiet uzyskuje wykształcenie w tym kierunku i szuka pracy w pogotowiu, jednak delegowane one są co najwyżej do szpitalnych oddziałów ratunkowych. Niewiele kobiet zatem pracuje w karetce.

Cechą, którą musi posiadać ratownik medyczny, jest dystans do własnego wyglądu i seksualności, ze względu na sporą ilość żartów kierowanych pod ich adresem.

Obciążenia w pracy ratowników medycznych zmuszają ich wręcz do szukania odskoczni, dodatkowych zainteresowań i rozrywek, które pomagają rozładować napięcie. Ratownicy lubią więc spędzać wolny czas na uprawianiu sportów ekstremalnych lub drużynowych. Popularne wśród ratowników medycznych są również rozrywki bardziej spokojne, jak kino i literatura. Ratownicy medyczni są zbiorowością, która po pracy tworzy grupy paramilitarne, czy drużyny harcerskie. Takie spotkania nieformalne są okazją nie tylko do zabawy i odreagowania, ale także do wymiany doświadczeń i sposobów radzenia sobie z różnymi problemami. Poza czystą rozrywką, ratownicy medyczni spotykają się na warsztatach, kongresach i wykładach, żeby podnosić swoje kompetencje.

W środowisku ratowników medycznych wyodrębnić można charakterystyczny język i sposób komunikowania się. Taki żargon powstał dzięki specyfice pracy ratowników medycznych. W związku z dynamiką pracy stworzone zostały skróty nazw sprzętów, wyrażeń związanych z przypadkami klinicznymi i innych określeń rozumianych tylko przez tą grupę zawodową. Posiadanie swoistego języka ma dwie funkcje. Po pierwsze umożliwia szybkie, jasne i efektywne porozumiewanie się w czasie pracy, a po drugie pozwala pracownikom budować odrębność, identyfikować się z grupą i integrować ją.

W kwestii wartości w zawodzie ratownika medycznego należy zauważyć, że wywodzą one się z różnych sfer życia. Punktem zbieżnym jest osiąganie społecznie akceptowalnego celu. Podstawowym celem adepta szkoły ratownictwa medycznego jest ochrona życia i staranie się o jego utrzymanie, korzystając ze wszystkich możliwych sposobów. Uwewnętrznienie tej wartości pozwala z czasem zrozumieć sens działań dla ochrony zdrowia i życia, a także zrozumieć powód podejmowania różnych wysiłków w trakcie ratowania ludzi. Ta podstawowa wartość niesie za sobą wewnętrzne ambicje ratownika do doskonalenia swoich umiejętności i ciągłe zdobywanie wiedzy w celu uzyskania coraz większej skuteczności. To właśnie skuteczność prowadzi do uzyskania szacunku i uznania innych, co stanowi kolejną istotną wartość. Przynależność to też istotna sprawa dla większości ratowników. Wielu szczyci się pracą w tym zawodzie i stara się ciągle z nią utożsamiać przez kupowanie kurtek, naszywek i gadżetów o tematyce ratunkowej. Ostatnią z tych najistotniejszych wartości jest karetka. To właśnie ten sprzęt ratownik dokładnie poznaje w pierwszej kolejności i bardzo dobrze obsługuje. Karetka jest miejscem bardzo zadbanym przez pracownika i często traktowana jak osoba. Pracując w pogotowiu, ratownicy zabezpieczają też swoim rodzinom materialny byt [5; 6].

Zespoły ratunkowe. Etapy akcji ratunkowej

Jako że ratownicy działają w różnych zespołach, tworzą pewną hierarchię. Można więc dokonać ich podziału na kilka sposobów. Jednak najpowszechniejszym w środowisku medycznym rozróżnieniem jest takie, które uwzględnienia rodzaj karetki, w jakiej ratownicy pracują. Można wyróżnić następujące rodzaje karetek, a co za tym idzie, zespoły ratunkowe. Po roku 2010, stopniowo stary podział został zastąpiony przez podział na karetki:

- specjalistyczne (karetki oznaczone "S", "eski") w skałd których wchodzi minimum trzyosobowa obsada, w której przynajmniej jedna osoba to lekarz. W przypadku, gdy żaden z innych członków zespołu nie ma uprawnień do prowadzenia pojazdów uprzywilejowanych, czwartą osobą w zespole może być kierowca.
- podstawowe (karetki oznaczone "P") z załogą składającą się z co najmniej dwóch osób będących ratownikami lub pielęgniarkami systemu. W tych zespołach nie ma lekarza.
- transportowe (karetki oznaczane "T") używane są do transportu chorych niewymagających intensywnego nadzoru lub transportu np. krwi bądź przeszczepów.
- W skład załogi wchodzi najczęściej kierowca i ratownik. W przypadku chorych wymagających nadzoru lekarskiego (w cięż-kich stanach) możliwe jest uzupełnienie zespołu o lekarza systemu.

- Obecnie nazywane są transportowymi. Przed reformą w 2010 roku nazywane były mianem karetek przewozowych (wtedy posiadały oznaczenie P).

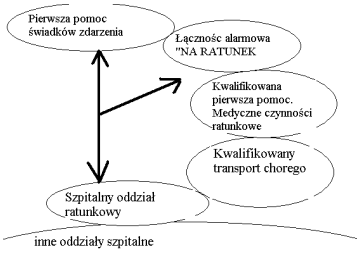
Spotkać można również karetki neonatologiczne (karetki "N", enki), używane do transportu noworodków i niemowląt (do 1 roku życia).

Przed wprowadzeniem nowych przepisów karetki dzieliły się na:

- karetki reanimacyjne (karetki oznaczone "R", erki), używane były w sytuacji bezpośredniego zagrożenia życia. W karetce reanimacyjnej musiał być lekarz. Najczęściej ich załoga składała się z lekarza dwóch ratowników medycznych i kierowcy. Po zmianach wszystkie karetki "R" zostały zastąpione przez karetki specjalistyczne "S";
- karetki wypadkowe (karetki oznaczone "W"), wysyłane były do urazów, wypadków i zachorowań, w których nie był konieczny wyjazd karetki R lub w razie braku dostępności zespołu R. Pod względem wyposażenia niewiele różniła się od karetki R, czasami miała identyczne wyposażenie. Obsada karetki składała się z trzech osób: pielęgniarki lub ratownika medycznego, lekarza i kierowcy. Zgodnie z nowymi przepisami karetki "W" zamieniono na podstawowe "P";
- karetki przewozowe (karetki oznaczone "P"), zamienione na karetki "T";
- karetki kardiologiczne (karetki "K") które były bardzo zbliżone do karetek wypadkowych lub reanimacyjnych, lecz posiadały w składzie załogi lekarza specjalizującego się w kardiologii lub chorobach wewnętrznych, wyposażone w lepszej jakości sprzęt służący do diagnostyki chorób układu krążenia.

Wyróżnić można również Lotnicze Pogotowie Ratunkowe (LPR) które jednak wymyka się z powyższej klasyfikacji tradycyjnego pogotowia, a zarazem ją uzupełnia. Do LPR zaliczymy samolotowe zespoły transportowe oraz zespoły helikopterów ratowniczych.

Praca ratownika medycznego umieszczona jest wewnątrz systemu zintegrowanego ratownictwa medycznego. W systemie tym zwraca się uwagę na takie elementy, jak: sprawny system medycyny ratunkowej oparty na koncepcji "łańcucha przeżycia", wysoki stopień wyszkolenia wszystkich pracowników personelu, wysokie kompetencje i jakość wyposażenia technicznego, a także wysoki poziom organizacyjny systemu [7; 8].



Rys. 1. Schemat "łańcucha przeżycia"[9]

Dobre i dynamiczne przeprowadzenie akcji ratunkowej sprawnie współdziałającej ekipy ratunkowej i szybkie dostarczenie poszkodowanego do szpitala opiera się na konkretnych zasadach. Najważniejszą zasadą jest tzw. "złota godzina". Określa ona granice czasowe akcji ratunkowej, które są często decydujące dla jej powodzenia. W zasadzie czas, w którym pacjent powinien dotrzeć na oddział lekarski w celu uzyskania specjalistycznej pomocy to 30–40 minut. Dodatkowa zasada istniejąca w "złotej godzinie" jest taka, że im ciężej poszkodowany jest pacjent, tym bardziej należy skrócić czas transportu do szpitala.

Na miejscu zdarzenia należy wykonać jedynie najważniejsze czynności, do których należą: unieruchomienie kręgosłupa, udrożnienie dróg oddechowych i utrzymanie drożności, wentylacja, zatamowanie krwotoków i przywrócenie krążenia.

Resztę czynności można wykonać w trakcie transportu do szpitala. W przypadku pacjentów z mniejszymi obrażeniami więcej czynności można wykonać na miejscu wypadku, ale należy ciągle mieć na uwadze zasadę "złotej godziny". Wyżej opisana zasada jest fundamentem akcji ratunkowej i jej przestrzeganie jest najczęściej decydujące o życiu i zdrowiu pacjenta. Wymaga współdziałania ekipy ratunkowej i sprawnego zabezpieczenia funkcji życiowych pacjenta. Cała akcja ratunkowa przebiega zgodnie z konkretnie ustalonymi etapami:

1. Utrzymanie stanu gotowości

Pozostawanie w ciągłej gotowości do akcji pozwala zmaksymalizować wykorzystanie czasu podczas akcji w czasie "złotej godziny". Stan gotowości obejmuje takie sfery jak:

- Utrzymanie sprawności ambulansu poprzez stałą techniczną kontrolę. Po każdej akcji bowiem należy sprawdzić stan techniczny karetki i zatankować paliwo, jeśli potrzeba, żeby nie zdarzyły się żadne techniczne "niespodzianki" podczas akcji.
- Kontrola działania i kompletności sprzętu medycznego, uzupełnianie leków i sprawdzanie mechanicznego działania urządzeń.
- Przygotowanie ratowników pod kątem fizycznym i psychicznym. Pracownik karetki powinien bowiem być wypoczęty i dobrze odżywiony. Powinien zadbać o sprawność fizyczną, regularnie ćwicząc, a na akcję powinien wyjeżdżać w stroju zapewniającym komfort i chroniącym go przed szkodliwymi warunkami atmosferycznymi, ponieważ od kondycji ratownika może zależeć zdrowie lub życie pacjentów, współpracowników i jego samego.

2. Uruchomienie systemu ratownictwa medycznego

Rozpoczęcie akcji zależy od dyspozytora Centrum Powiadamiania Ratunkowego. To właśnie on przyjmuje wezwanie o nagłym zagrożeniu zdrowia lub życia, kwalifikuje problem i oddelegowuje do konkretnych służb, w tym wypadku do jednostek ratownictwa medycznego. Wezwanie zespołu następuje jeszcze w czasie rozmowy z osobą zgłaszającą.

3. Dojazd na miejsce zdarzenia

Dojazd do miejsca zdarzenia lub osoby poszkodowanej odbywa się pojazdem uprzywilejowanym, co skraca czas akcji i pozwala przestrzegać zasady "złotej godziny".

4. Działania ratunkowe na miejscu zdarzenia

Miejscem zdarzenia jest miejsce, w którym doszło do nagłego zagrożenia zdrowia lub życia. Działaniami podejmowanymi w tym miejscu są:

Zabezpieczenie miejsca akcji – W tym etapie fundamentem działań jest zadbanie o bezpieczeństwo całego zespołu ratunkowego. Ocena stanu poszkodowanego następuje dopiero po dobrym zaparkowaniu ambulansu, dokładnym obejrzeniu miejsca zdarzenia i zaplanowaniu czynności ratunkowych. W wypadkach drogowych należy wstrzymać ruch pojazdów, gdyż jest to podstawa bezpieczeństwa dla pacjentów i zespołu ratunkowego. W czasie zabezpieczania miejsca akcji ważne jest także oszacowanie liczby pacjentów. W przypadku większej liczby poszkodowanych należy wezwać dodatkowe jednostki do pomocy. Przed transportem do szpitala należy rozpoznać urazy, udzielić niezbędnej pomocy i przetransportować poszkodowanego do karetki. W sytuacjach wypadków drogowych działania pogotowia wspierane są przez oddziały straży pożarnej.

- Zabezpieczenie się przez zakażeniem – Na miejscu zdarzenia bardzo prawdopodobny jest kontakt z płynami ustrojowymi pacjenta, a działania takie jak wkłucia podejmowane są pod presją czasu, należy więc zadbać o ochronę ratownika przed chorobami pacjenta. Należy zatem założyć rękawiczki ochronne, a w niektórych wypadkach także okulary i maski.

5. Transport poszkodowanego do oddziału ratunkowego.

Etap ten został opisany powyżej w kontekście zasady "złotej godziny".

6. Powrót do bazy i przywrócenie stanu gotowości.

Po akcji ratunkowej i odtransportowaniu pacjenta do szpitala następuje powrót do bazy, przygotowanie sprzętu i utrzymanie stanu gotowości [10].

Obciążenia w pracy ratownika medycznego

Ratownik medyczny wykonuje zawód, w którym jest bardzo często obciążony obowiązkiem podejmowania bardzo ważnych decyzji. Co więcej, jest on zmuszony do decydowania przy niewielkiej ilości informacji, często również przy niejasności sytuacji. To właśnie podejmowanie decyzji i sytuacje zagrażające życiu i zdrowiu, a także niesienie pomocy w sytuacji katastrof prowadzi do powstawania stresu u ratowników medycznych. Sytuacja stresowa dotyczy ratowników i pacjentów, dlatego niezbędna jest wiedza ratowników o tym zjawisku.

Reakcja na stres jest kilkuwymiarowa:

- Reakcje emocjonalne to takie jak: lęk, napięcie, niepokój, zdenerwowanie, zmartwienie i napięcie.
- Reakcje somatyczne to na przykład: przyspieszona praca serca, suchość w ustach i zwiększone napięcie mięśni.
- Reakcje psychiczne obejmują ciągłe rozwiązywanie problemu, poszukiwanie informacji i pomocy, stosowanie niedojrzałych mechanizmów obronnych, a także nadużywanie alkoholu i leków.

Postępowanie z pacjentem narażonym na stres jest bardzo ważną funkcja ratownika medycznego. Pracownik karetki powinien zapewnić możliwie największy komfort psychiczny i fizyczny poszkodowanemu, utrzymywać z nim kontakt, wesprzeć poprzez wysłuchanie i pozwolenie na wyrażenie obecnych uczuć. W pracy ratownika należy unikać błędów w nawiązywaniu kontaktu, a są nimi:

- "Pochyła płaszczyzna kontaktu", czyli patrzenie i traktowanie z góry pacjenta.
- "Maska skuteczności". W sytuacji wypadku następuje tymczasowy regres emocjonalny pacjenta. Z łatwością wychwytuje wtedy wszelką sztuczność i pozy władcy, mędrca czy życzliwości, które w rzeczywistości są nieprawdziwe.
- "Postawa sędziego" to wytykanie błędów poszkodowanego prowadzące do lęku i poczucia winy.

Sposób komunikowania się z pacjentem jest zatem bardzo ważny i nie chodzi tu o nadopiekuńczość, ale o profesjonalne wsparcie pacjenta.

Pomoc pacjentom to sprawa bardzo ważna. Obciążeni stresem jednak są również ratownicy. Podstawową metodą walki ze stresem jest rozmowa ze współpracownikami i omawianie sytuacji, które się wydarzały. Dodatkowo ratownik medyczny powinien opanować metody relaksacji, a także dobrze organizować sobie czas pracy i wypoczynku. Obecnie coraz popularniejsze są zajęcia psychohigieniczne takie jak:

- Rozładowanie – możliwość dobrowolnego wyrażenia uczuć i myśli związanych z akcją ratowniczą. Czas trwania takich zajęć to 10–30 minut.
- Przedyskutowanie – to dłuższe formy omawiania przeżyć po akcji ratunkowej, która była bardzo obciążająca (np. katastrofa lub wypadek, w którym zginęła duża ilość osób). Zajęcia takie prowadzi profesjonalista i odbywają się one 24–48 godzin po zaistnieniu sytuacji trudnej.

Udział w zajęciach psychohigienicznych i profilaktycznych powinien być dobrowolny.

Profesjonalna pomoc psychologiczna względem ratowników (Różycka, 2010) obejmuje takie działania psychologa, jak wsparcie psychiczne, interwencja kryzysowa, a w sytuacji przewlekłych zaburzeń zaleca się indywidualna psychoterapię [11–13].

Podsumowanie

Zawód ratownika medycznego jest profesja której adepci na co dzień stykają się ze śmiercią i ludzkim cierpieniem. Z tego względu wykonywanie go wymaga od ratowników szczególnej odporności psychicznej, zdolności szybkiego podejmowania decyzji i działań pod presją czasu. Duża wiedza oraz zdobyte doświadczenie pomaga uporać się z tymi problemami, jednak mimo wszystko często to ratownicy staja się pacjentami którzy poszukują wsparcia psychologicznego którego na co dzień udzielają swoim pacjentom.

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Chapter 6. ANALYSIS OF BABY MIXTURES AND PORRIDGE ON THE MARKET OF UKRAINE ON THE CONTENT OF FATS AND FAT-SOLUBLE VITAMINS

N. STADNYTSKA, V. LYLO, O. SHVED, V. NOVIKOV
Lviv Polytechnic National University,
3/4, Yura square Str., Building 8, 79000 Lviv, Ukraine
e-mail: nataliyastadnytska@gmail.com
e-mail: ovshved@ukr.net

Abstract. *The problem of breastfeeding, which is a guarantee of harmonious development and health throughout life, is a disease in lactating mothers, or a cessation of lactation. An alternative in this case is feeding with baby mixes and instant cereals. Over the last several decades, the range of search for new formulations of artificial breast milk substitutes has been increasing, which would be as close to breast milk as possible in quantitative and qualitative composition. Scientists are focusing greatly on the fat components of the mixtures, as they are responsible for the energy costs that are the basis of the biological development of the developing organism. The assortment of baby food mixes and instant cereals presented in the market of Ukraine provides the needs of different age groups of children in a quality balanced diet according to individual needs, differing in degree of adaptation to breast milk, has regulatory or therapeutic effects on the body. The basis of the fat component of children's mixes of firms HUMANA, NESTLE, HIPP, FRISO, NUTRILON, MILUPA are vegetable oils: palm, coconut, sunflower and rape. The products of domestic producers MALYSHKA, MALYUTKA differ in content of products of fats of animal origin.*

Keywords: *Baby mixtures; Instant cereals; Fats; Fat-soluble vitamins; Vitamin A, D, E, K.*

Formulation of the problem

The study of the domestic market of infant food showed the fullness of the proposals of useful products for feeding infants up to 2 years. Healthy eating is, above all, a proper diet, which should be clearly defined by balanced nutritionally-selected nutrients that are essential for human development.

It is believed that feeding a baby with breast milk in the first years of life is the only correct and healthy way of feeding that ensures its harmonious development and is a guarantee of health throughout life. According to WHO and UNICEF, during the first six months of life the baby is optimally breastfeeding, followed by feeding with infant formulas or instant cereals, and continued breastfeeding for up to two years and more. Such statements are based on fundamental scientific studies of physiology of the function of lactation and the study of the composition of milk on the principles of evidence-based medicine. It has been scientifically proven that neither today nor in the future is artificially impossible to create a similar product to breast milk. It is known, however, that during the lactation period there are moments when lactation in the lactating mothers decreases or even ceases at all, that breastfeeding protects infant from infections, primarily from diarrhea and respiratory diseases [2].

The medical experts in breastfeeding are believed to reduce the mortality of children by 31% if 99% of mothers begin to breastfeed at the first hour of her life [5].

The advantage of breast milk is that it is characterized by a high content of ideal nutrients for infants and is very easily absorbed by the body [1].

Children breast-feeding are less susceptible to:

- respiratory diseases and ear infections;

- urinary tract infections;
- early manifestations of diabetes and various allergic reactions;
- asthma and breathlessness;
- crohn's disease;
- some types of childhood cancers (leukemia, lymphoma) [4].

Children who are on exclusive breastfeeding have improved abilities to:

- a better response to vaccination;
- more qualitative cognitive and mental development;
- less cases of caries and anomalies of dental occlusion;
- better visual acuity [8].

Based on the above, we note that obtaining all the vital-necessary factors for a full-fledged development of a baby can be achieved using exclusively breastfeeding. However, during the lactation period there are moments when lactation in the lactating mothers is reduced or even stopped altogether. This is usually due to emotional stress or physical overload. At such a moment, it is necessary to introduce newborns supplements. The introduction of supplements is a very crucial step in the transition of the child to a new form of nutrition. Therefore, first of all, it is necessary to make the right choice of the product, evaluating its taste and nutritional properties[6; 7; 9].

The assortment of baby food on the modern food market is diverse and presented in the form of mixtures, instant cereals, canned products (mashed potatoes, meat and vegetable canned food, juices), dry breakfast (flakes, crackers) [3]. Depending on the physiological needs of children, mothers can choose for their baby such a mixture or porridge, which will meet the individual physiological needs of her child's body. Choosing should be based on the conclusion ESPGHAN (European Society for Pediatric Gastroenterology, Hepatology, and Nutrition, European Society of Pediatric Gastroenterology, Hepatology and Nutritionists), which states that the most optimal mixtures and instant cereals for the artificial feeding of the child are such that "Provide children with the same indicators of development, immune responses and metabolic profile, as in children on natural feeding" [6].

The modern market of infant food products is formed in accordance with the presented laws, regulations and other documents aimed at the development of a healthy population:

1. Law of Ukraine "On Safety and Quality of Food Products" of 23.12.1997.
2. Resolution of the Cabinet of Ministers of Ukraine dated November 22, 2004 No. 1591 "On Approval of Nutrition Standards in Educational and Kindergartens for Recuperation and Rest".
3. Joint Order of the Ministry of Health and the Ministry of Education and Science of Ukraine of 01.06.2005 N 242/329 "On Approval of the Procedure for the Organization of Feeding Children in Educational and Recreational Facilities".
   Instruction on the organization of nutrition of children in preschool educational establishments, approved by the joint order of the Ministry of Education and Science of Ukraine and the Ministry of Health of Ukraine dated April 17, 2006, No. 298/227, as amended in accordance with the order of the Ministry of Education and Science, Youth and sport from 02/26/2013 № 202/165.
4. Joint Order of the Ministry of Health and Ministry of Education and Science of Ukraine of April 17, 2006 N 298/227 "On Approval of the Instruction on the organization of nutrition of children in preschool educational institutions".
5. Joint Order of the Ministry of Health and the Ministry of Education and Science of Ukraine dated August 15, 2006 N 620/563 "On urgent measures for the organization of feeding children in preschool, general, non-school educational institutions".
6. Letter of the Ministry of Education and Science of Ukraine dated June 21, 2007 No. 1 / 9-394 "On monitoring the organization of feeding children in pre-school educational institutions".

7. The Law of Ukraine "On Infant Nutrition" dated January 1, 2007.
8. Order of the Ministry of Health of Ukraine dated September 3, 2017 No. 1073 "On Approval of the Norms of the Physiological Needs of the Population of Ukraine in the Basic Nutrients and Energy".

Baby food products today are subject to the general rules and recommendations of the International Food Quality System (HACCP) (Hazard Analysis and Critical Control Points, a system for risk analysis, hazard analysis and critical points control). The essence of the HACCP system is to monitor the safety of food products and to identify potential hazards (biological, chemical, physical). The implementation of this system in Ukraine is regulated by the Laws No. 771/97-VR of December 23, 1997 "On Basic Principles and Requirements for Food Safety" and from 18.05.17, No. 2042-VIII "On State Control over Compliance with Food Legislation" products, feed, animal by-products, animal health and welfare". Compliance with the requirements for the quality of food products, in particular, baby food, is provided by the State Committee for Consumer Goods and Consumer Protection, created in accordance with the Resolution of the Cabinet of Ministers of Ukraine dated September 10, 2014, No. 442 "On the Optimization of the System of Central Bodies of Executive Power".

Purpose of research: to study the assortment of food products for infants under 2 years old in the current market of Ukraine and to analyze the content of these products, namely in dairy and dairy mixes and portions of fats and fat-soluble vitamins.

Presentation of the main material

Over the last several decades, the range of search for new formulations of artificial breast milk substitutes has been increasing, which would be as close to breast milk as possible in quantitative and qualitative composition. The questions of optimal quantity and ratio of protein fractions of casein, hydrocarbon components – lactose and maltodextrin are discussed. However, in recent years, scientists focus on the fat components of mixtures, as they are responsible for energy costs, which are the basis of the biological development of the organism.

As you know, lipids (from greek lipos – fat) are a large group of natural compounds (fats and fatty substances that are part of the cells of all living organisms (bacteria, plants, animals, etc.). Fat provides the basic functions of the body's vital functions: they form the basis for the structure of cell and tissue membranes, contribute to the formation of energy reserves in the body, protect the tissues from the action of water, temperature, mechanical effects, affect the processes of permeability and metabolism, a large group of biologically active substances (bile and acids, sex hormones, adrenal hormones, prostaglandins and other bioregulators, some vitamins, etc.) that affect various functional activities of the body.

In the initial period of life, all the necessary fats are given to the baby with breast milk. Mother's milk is an unsurpassed creation of nature from which the infant gets all the nutrients that are easily digested by the child's body. In the future, the source of fats is products of animal and plant origin (seeds and fruits). Unlike other natural food complexes, female milk is a unique combination of nutrients, a complex biological system that performs plastic, energy, immunomodulatory functions. At the end of pregnancy and in the first days after delivery, colostrum is excreted. It is an adhesive of a yellowish liquid that fills the alveoli during the last trimester of pregnancy and is produced within a few days after delivery.

The amount of colostrum varies from a wide range of 10 to 100 ml/day with an average of about 30 ml/day. Energy value of colostrum on the first day of life is 1500 kcal/l, on day 2 – 1100 kcal/l, on the third day – 800 kcal/l, on the 4th – 750 kcal/liter, on the 5 th – 700 kcal/liter. The colostrum contains less lactose, fat and water-soluble vitamins than in mature milk, but more protein, fat-soluble vitamins (E, A, K) and more minerals (Mg, Zn), high levels of immunoglobulins. Breeding milk fully meets the needs of the baby. Insufficiently developed neonates of a newborn child can not process large volumes of fluid without metabolic stress;

products of lactose and other intestinal enzymes are just beginning; To protect against oxidative damage and hemorrhagic diseases, inhibitors and quinones are required; immunoglobulins cover the immature surface of the child's intestine, thus protecting it from bacteria of viruses, parasites and other pathogenic factors, and the growth factor stimulates the child's own systems, thus, the colostrum acts as a modulator of the child's development. The action of colostrum is weakened by the addition of water, or eliminated by the introduction of other mediators into the gastrointestinal tract altogether. Breast milk passes into mature milk at 3–14 days after childbirth [9].

The composition of mature breast milk is extremely rich in proteins, lipids, carbohydrates, vitamins, minerals and trace elements [9].

According to the results of qualitative and quantitative studies of WHO breast milk contains protein – 1.15 g/100 ml, except for the first month when this indicator is 1.3 g/100 ml. Proteins of whey of feminine milk consist mainly of α-lactalbumin, an important component of the enzyme system in the synthesis of lactose. Some hormones (oxytocin, prolactin, adrenal and ovarian steroids, and prostaglandins) are present in breast milk, as well as Gn-Rh (gonadotrophin-releasing hormone), GRF (growth hormone-releasing factor), insulin, somatotropic, relaxin, calcitonin and neurotensin, TRN (thyrotropin-releasing hormone), TSN (thyreotropin-stimulating hormone), thyroxine, triiodothyronine, erythropoietin. Casein of female milk is an inhibitor of Nelisobaster pylori sticking to the gastric mucosa. This also applies to the adhesion of Streptococcus pneumoniae to the epithelial cells of the respiratory tract. The casein coefficient in female milk is approximately 40 : 60, while breast milk substitutes vary in the range from 82 : 18 to 40 : 60. The casein ratio of breast milk makes it possible to create a mild cheesecloth in the stomach of the baby, which facilitates digestion. Lysozyme, unlike other breast milk proteins, is resistant to digestive secretions, but more susceptible to trypsin action. Its concentration increases throughout the lactation period. Enzymes present in human milk have protective properties: they are protects the gastrointestinal tract of infants from inflammatory diseases, such as necrotic enterocolitis [9].

Lactose is the main carbohydrate of female milk, although it also contains galactose, fructose and other oligosaccharides in small quantities. Lactose is one of the stable components of breast milk. It provides about 40% of energy needs, and also performs other functions. Lactose is converted into metabolism in glucose (energy source) and galactose, an integral part of galactolipid, necessary for the development of the central nervous system. It promotes the absorption of calcium and iron and stimulates the formation of intestinal colonies *Lactobacillus bifidus* [9].

With some exceptions, the fat content of mature female milk is ideal for a child and meets the physiological needs. The fat content is increased from about 2.0 g/100 ml in colostrum to an average value in the mature milk of 4–4.5 g/100 ml on day 15 after delivery. Fat is the most variable component of all the components of milk. There are daily fluctuations of fats with a maximum, which is recorded, as a rule, late in the morning and immediately after noon. It is believed that the fat content at the end of feeding acts as a saturation regulator, since milk is the most energy-valuable before the end of feeding. In female milk predominate triglycerides and contains 42% saturated and 57% unsaturated acids. Among the polyunsaturated amino acids, arachidonic and linolenic are particularly important, with a content of 0.4 g/100 ml. They affect most of the physiological functions that activate digestion along with the maturation of the intestinal cells, thus affecting the entire protective mechanism [9].

Female milk also contains other lipid-related antiviral ingredients. The fat component of breast milk is of great importance – linolenic acid (omega 3) and linoleic polyunsaturated fatty acids (omega 6). Linoleic acid is transformed into arachidonic acid (ARA), – linolenic acid to docosahexaenoic acid (DHA). These chains contribute to myelinization of nerve fibers,

participate in the formation of psychomotor and intellectual development, visual analyzer, make up 60% of the major fatty acids of the phospholipids of the cerebral cortex, promote transmembrane transport of ions, participate in the formation of immunity [9].

The content of vitamins in female milk almost always corresponds to the needs of the child, although it may vary depending on the woman's diet. The content of vitamin A in mature female milk is twice as high as in colostrum. In the second month of life, vitamin A deficiency is common among children who have stopped feeding early. The level of vitamin C in mature breast milk in women who eat fully, is about 100 mg/l. Immediately after birth, the concentration of vitamin K is higher in colostrum and early breast milk than in the late one. Concentration of vitamin K (0.8–1.0 mg/l) increases to about 60 mg/l if the mother regularly uses vitamin-K-containing products. In children who are deprived of colostrum, or do not receive "late" milk, the risk of bleeding is higher than that of children who were fully fed. Vitamin E content in female milk is relevant to the needs of the child if the mother does not use excessive amounts of polyunsaturated fats without additional vitamin E intake. The highest concentrations of alpha tocopherol in colostrum (8 mg/l), breast milk – about 3–4 mg/l. The content of vitamin D in female milk is 0.88 μg/100 ml. Concentration of vitamin B12 in breast milk is very low (0.5–0.1 mg/l). Experimentally it has been established that the diet practically does not affect the content of vitamin B12 in breast milk, or affects slightly. The content of vitamin B6 in early milk varies within 0.09 mg/l, and in ripe breast milk – 0.13 mg/l. The level of vitamin B6 in breast milk is 10 times higher than in the blood serum of the mother. In women who have taken orally taking contraceptives, vitamin B6 deficiency in breast milk may be observed [9].

Also important is the content of most minerals in breast milk (phosphorus, calcium, iron, magnesium, zinc, potassium, fluoride compounds) were slightly dependent on the woman's diet. Calcium is absorbed more effectively because breast milk is rich in calcium: the ratio of calcium to phosphorus (2 : 1). The concentration of phosphorus in breast milk ranges from 147 mg/l in the first three weeks of lactation to 107 mg/l in 26 weeks of lactation. The content of calcium in breast milk is 259–248 mg/l. Iron deficiency anemia is very rare in infants fed solely breast milk during the first 6–8 months of life. However, the early introduction of other products in the diet of such children can disrupt this picture. For example, pears form chelating compounds with iron of breast milk, making it insoluble and inaccessible to the baby, and the administration of extra iron may reduce the absorption of zinc and copper. Zinc is necessary for the structure and functioning of enzymes, growth and cellular immunity. Its content in breast milk is low, but sufficient to meet the needs of the baby, without disturbing the absorption of copper and iron; Its biological value is high compared with zinc, which is added to milk substitutes [9].

However, with valuable the character of the milk and with the sufficient knowledge of women in the need for breastfeeding and its benefits to the child's body, part of women deliberately, or due to certain adverse circumstances, transfer children to feed artificial mixtures and other infant food products.

Depending on age, baby food products are divided into 4 main groups:

- products for children from 0 to 6 months;
- products for children from 6 months to 1 year;
- special baby food products;
- products for children from 1 to 3 years old [3].

At the same time, the products of baby food are classified according to their purpose, namely the degree of adaptation to breast milk, the presence of regulatory influence on the body, as well as the presence of therapeutic properties *Fig. 1* [4].

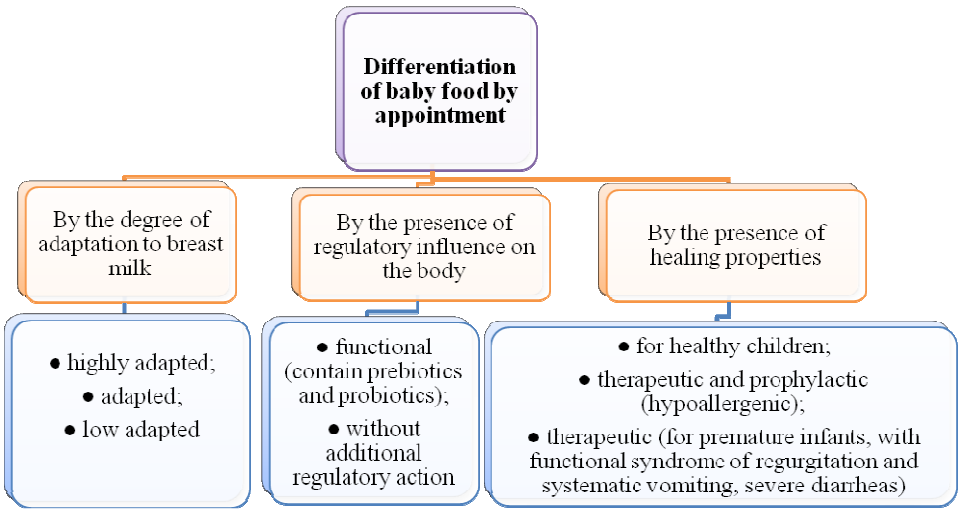

Fig. 1. Block diagram of the division of children's food products by purpose

Up to 4–5 months of the child's use of infant formula as an additional source of baby food. The chosen mixture is taken starting from 5–10 ml 2–3 times a day, gradually increasing its amount. Starting from 4–5 months of life, depending on the increase in body weight, they start feeding in the form of porridge.

Analyzing baby food products, we took into account the indicators of consumer quality of food products, which are determined by the following factors:

1) *the biological value of the product* – the allocation of ten essential amino acids, polyunsaturated fatty acids, vitamins, minerals of high biological value, phospholipids, and some dyes and other biologically active substances;

2) *the physiological value of the product* is due to the influence of certain substances that it contains, on the nervous, cardiovascular, gastrointestinal system: such influence is done by theobromine of cocoa powder, chocolate, extracts of meat, fish, alkaloids of onion vegetables, pepper, horseradish and other vegetables;

3) *the therapeutic and prophylactic value of the product* is determined by the ability of its substances to treat and prevent illness;

4) *benignity of a product* is determined by the conformity of organoleptic and physico-chemical indicators of its quality to the norms provided by the operating standards and technical conditions;

5) *product safety* is the absence of substances harmful to the human body in it;

6) *the organoleptic value of the product* is determined by its appearance, consistency, smell, aroma and degree of freshness;

7) *the energy value of the product* is determined by the amount of energy released after the biological oxidation of the substance, determined in kcal or KJ (1 kcal corresponds to 4.186 KJ) [10].

The quality of food products is understood as a set of properties that determine their ability to meet the corresponding human needs.

Quality indicators are unique, which determine one of the indicators of product quality, for example: color, consistency, amount of fats, acids, sugar, etc., and complex, which characterize two or more indicators of product qualities, for example, combines form, size and color [10].

Quality Scores are divided into:

- *organoleptic* – shape, color, surface condition, smell, taste, consistency, etc. (determined by the sensory organs);

- *physico-chemical* – specific gravity, density, melting point, mass fraction of water, sugar, salt, acids, fat;
- *microbiological* – on the content of salmonella, bacteria, *E. coli*, yeast, and the like [10].

Physical quality indices are determined by physical methods using instruments, for example, the melting temperature using a thermometer, the density of a liquid – a pycnometer, an areter, a color intensity – a colorimeter, a refractive angle – a refractometer. Chemical indices are determined by chemical methods, namely, the mass fraction of acids – titration of alkaline solution; kitchen salt – titration of a solution of nitric-acid silver. Microbiological indicators – the method of taking samples of products, having digested them on the nutrient medium and counting the number of individual groups of microorganisms that have sprouted [10].

All indicators of food quality are conventionally grouped into groups:

- indicators of destination;
- indicators of storage and aesthetics;
- indicators of transportability;
- environmental and safety indicators for consumption.

Indicators of characterization describe the quality of the product by packaging, packaging, marking, organoleptic leptinitis and physical and chemical purity. *Storage indicators* characterize the ability of the product to maintain quality over a specified period of time under optimal conditions. *Aesthetic indicators* are information display of goods, attractiveness, rationality of forms, merchandising of packaging material, clear marking, execution of all marks, etc. *Indicators of transportability* are the ability of edible products to maintain consumer quality during transportation. *Ecological indicators* – characterize the degree of harmful substances during storage, transportation, and the impact of goods on the environment. *Indicators of safety* – characterize the harmlessness and safety of the product for people when consumed [10].

In accordance with the concept of balanced nutrition, which is the basis of rational nutrition, nutrients should be fed to the body in an amount that corresponds to the adaptive capacity of the child's digestive tract and the level of its metabolic processes [2].

Quality food is characterized by the content in the diet of proteins, fats, carbohydrates, mineral salts and vitamins. In this work, among all nutrients, we have focused on fats and fat soluble vitamins A, D, E, K.

Fats and fat-soluble substances are complex organic compounds, which differ in structure and functional values. They play an important physiological role. Are suppliers of polyunsaturated fatty acids and fat-soluble vitamins important for the body's development. Cholesterol reduces membrane permeability for viruses. It is a source for the synthesis of hormones, including steroids (adrenal hormones, sex hormones), involved in the synthesis of bile acids, vitamin D3. Phospholipids and cholesterol are the major lipid of the nerve tissue and myelin fibers. Fats are the most important energy component of the diet – 1 gram of fat gives 37.7 kJ (9 kcal) of energy [1].

The mechanism of action of fats on the body manifests itself at different levels: cellular, tissue and organism *(Table 1)*.

Table 1

The relationship between the role and mechanism of action of fats in the human body

The role of fat	Mechanism of action
Depreciation	Protection of bones, tissues and internal organs from shock and shock.
Thermal insulation	Protecting fabrics from cold and heat.
Aesthetic	Align the acute angles of the skeleton, giving the body a gentle roundness.
Building	Construction material of cell membranes.

To determine the need for fats, it is necessary to take into account the proportion of fat in the total caloric intake of the diet. The highest this value at an early age is 40–50%, at school age it decreases to 30.5–31%. The need for children in fats is given in *Table 2* [2].

Table 2

Recommended values of fat intake (per day) for children and adolescents

Age group	Total, g per day	Vegetables, g	% vegetable from the total amount of fats
up to 12 months	20–50	3	10
1–3 years	53	5	10
4–6 years	68	10	15
7–10 years	79	18	20
11–13 years (boys)	93	19	20
11–13 years (girls)	35	17	20
14–17 years (younker)	100	20	20
14–17 years (girls)	90	18	20

The fatty component of baby food mainly uses vegetable fats. Particularly, HUMANA, NESTLE, HIPP, FRISO, NUTRILON, MILUPA contain infant formulas such as palm, coconut, sunflower and rapeseed. They are the main source of polyunsaturated fatty acids and vitamin E. Linoleic acid (omega-6) is found in sunflower and corn oil, linoleic (omega-3) in soya. Coconut oil is a source of medium-chain fatty acids [1]. Linoleic and linolenic acids are not synthesized in the body, but should come from food as they are spent for the construction of membranes of the cells of the brain and the nervous system [1]. Vegetable fats play an important role in the metabolism of the body, and their excess or shortage influences the risk of the emergence or prevention of many diseases *(Table 3)*.

Table 3

Components of fats, plant sources and their influence on processes in the body

Component of fat	Vegetable oils	Influence on metabolic processes	Physiological action
Saturated fatty acids	Coconut oil, palm oil	Increase the amount of high and low density lipoprotein cholesterol, may increase thrombosis.	Increased risk of coronary heart disease.
Mono-unsaturated fatty acids	Sunflower oil, corn oil, olive oil	Reduce low-density lipoprotein cholesterol and increase high-density lipoprotein cholesterol.	Reduces the risk of coronary heart disease.
Polyunsaturated fatty acids, Omega-3 derivatives of α-linoleic acid	Rape, flax	Reduces thrombocytes, which are important for the development of the brain.	Reducing the risk of coronary heart disease, increasing the weight of newborns, reducing the risk of sudden death.

The role of fats in the biochemical processes of the body depends on their lipid-acid composition and the presence of additional components – vitamins, phospholipids. It is believed that the optimal proportion for the good assimilation of fats by the body is the ratio of 1/3 of vegetable and 2/3 of animal fats. The physical and chemical properties of oils and fats depend on

the ratio of fatty acids *(Fig. 2)*. According to the literature [1], coconut oil contains 90% saturated fatty acids and 10% unsaturated fatty acids of vegetable oils, 83% saturated and 17% unsaturated in palmiotrope 60% saturated fatty acids and 40% unsaturated are contained in cocoa butter. Palm oil has 57% saturated and 43% unsaturated fatty acids, cotton and soya – 25% saturated and 75% unsaturated fatty acids. Olive oil in its composition has 18% saturated acids and 82% unsaturated, sunflower – 10% saturated and 90% unsaturated fatty acids. Only 9% of saturated fatty acids contains flaxseed oil and 91% unsaturated fatty acids. The smallest content of saturated acids contains rapeseed oil – 6% and the highest unsaturated content – 94%.

Vegetable oils are a natural source of fat-soluble vitamins and physiologically active dyes, in particular carotenoids. Vitamins are a group of indispensable nutrients of organic nature, a diverse structure that is necessary to ensure the metabolism of both the infant and adult in the body. Vitamins should be constantly fed with food, because they are almost not synthesized in the body, and only some are deposited in the tissues. The need for vitamins is calculated in milligrams and even in parts of a milligram – micrograms per 1 g of product or mg% (milligrams of vitamin per 100 g of product) [7].

All vitamins are divided into two large groups: water soluble (water soluble), soluble in fats (fat-soluble). Water-soluble vitamins include ascorbic acid, thiamine, riboflavin, pantothenic acid, pyridoxine, nicotinic acid, ciancobalamin, folic acid, biotin. Fat-soluble vitamins – retinol, tocopherol, calciferol, vikasol – have the ability to purposefully affect the tissues of the body, ensuring the normalization of metabolic processes in these "target tissues" [2].

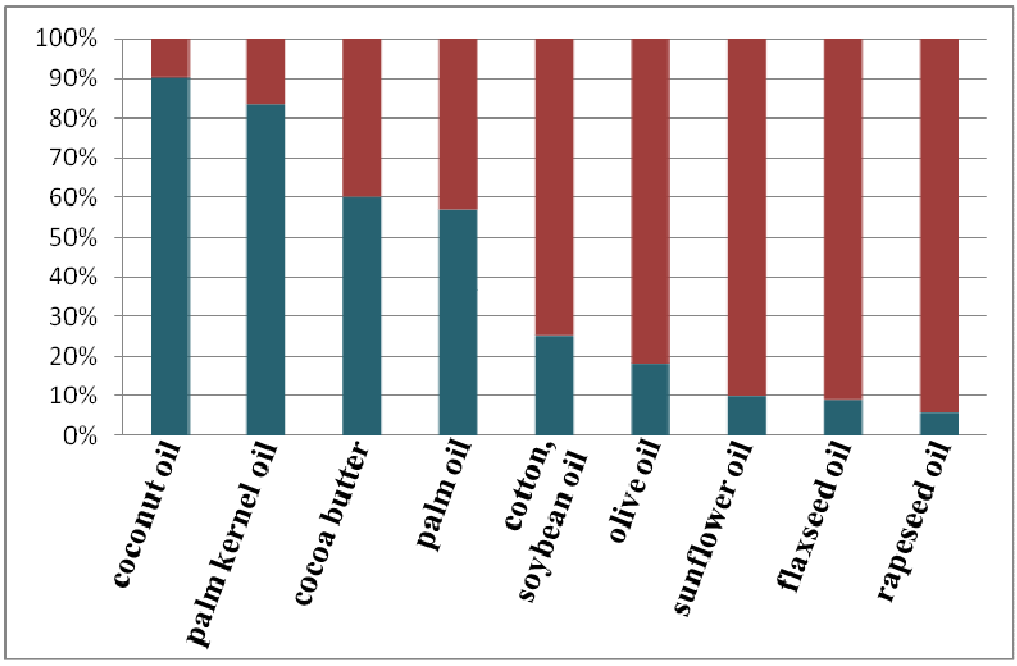

Fig. 2. The content of saturated and unsaturated fatty acids in vegetable oils

In the absence of one or more vitamins in foods, vitamin deficiency develops. It happens in two stages: avitaminosis and hypovitaminosis. Avitaminosis is a state of deep deficiency of some vitamin in an organism with a detailed clinical picture of insufficiency (scurvy, beriberi, pelagra, etc.). Hypovitaminosis is a state of the body with insufficient content of one or several

vitamins and food. Hypovitaminosis occurs more often at the end of winter, in the spring, when the intake of vitamins with food is rather limited, as they collapse during the storage of food. When excessive intake of vitamins, they are usually excreted from the body through the kidneys with urine. In some cases, their content increases and the hypervitaminosis develops, which leads to a disturbance of metabolic processes.

Particularly dangerous in this respect is the overdose of vitamins A and D that are prescribed for children to prevent rickets and growth disorders [7]. According to the Order of the Ministry of Health of Ukraine dated September 3, 2017 No. 1073 "On Approval of the Norms of Physiological Needs of the Population of Ukraine in the Basic Nutrients and Energy" in the specified daily need of children in vitamins A, D, E, K [6].

The processed results are presented in *Table 4*.

All vitamins play a significant role in the normal functioning of the body, and therefore the need for their regular intake is significant and should be maximally ensured from the daily diet of infants *(Table 5)*.

Table 4

Daily requirement of children and adolescents in fat-soluble vitamins

Age group	A, μg PE	D, μg	E, μg TE	K, μg
0–3 months	400	8	3	5
4–6 months	400	10	4	8
7–12 months в	500	10	5	10
1–3 years	500	10	6	15
4–6 years	500	10	7	20
6 years	500	10	8	25
7–10 years	500	5	10	30
11–13 years (boys)	600	5	13	45
11–13 years (girls)	600	5	10	45
14–17 years (younker)	600	5	15	65
14–17 years (girls)	600	5	13	55

Table 5

The role of vitamins in the physiological development of children and their properties

Name of vitamin	Role in the body	Insufficiency	Properties
A (retinol)	- development of the visual system; - formation of a skeleton; - participation in the formation of the mucous membranes of the body.	- reduced visual acuity and keratinization of mucous membranes; - slowing down growth.	Is destroyed by ultraviolet rays and oxygen by air.
D (calciferol)	- regulation of the exchange of calcium and phosphorus.	- development of rickets; - annoyance, bad sleep, sweating, loss of appetite.	Resistant to high temperature.
E (tocopherol)	- active antioxidant; - maintenance of metabolic processes in skeletal muscle, heart muscle, liver and nervous system.	- mild weakness; - violation of sexual function; - destruction of red blood cells.	The need increases with lack of oxygen.
K (vikasol)	- participation in the synthesis of compounds necessary for blood coagulation.	- bleeding.	Resistant to heat, is destroyed by light.

In accordance with the purpose of our study, we have studied the range of infant formulas and instant cereals, both domestic and imported, that are presented in the Ukrainian market, and summarized information about the content of fats and fat-soluble vitamins *(Tab. 6)*. The subjects of the analysis were the production of foreign firms HUMANA (Germany), NESTLE (Switzerland), HIPP (Germany), FRISO (the Netherlands), NUTRILON (Poland), MILUPA (Poland), domestic MALYSH, MALYUTKA.

Table 6

Quantitative fat and fat-soluble vitamins in baby mixtures and instant cereals

Baby food brand	**Manufacturer**	**Nutritional value per 100 g of powder**				
		Fat, g	*Vitamin A, μg*	*Vitamin D, μg*	*Vitamin E, mg*	*Vitamin K, μg*
MIXTURES						
Humana 1	HUMANA	23.7	470	6.7	7.2	33
Humana 2	HUMANA	23.8	480	7.8	5.6	43
Humana 3	HUMANA	19.5	460	8.8	-	-
Humana HN	HUMANA	14.2	400	7.1	5.7	35
Humana SL	HUMANA	24.1	500	7.0	6.4	44
Humana AntiColic	HUMANA	27.0	500	8.2	6.7	38
Humana Bifidus	HUMANA	25.9	520	8.4	6.4	41
Humana AR	HUMANA	23.7	485	8.2	6.0	45
NAN OPTIPRO HN 1	NESTLE	26.1	510	6.8	8.7	40
NAN OPTIPRO HN 3	NESTLE	22.7	509	6.8	8	34
NAN sour milk 1	NESTLE	27.7	530	7.4	8	43,5
NAN sour milk 2	NESTLE	23.9	480	8.8	9,2	44
NAN Peptamen	NESTLE	16	552	7.4	4,6	38
NAN without lactose	NESTLE	25.4	535	6.7	6,5	38,2
NAN triple comfort	NESTLE	27	510	6.8	10	44
NAN OPTIPRO 1	NESTLE	27.7	527	7.2	8,5	43
NAN OPTIPRO 2	NESTLE	23.6	500	8.2	8,5	43
NAN OPTIPRO3,4	NESTLE	21.2	550	9	11	50
Nestogen 1	NESTLE	24.8	590	6.5	7	35
Nestogen 2	NESTLE	21.5	590	9	8,6	38
Nestogen 3, 4	NESTLE	21.6	600	9.5	9,5	40
Combiotic 2	HIPP	25.4	395	6.4	6,2	-
Organic 1	HIPP	26.7	539	9.0	5,4	38,5
Organic 2	HIPP	24.9	500	8.3	7,3	36
Organic 3 Junior	HIPP	27.8	580	10	9,6	41
Comfort	HIPP	26.6	505	8.4	6,0	-
Frisolac 1	FRISO	27.0	540	9.3	6,7	39
Frisolac 2	FRISO	19.9	475	8.6	8,0	35
Frisolac 3 Junior	FRISO	15.0	340	6.4	6,0	20
Nutrilon 1	NUTRILON	24.7	399	8.7	8,0	32
Nutrilon 2	NUTRILON	20.6	452	9.8	8,0	35
Nutrilon 3	NUTRILON	17.5	456	21	7,5	34
Nutrilon 4	NUTRILON	19.4	452	12	7,9	34
Nutrilon Pepti	NUTRILON	25.7	388	9.4	7,6	35
Nutrilon Pronutra + premature home care	NUTRILON	26.0	654	11	14	39
Nutrilon Pronutra + premature care	NUTRILON	22.9	2134	18	21	36

Nutrilon AR	NUTRILON	26.5	378	9.1	7,8	34
Nutrilon without lactose	NUTRILON	27.3	429	9.3	9,0	35
Milupa 1	MILUPA	24.5	399	8.7	8,0	32
Milupa 2	MILUPA	20.5	459	10.0	8,0	35
Milupa 3	MILUPA	17.4	456	21	7,5	34
"Malysh" withoat flour	"MALYSH"	26.50	581.50	8.65	6,45	31.45
"Malysh" with buckwheat flour	"MALYSH"	26.00	581.50	8.65	6,45	31.45
"Malysh" with rice flour	"MALYSH"	25.50	581.50	8.65	6,45	31.45
"Malyutka" 1, 2, 3	"MALYUTKA"	26.50	581.50	8.65	6,45	32.45
"Malyutka" Premium 1	"MALYUTKA"	26.50	581.50	8.65	6,45	32.45
"Malyutka" Premium 2	"MALYUTKA"	26.00	581.50	8.65	6,45	32.45
"Malyutka" Premium 3	"MALYUTKA"	16.00	600	9.10	6,45	37.20
PORRIDGE						
Nutrilon buckwheat	NUTRILON	11.37	419	6.03	6.75	-
Nutrilon multi-cereal	NUTRILON	11.7	422.1	6.03	7.16	-
Nutrilon 4 cereals with rice balls	NUTRILON	12.7	419.4	6.03	7.26	-
Milupa rice b/m	MILUPA	1.0	-	-	-	-
Milupa rice	MILUPA	10.5	419.3	6.03	6.62	-
Milupa rice with a banana	MILUPA	6.2	421	6.0	6.1	-
Milupa rice with raspberries	MILUPA	9.2	419	6.0	6.5	-
Milupa rice with apricot	MILUPA	4.8	419	6.0	5.9	-
Milupa fruit manna	MILUPA	10.6	421.3	6.03	6.68	-
Milupa oatmeal	MILUPA	13.4	419.3	6.03	6.62	-
Milupa multi-cereal with baby biscuits	MILUPA	11.8	420	6.03	6.85	-
Milupa multi-cereal with a mixture of fruits	MILUPA	10.1	422.3	6.03	7.17	-
Milupa with pear and crackers	MILUPA	11.5	419.4	6.03	6.73	-
Milupa multi-cereal with fruits, flakes and balls	MILUPA	9.61	424	6.03	6.9	-
Nestle corn b/m	NESTLE	2.0	-	-	-	-
Nestle rice b/m	NESTLE	1.0	-	-	-	-
Nestle oat , black-plum wheat	NESTLE	4.3	290	8.8	5	-
Nestle 5 cereals with lime blossom	NESTLE	1.65	300	8	4	-
Nestle buckwheat	NESTLE	67	400	7	2.8	33
Nestle rice with a banana, an apple and a pear	NESTLE	10.5	390	6.8	2.7	31
Nestle rice with plum and apricot	NESTLE	10.5	390	6.8	2.7	31
Nestle multi-cereal with apple, pear and apricot	NESTLE	10	390	6.9	2,5	30

Bebi corn b/m	BEBI	2.1	385	8.0	6.0	13.0
Bebi oatmeal b/m	BEBI	4.4	480	12.0	9.0	10.0
Bebi buckwheat b/m	BEBI	1.9	332	8.0	6.0	6.8
Bebi 7 cereals with blueberries	BEBI	10.2	400	10.5	6.5	12.0
Bebi rice	BEBI	10.2	330	5.0	6.0	6.8
Bebi oatmeal	BEBI	11.0	450	5.0	6.0	6.8
Bebi oatmeal with peach	BEBI	10.9	450	5.0	6.0	6.8
Bebi rice with bananas	BEBI	10.3	330	5.0	6.0	6,8
Bebi fruit-grain assorted	BEBI	10.4	450	7.5	9.2	10.2
Bebi 7 cereals	BEBI	10.0	400	10.5	6.6	12.0
Bebi buckwheat	BEBI	10.0	450	5.0	6.0	6.8
Bebi cookies with raspberries and cherries	BEBI	11.5	410	9.3	7.0	13.7
Bebi Pears cookies	BEBI	11.7	435	9.7	7.0	13.7
buckwheat b/m	HIPP	3.1	-	-	-	-
oatmeal b/m	HIPP	7.6	-	-	-	-
rice b/m	HIPP	0.7	-	-	-	-
5 cereals with black plum	HIPP	11.4	400	6.5	5.5	17
Humana wheat b/m	HUMANA	1.5	-	-	-	-
Humana rice	HUMANA	1.0	-	-	-	-
Humana 5 grasses	HUMANA	2.0	-	-	-	-
Humana whole grain with banana	HUMANA	8.9	375	7.5	3.6	10.0
Humana buckwheat	HUMANA	9.0	375	7.5	3.6	10.0
Humana corn	HUMANA	8.9	375	7.5	3.6	10.0
"Malyshka" blend of rice, corn, oatmeal, buckwheat	"MALYSHKA"	8.80	559	8.65	6.45	31.45
"Malyshka" buckwheat – rice, corn, buckwheat	"MALYSHKA"	8.50	559	8.65	6.45	31.45

The obtained data on the quantitative content of fats and vitamins in infant formulas and instant cereals characterize the characteristics of each product. Depending on the age category and special needs, the content of the respective components in the milk mixes varies within: fat – 14,2–27,7 g / 100 g powder, vitamin A – 400–600 μg / 100 g (except for the mixture of Nutrilon Pronutra + premature care of vitamin A content 2134 μg / 100 g), vitamin D – 6.7–21.0 μg / 100 g, vitamin E 5.4–21.0 mg / 100 g, vitamin K 20.0–50.0 μg / 100 g. Accordingly, in children's instant cereals, the following tendency is observed: fats – 1.0–67.0 g / 100 g of powder, vitamin A – 290–559 μg / 100 g, vitamin D – 5.0–12.0 μg / 100 g, vitamin E 2.5–9.2 mg / 100 g, vitamin K 6.8–50.0 μg / 100 g.

It should be noted that some producers do not indicate the content of vitamins in certain varieties of their production of instant cereals relative to the whole range of vitamins that we have reviewed in product samples (Milupa rice, Nestle corn, Nestle rice, HIPP buckwheat, HIPP oat, HIPP rice, Humana wheat bromine, Humana rice, Humana 5 instant cereals) and in other samples (Nutrilon buckwheat, Nutrilon multi cereal, Nutrilon 4 cereal with rice balls, Milupa rice, Milupa rice with banana, Milupa rice with raspberry, Milupa rice with apricot, Milupa fruit manna, Milupa oatmeal, Milupa multislake with baby biscuits m, Milupa multislak with a mixture of fruits, Milupa with pear and crackers, Milupa multislak with fruits, flakes and balls) for a specific vitamin K.

Conclusions

The assortment of baby food mixes and instant cereals presented in the market of Ukraine provides the needs of different age groups of children in high-quality balanced nutrition according to individual needs, differing in the degree of adaptation to breast milk, has regulatory or therapeutic effects on the body. The basis of the fat component of children's mixes of firms HUMANA, NESTLE, HIPP, FRISO, NUTRILON, MILUPA are vegetable oils: palm, coconut, sunflower and rape. The products of domestic producers MALYSHKA, MALYUTKA differ in content of products of fats of animal origin.

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Chapter 7. BLOOD GROUP AS A MARKER OF CARDIOVASCULAR DISEASES TRANSPARENCY

V. FIL, R. KUZ
Drohobych Ivan Franko State Pedagogical University,
24, I. Franko Str.,82100 Drohobych, Ukraine
e-mail: fillvitalij@gmail.com

Abstract. *The research presents the results of the study for the relationship between the blood group and the risk of cardiovascular disease. 453 people in the city of Drohobych and the district, which the age range of was 26–78 years old, were surveyed. 206 subjects had the blood group O, which was 45.6%; blood group A was noted in 123 persons, which was 27.1%, B – in 82 persons (18.1%) and the phenotype AB – in 9.2% of the examined (42 persons). Of the total subjects accounting for 51% who were identified with cardiovascular disease were selected. It was found that the most common diseases were coronary heart disease, arterial hypertension, myocardial infarction, angina pectoris and atherosclerosis. The listed diseases were detected in 199 surveyed persons. Other persons had less common pathologies of the cardiovascular system, such as stroke, anemia, diabetic angiopathy, arrhythmia and thrombophlebitis. It was established that the blood group AB, which is the rarest group, carries the greatest risk of heart disease and blood group O carries the least risk.*

Keywords: *Blood groups; Cardiovascular system; Cardiovascular diseases; Ischemic heart disease; Arterial hypertension; Myocardial infarction; Angina pectoris.*

Introduction

A number of chronic non-infectious diseases have a decisive influence for the formation of the population health in Ukraine, as in most European countries: circulatory system diseases, malignant neoplasms, diabetes mellitus, obstructive pulmonary diseases, socially dangerous conditions, etc. Special attention is paid to diseases of the circulatory system, of which more than 4 million people die every year in Europe, and about 500 000 in Ukraine, and is the leading cause of morbidity, disability and death [12].

Ukraine possesses one of the first places in Europe by indicators of mortality from circulatory system diseases (459.48 per 100 000 persons), which substantially exceeds similar indices in France (30.08 per 100 000 persons), Germany (75.09 per 100 000 persons.), Poland (88.37 per 100 000 persons), Great Britain (76.11 per 100 000 persons) [2]. In Europe, cardiovascular diseases accounts for about 40% of all deaths in people under the age of 75, of which over 60% are sudden death [7].

The search and analysis of the associations of various genetic markers with diseases is relevant and promising, since this makes it possible to judge the influence of risk factors in the development of a particular disease [6; 10]. In turn, the frequency of such associations indicates the importance of this feature in the development of the pathological process. At the same time, such researches can be found among the population of a group of people with phenotypes of increased risk for particular diseases, which will enable the development of a system of professional selection and the definition of preventive measures [1; 5].

In 1901, Carl Landsteiner identified ABO blood groups as a recognized beginning of the human blood system. The clinical significance of ABO blood groups extends beyond the limits of medical and organ transfusion (hematopoietic transplantation). Today, numerous studies point to important relationships between ABO blood groups and various diseases such as stomach cancer [20], periodontal disease [19], and cardiometabolic diseases [26; 27].

Despite the relative simplicity of antigens A and B, especially considering the modest biochemical difference between them, the ABO blood group is one of the most interesting, both clinically and scientifically.

The role of genetic predisposition to the occurrence of a person with various diseases is not denied by various authors and is substantiated by numerous studies on this topic. Blood-group specificity, among other factors, can also be a risk factor for the development of human diseases associated with acute ischemia of tissues such as myocardial infarction and ischemic stroke [6; 11; 4; 15], respiratory diseases pathology [13], etc.

The study of the relationship between cardiovascular disease (CVD) and ABO blood groups has a long history. In 1955, Woolf proposed a chances ratio as a measure for quantifying the risk of a disease provided by a blood group [30]. In 1969, Jick et al. reported a small number of patients with the blood group O among those who received anticoagulants in venous thromboembolism [23]. Prior to the detection of mutations in the analysis of hemophilia carriers, the coefficients of the likelihood of the hemophilia A carrier were based on the factor VIII level of the conditioned blood group [22]. A number of further studies showed that ABO blood groups, in addition to the blood group O, are associated with major cardiovascular risk factors and high CVS [24; 25; 28]. However, there is limited consensus on the magnitude and importance of the effects of AVO at the population level, and whether it relates to all diseases evenly or predominantly modulates thrombotic pathways and disorders [31].

In the scientific literature, there is evidence that the distribution of the population in blood groups is related to the territorial ecological risks and along with them is the cause of the various pathologies development, including the CVS [14].

Frequency of general ABO phenotypes varies among different populations. Population with a high frequency of phenotype A occurs mainly in the north and in central Europe. Phenotype B most often occurs in Central Asia. Blood type O is one of the most common phenotypes around the world, showing the highest frequencies in most countries in Africa and Australia [29].

Therefore, the generalization of the basic concepts of biochemistry for ABO blood groups, recent findings on their relationship between the CVS and based on previously published data, which established the connection between the group's belongings of the human blood and its predisposition to various diseases, this study was conducted. It is relevant for future studies for communication between ABO blood group groups and the risk of various pathologies from the cardiovascular system.

The purpose of research is to identify the relationship between ABO blood group and the risk of cardiovascular disease.

Relationship of work with scientific programs, themes

The work is performed in accordance with the plan of research work at the Department of Anatomy, Physiology and Valéology of the Drohobych Ivan Franko State Pedagogical University.

Material and methods

The study was carried out in the clinic and diagnostic laboratory of the Drohobych city hospital No. 1. The compilation of material on the incidence was carried out by analysis of medical cards. 453 cards from the selective samples of residents from Drohobych city and district aged from 28 to 76 years wasanalyzed. The presence of a particular disease was judged by a final diagnosis, which was exhibited by a doctor only after all objective and subjective symptoms were analyzed, all necessary examinations were carried out.

All the subjects were assigned blood groups in ABO systems for colocolline antibodies. Only two common phenotypes – Rh^+ and Rh^- were detected on the Rh system.

The links between genetic markers (blood group in the ABO system) and the presence of a pathology in cardiovascular system were detected and evaluated using statistical methods. The concomitant diseases were also included in the analysis.

The statistical analysis was carried out in the "Microsoft Excel 2007" software package.

Results and discussion

As a result of the study, it was found that there are four main phenotypes of the ABO blood group of the system in the examined individuals.

206 subjects had the blood group O, which was 45.6%; blood group A was noted in 123 persons, which was 27.1%, B – in 82 persons (18.1%) and the phenotype AB – in 9.2% of the examined (42 persons) *(Fig. 1)*.

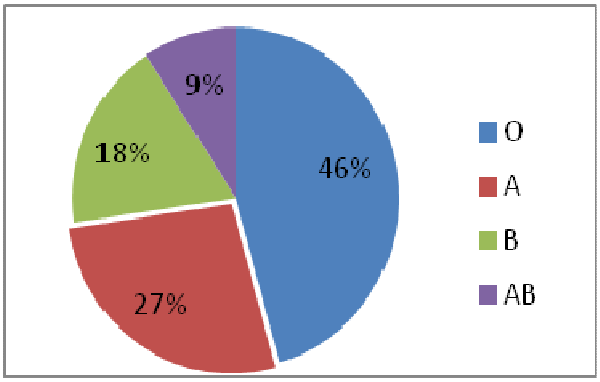

Fig. 1. Distribution of blood groups in the ABO system among the surveyed population in the city of Drohobych and the district

Phenotype Rh^+ was detected in 376 subjects (83.1%), and the phenotype of Rh^- was in 77 (16.9%).

The obtained results in the general groups of phenotypes do not differ significantly from the general data of other researchers for the inhabitants of Ukraine [9; 14].

Of the total subjects (453 persons who were identified with cardiovascular disease) were selected, accounting for 51% (230 persons). Analyzing the findings of 230 patients with CVD, it was found that the majority of patients had the blood group O (40.9%), 66 persons (28.7%) were identified with blood group A, blood group B was detected in 20% of the subjects, and the 24 subjects had blood group AB (10.4%) *(Fig. 2)*.

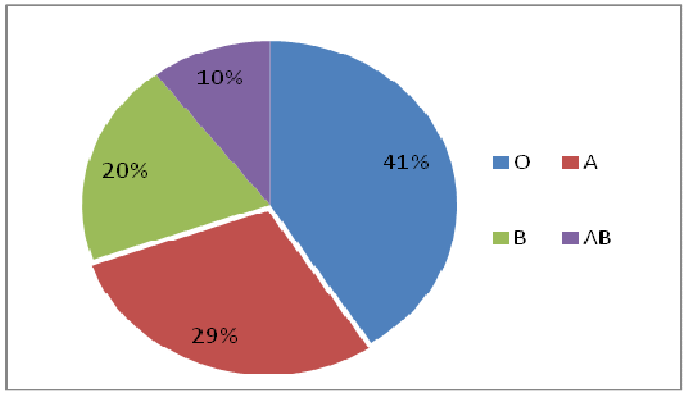

Fig. 2. Distribution by blood groups in persons with cardiovascular diseases

The most common diseases in the subjects were coronary heart disease, arterial hypertension, myocardial infarction, angina pectoris and atherosclerosis *(Table 1)*. The listed diseases were detected in 199 surveyed individuals, which was 86.6%. Other persons had less common pathologies of the cardiovascular system, such as stroke, anemia, diabetic angiopathy, arrhythmia and thrombophlebitis (13.4%).

Analyzing the findings of 230 patients with CVD, it was found that the majority of patients had the blood group O (40.9%), 66 (28.7%) were detected with the blood group A, blood group B was detected in 20% of the examined individuals and in the 24 patients had the blood group AB (10.4%). This distribution is consistent with literary data regarding the blood groups O and A.

Table 1

Distribution of persons with cardiovascular diseases depending on the blood group

Disease	blood groups				Total number of patients
	O	*A*	*B*	*AB*	
CHD	32	28	5	6	71
Myocardial infarction	10	10	14	2	36
Arterial hypertension	26	12	12	4	54
Atherosclerosis	8	4	2	4	18
Angina pectoris	8	6	6	–	20
Stroke	6	1	2	–	9
Diabetic angiopathy	6	2	–	–	8
Anemia	–	2	–	4	6
Arrhythmia	–	2	2	–	4
Thrombophlebitis	–	2	–	2	4

However, analyzing the entire population (453 persons), it was found that the greatest risk of contracting cardiovascular disease was among the persons of the blood group AB, and the smallest among the representatives of the blood group O *(Fig. 3)*.

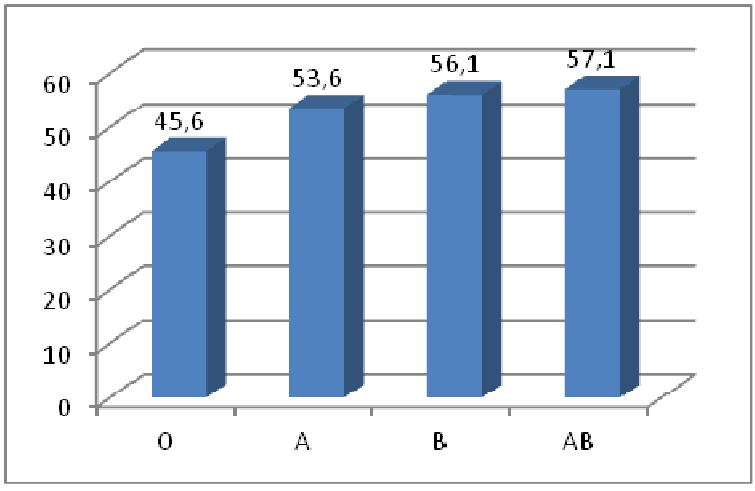

Fig. 3. Distribution of persons with cardiovascular diseases by blood group among the whole population

The rarest type of blood type AB (blood group 4) carries the greatest risk of developing heart disease, and the blood group O (blood group 1) has the smallest risk. Persons with the blood group A, B, AB are at greater risk of CVS compared to those in the blood group AB [21].

Persons with a blood group A have an increased risk of excessive lipoprotein formation – soft cholesterol, which is a predictor of the risk in developing cardiovascular and microvascular diseases due to clogging of arteries. The blood group AB is often associated with the development of inflammatory processes that may interfere with the functioning of the blood vessels. At the same time, a substance that plays an important role in the organization of blood circulation and blood coagulation may be higher comparing the persons with the blood group O [17].

It should be noted that according to the research Meshalkin E. N. [11], the risk of developing CHD was higher in persons with the blood group A. Given the similar risk factors and pathogenetic aspects of the development of ischemic stroke and myocardial infarction, it is impossible to exclude some distribution of the pattern of blood groups distribution in the population in the elderly age group. The most significant causes of this difference are prophylactic anticoagulant therapy, designed for persons with CHD, and mortality from myocardial infarction.

Based on previously published works, it can be assumed that the basis for the influence of blood-group specificity on the risk of developing ischemic stroke is the differences in the functioning of the blood coagulation system.

Inadvertent blood coagulation in the human body prevents, among other factors, the negative electrical charge of the formed blood elements arising from the molecules of neuraminic acid adsorbed on the cells surface. The presence of erythrocytes in the membrane of other molecules is influenced by the value of the electric charge of the membrane, and, therefore, may also affect the tendency of red blood cells to aggregate [8]. The identified differences between erythrocytes belonging to different blood groups of the ABO system could be obtained by comparing their resistance to aggregation induced by lanthanum chloride. Thus, the highest resistance have erythrocytes of AB (IV) and B (III) blood groups [3].

Considering the possible influence of the electric charge on red blood cells on their aggregation resistance, it is necessary to consider that vascular pathology occurs, in the vast majority of cases, in a changed condition due to atherosclerosis of the vascular wall and local blood flow disturbances. An unstable atherosclerotic plaque results in the destruction of the vascular wall intima and changes its properties.

Possibly there is an inversion of the positive effect of the electric charge in the formed blood elements on their aggregation stability, under such conditions. Adsorption of erythrocytes due to electrostatic attraction to the damaged intima segment at the vascular wall, along with platelet adhesion, can cause the development of stasis, thrombosis and tissue ischemia. In this case, with a higher charge of the erythrocyte membrane due to the group specificity, it may be an additional risk factor in the development of such diseases. Taking into account the prevalence of vascular damage (ischemia, atherosclerosis), high mortality and persistent disability, further study of genetic factors and risk factors has great medical significance for the development of effective programs and methods for the prevention and treatment of these diseases [8].

The increased risk associated with blood groups A, B and AB can be explained by a higher level or functional modification in specific endothelial glycoproteins, specific platelet glycoproteins, or both. The explanation may also be glycoproteins from extra cells and leukocyte tissues, despite the fact that they are probably not the main sources, since they do not have enough ABO enzymes [16].

One of the major results of our study was to find a strong correlation between the ABO status and cardiovascular risk: persons with a blood type other than O had significantly higher rates of cardiovascular side effects comparing those with O-type blood. Thus, our data are consistent with previous studies on the importance of the AO blood type in the CVD pathogenesis [18].

The studies were conducted in different populations, while the studied samples were not gender-based. Organic pathologies, like any other phenotypic features of the body, are the result of the interaction between the genotype and the environment.

Thus, data on the labeled effects of certain genes in the blood group are local in nature and require in-depth study in relation to different intra-population groups within each territory. The bases of such locally attached data will certainly be very useful for predictions of cardiovascular morbidity.

Conclusions

1. The most common diseases in the examined individuals were ischemic heart disease, arterial hypertension, myocardial infarction, angina pectoris and atherosclerosis. The listed diseases were detected in 199 surveyed individuals, which was 86.6%. Other persons had less common pathologies of the cardiovascular system, such as stroke, anemia, diabetic angiopathy, arrhythmia and thrombophlebitis (13.4%).
2. The rarest blood type AB (blood group 4) carries the greatest risk of developing heart disease, and a blood type O (blood group 1) – the smallest. Persons with the blood groups A, B, and AB are at greater risk of receiving CVD compared to those in the blood group O.
3. Consequently, our study, conducted to reveal the relationship between the development of CVD and the blood, showed its informativeness. The definition of blood groups will allow the introduction of preventive measures to change the risk factors. Knowing own risk level, it can be lowered by a healthy lifestyle and following particular rules.

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Chapter 8. TOXIC AND HARMFUL PLANTS OF WESTERN POLISSYA FOR NATURAL PASTURES – ORGANIC-ECOLOGICAL THREATS TO ORGANIC STOCKBREADING

S. FARAFONOV[1], V. STAKHIV[2], R.-I. KRAVTSIV[2]
[1]Volyn State Agricultural Experimental Station of the National Academy of Agrarian Sciences of Ukraine, 2, Shkilna Str., 45625 Rokiny, Ukraine
e-mail: voldsgds@gmail.com
[2]Drohobych Ivan Franko State Pedagogical University, 24, I. Franko Str., 82100 Drohobych, Ukraine
e-mail: vasylstakhiv@ukr.net

Abstract. *The basic advantages of pasture as one of the components of organic stockbreading have been reveled. The types of natural pasture lands of the Western Polissya of Ukraine and their yields are described. The main types of harmful and poisonous plants for agricultural animals are presented. It also described the most prevalent poisoning of various types of pasture plants, signs of poisoning, first aid measures and prevention. The consequences of the consumption by ruminants of some harmful plants and the results of their influence on the quality of milk and meat are revealed. Describes the toxic effect of cultivated plants when they are eaten at different stages of vegetation. The component composition of grasslands investigated pasture was established. The results of researches of natural pastures of different farms of Western Polissya for the presence of poisonous plants and their species are presented. Description of toxic organs of plants, organs and systems of the animals that are struck is given. Recommendations on measures to control poisonous plants of pastures have been developed and substantiated.*

Keywords: *Pastures, yields of pastures; Cultivated plants; Harmful plants; Poisonous plants; Poisonous parts of the plant; Toxins; Toxin formation; Poisoning; Therapy; Prevention; Measures of struggle.*

Introduction

Ukraine has a great potential for the production of organic products, is able to provide a full range of organic food for the domestic market and make a significant contribution to the export of agricultural products. On July 10, 2018, President of Ukraine Poroshenko P. O. signed the Law of Ukraine No. 2496-VIII "On Basic Principles and Requirements for Organic Production, Circulation and Marking of Organic Products" [10]. A significant part of this legislative act is devoted to the requirements for the production of organic livestock goods. An integral part of the livestock sector is dairy and meat cattle breeding. In particular, very high requirements relate to feed and conditions for feeding and keeping bovine animals. One of the requirements is to keep animals in pasture. Western Polissya is considered as a special territory among other regions of Ukraine. In conditions of market relations, it can compete properly in the field of animal husbandry, namely, dairy and meat cattle breeding. The pasturelands of the Western Polissya region correspond most closely to the requirements of organic production of cattle breeding, it has all the prerequisites of compliance for the production of organic fodder. In particular, the maintenance on the pasture provides for compliance with the requirements of paragraph 2 of Article 19 of the above-mentioned Law [3; 14]. Holdings on the pasture are also a powerful factor in the prevention of many diseases of bovine animals, which corresponds to paragraph 5 Article 19 of the Law "On Basic Principles and Requirements for Organic Production, Turning and Marking of Organic Products". Pasture-keeping of animals has a lot of priority in

front of steady maintenance. It reduces the cost of livestock production and restores animals to health. Good pastures are the source of cheap and most valuable green fodder for animals in the western part of Polissya [2; 4; 5].

Free movement of animals in the fresh air and solar radiation favorably affect all functions of the body, vital tone, metabolism; promote the growth of young animals and good development of their bones, muscles, tendons, ligaments, lungs, heart and other organs. It is precisely in the grazing land that the animals receive easily digestible green fodder, which is rich in protein, mineral salts, trace elements and vitamins. As a result, the animals on the pasture significantly increase the productivity, become stronger and more resistant to various diseases. Pasture content is a major prophylactic measure against tuberculosis, rickets, osteodystrophy, avitaminosis, diseases of the gastrointestinal tract, etc. In males, sexual activity is stimulated, sperm is enhanced and quality of semen improves. In females, fertility and fecundity are increased, easier childbirth is more common, postpartum diseases occur more rarely, more stable and viable fetuses are born [2; 4; 5]. However, the feeding value of grasslands (meadows) and pasture sometimes significantly reduced the growth of poisonous and harmful plants. At present, in grasslands and pastures, abundantly grow harmful and poisonous plants, which often cause poisoning and death of animals, and thus cause considerable damage to livestock and, more often, to sheep breeding. Usually, information about animal poisoning with poisonous plants does not always contain reliable data: in many cases, poisoning cases remain unaccounted for or recorded as other diseases. One of the main causes of poisoning and death of farm animals from plant poison is the lack of knowledge or inability of livestock workers to detect these poisonous plants in a timely manner and to conduct a targeted fight against them. To do this, it is necessary that livestock farmers know the biological characteristics of poisonous and harmful plants, effectively and systematically fighting with them [6; 13]. Among the grassland of the natural forage land of the Polissya zone, as well as on the marginal lands, a large number of harmful and poisonous plants grow. Optimal conditions are created for their growth and development in the medium and highly degraded forage lands. Usually, in the middle- or significantly-grazed areas of pasture grass valuable forage plants throughout the grazing period are in a depressed state and harmful and poisonous herbs, developing rapidly and powerfully, not only suppress them, but also crowded out with herbs, thus occupying a freed place. A significant number of them are found near livestock farms, settlements, and water sources. In addition, certain types of poisonous grasses grows and develops in reduced places, in run-down homesteads, as well as in unsuitable lands that have now become nursery weeds, harmful and poisonous plants. Those plants, which animals eat, even in insignificant quantities, can cause a morbid condition, poisoning, or lead them to death, are poisonous. In principle, the group of "conditionally poisonous" includes valuable forage plants from field fodder production: millet *(Panicum miliaceum L)*, sorghum *(Sorghum bicolor)*, sudanese grass *(Sorghum bicolor subsp. drummondii)*, beet *(Beta)*, buckwheat *(Fagopyrum esculentum)*, corn *(Zea mays)* and many others, because under certain conditions they are able to accumulate poisonous substances. There are known cases of poisoning of agricultural animals with plant poisons not only in pastures and hayfields, but also in their steady maintenance and feeding them with hay, silos, haylage from poisonous herbs [2; 6; 9; 12; 16–19].

In many ways, toxin formation and toxin accumulation in herbaceous plants depend on external conditions. It was established that in conditions of drought and elevated temperatures, the amount of poisonous substances in pasture plants and hayfields accumulates more, while in cool and gloomy weather – they accumulate less. In different periods of growth and development of plants, the formation and accumulation of herbaceous toxins is not the same, so young European white helebore *(Veratrum album L)* are the most poisonous, while field poppy *(Papaver rhoeas)* in the immature fruit accumulates the greatest amount of poison. The great burdock *(Arctium lappa L)* is highly poisonous cotyledons and the first true leaf and fruit.

The most commonly found in celery-leaved *(Ranunculus sceleratus)*, which is poisonous only in green and absolutely safe after drying. The degree of poisoning in individual plants varies and depending on the season of the year, so jimson-weed *(Datura stramonium L)* is especially poisonous at a young age, and with the age of accumulation of toxic substances decreases. Some poisonous plants, when sowed or mowed, lose their poisoning and become almost safe, but in some cases, their poison is leaking silage green mass. So, in the process of silage, if the hellebore falls into the silo green mass, then in the process of preservation the poisonous substances contained in it impregnate this mass [2; 11].

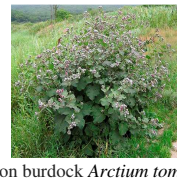
Adult animals, as a rule, do not eat poisonous and harmful plants, so often in some areas poisonous herbs remain intact. Poisoning on the graft is more common in young animals and animals brought to these forages, as it is harder for them to recognize what can be eaten and what cannot. In general, poisonous grasses have a repulsive, burning unpleasant smell (European white helebore *(Veratrum album L)*, lilac sage *(Salvia verticillata)*, etc.), on which animals react. A special danger lurks animals at stall keeping, when they are fed with crushed green mass, which contains impurities of poisonous herbs, as animals without the breakdown eat fodder with poisonous plants. Special danger is the transfer of animals from high-yielding pasture land to low-yielding. They are forced to eat forage grasses together with harmful and poisonous plants [2; 11].

Analysis of long-term data shows that the risk of poisoning in the spring is very high for sheep with litter, since they are forced to eat grass from degraded areas near sheep farms, where harmful and poisonous plants grow in abundance. Practice shows that the degree of poisoning in animals is manifested depending on the species, gender, even the physiological state. So, some species of animals can safely eat poisonous plants, whereas for another species they can be fatal. For example, if spurge *(Euphórbia)* represents a great danger for sheep when they are green (usually they die), the goats eat it without visible signs of poisoning. First of all, the degree of poisoning with harmful herbs depends on the state of the animals. Typically, the most vulnerable are exhausted, sick and hungry animals and young adults. Since this group eats all the plants that happen to them when grazing on degraded grazing areas and pastures, without the ability to distinguish harmful and poisonous grass [2; 11].

In *Fig. 1.* harmful plants of Western Polissya are presented, which most often cause mechanical damage to animals.

A. Curied thistle *Cardui mariae fructus*

B. Creeping Thistle *Cirsium arvense*



C. Cotton burdock *Arctium tomentosum*

D. Yellow foxtail *Setaria pumila*

E. Green foxtail *Setaria viridis*

F. Wall barley *Hordeum leporinum*

Fig. 1. Hazardous plants of Western Polissya pasture causing mechanical damage to animals

These harmful plants do not contain toxic substances, but they are dangerous for animals with sharp edges, fluffy inflorescences, and jagged aphids. This group includes plants which consumption can change the quality of the products obtained (the color and smell of milk and meat, the integrity of the skin, the quality of wool, etc.) [2].

For plants, pastures Western Polissya, causing mechanical damage in animals include:

- *Curied thistle (Cardui mariae fructus), Creeping Thistle (Cirsium arvense) – Fig. 1A, B.* When eating rough leaves in the hay, thorns damage the mucous membrane of the oral cavity. For preventive maintenance it is necessary to conduct the correct cultivation of the soil, on the hayfields – frequent mowing, as well as early grazing [2; 11].
- *Cotton burdock (Arctium tomentosum) (Fig. 1C.)* In the second year after the maturation of the corneas, the dried baskets of the crocheted hooks wound their eyes. In order to prevent the lesions, it should be systematically suspended before flowering [2; 11].
- *Yellow foxtail* (*Setaria pumila), Green foxtail (Setaria viridis) (Fig. 1D, E).* They damage the mucous membrane of the oral cavity. Measures to prevent such injuries are cutting green mass of hay before they grow spicks [2; 11].
- *Wild barley (Hordeum leporinum) (Fig. 1F).* Dry aspen patches fall in the eyes, damage the gums and tongue. As a way of preventing injury, regular mowing of the plots should be used prior to the formation of the seeds, if possible, their plowing and ingestion [2; 11].

A. *Yellow sweet clover Melilótus officinalis* (L.) Pall.

B. *White sweet clover Melilótus álbus*

C. *Alfalfa Medicago sativa*

D. *Bird's-foot trefoil Lotus corniculatus*

E. *Sorghum Sorghum bicolor*

F. *Sudangrass Sorghum bicolor* subsp. *drummondii*

Fig. 2. Some crops, in certain periods of development that may be harmful to cattle

Certain plant species, especially in the later phases of vegetation, can cause in animals while eating damage to the mucous membranes of the mouth and gastrointestinal tract. These plants include: thistles (*Cirsium*), knapweed *(Centaurea diffusa Lam)*, feather-grass *(Stipa capillata)*, wild oat *(Avena fatua L)*, rock-lily *(Pulsatilla patens (L.) Mill.),* Curied thistle *(Cardui mariae)*, foxtail grass *(Setaria)*, puncture vine *(Tribulus terrestris)*.

In animals that eat some types of plants, there are cases of a peculiar disease – phagopyrimism. This disease is characterized by inflammatory processes in the unpigmented areas of the skin and in the subcutaneous layer under the action of ultraviolet rays. Phagopyriism is observed after eating buckwheat *(Fagopyrum esculentum),* millet *(Panicum miliaceum L),* cow parsnip *(Heracleum sosnowskyi Manden),* sheep bur *(Xanthium strumarium),* Pigweed *(Chenopodium album),* rough pigweed *(Amaranthus retroflexus),* common St John's-wort *(Hypericum perforatum L.),* puncture vine *(Tribulus terrestris)* [2; 11].

Plants which consumption affects product quality

The plants that cause damage to milk from cows include: water germander *(Téucrium scórdium)* – adds bitter taste to the milk and garlic odor; field pepperweed *(Lepidium campestre)* – adds a bad smell to milk; lady's clover *(Oxalis acetosella L.)* or common wood sorrel – promotes rapid coagulation of milk and butter churning poor; feeding cows with onion *(Allium schoenoprasum L.)* andor garlic *(Allium sativum)* give the milk and butter a red-yellow color and garlic or onion smell; hastate orach *(Melampyrum nemorosum)* – when eating cows on pasture, milk gets bluish color and unpleasant taste; wild madder *(Galium mollugo)* – adds milk of red color; mugwort *(Artemisia vulgaris)* and other types of mugwort *(Artemisia)* – give the milk a bitter flavor and mugwort smell; chamomile *(Chamomilla recutita)* – when eating its cows on the pasture, the milk gets an unpleasant odor, in the hay – the smell is lost; cuckoo-flower *(Cardamine amara)* – spoil the taste of milk, cheese and butter get poor quality; Jimhill-weed *(Thalassa arvense)* – adds garlic smell to milk [8; 15].

In addition to these plants, the bitter taste of milk is caused by: buttercup *(Ranunculus)*, lupine *(Lupinus)*, burdock *(Arctium)*, nibleweed *(Anemone)*, sweet clover *(Melilótus)*, ginger plant *(Tanacetum vulgare L.)*, parsnip *(Pastináca sátiva L.)*, chicory *(Cichorium intybus)*, European white helebore *(Veratrum album L)*, English ivy *(Hedera helix L)*, Alpine rose *(Rhododendron luteum)*, yarrow *(Achillea millefolium)*, fall dendilion *(Leontodon autumnalis)*, charlock *(Sinapis arvensis)*, kale *(Brássica olerácea)*, beet *(Beta)*, alder *(Alnus)*, aspen *(Populus tremula L)*, English oak *(Quercus robur L.)* [8; 15]. Meat from animals gets an unpleasant taste and smell by eating plants such as heliotrope *(Heliotropium dasyocarpum Ldb.)*, field pepperwort *(Lepidium campestre)*, bee nettle *(Galeopsis speciosa)*, false flax *(Camelina glabrata)* [1]. Some types of plants clog the wool of sheep and goats. These plants include: bell thistle *(Cirsium lanceolatum)*, knapweed *(Centaurea diffusa Lam)*, great burdock *(Arctium lappa L.)* and thorny burr *(Arctium nemorosum)*, awnless brome *(Bromus inermis)*, burseed *(Lappula squarrosa (Retz.)* Dumort.), cotton burdock *(Arctium tomentosum)*, alfalfa *(Medicago minima)*, catchweed *(Asperugo procumbens)*, feather-grass *(Stipa capillata)*, pitch-forks *(Bidens tripartita)*, dog-bur *(Cynoglossum officinale)*, foxtail grass *(Setaria verticillata)* [1].

Some plants – yellow sweet clover *(Melilótus officinalis (L.) Pall.)* And white sweet clover *(Melilótus álbus)*, which are shown in *Figure 2A, B,* during flowering contain large amounts of coumarin, which in molding equipment becomes more toxic dicumarin. For preventive purposes, it is necessary to prevent the feeding of green mass during flowering, as well as mold hay and silage. Green mass of alfalfa seedlings *(Medicago sativa) (Fig. 1C)*, especially after rain or dew, causes swelling of the scar. West warning is to prevent the grazing of animals after rain and dew, not grazing hungry animals.

Bird's-foot trefoil *(Lotus corniculatus) (Fig. 1D)* is toxic during flowering. To prevent poisoning, grafting is not allowed until flowering, as well as hay or silage use. *Sorghum (Sorghum bicolor) (Fig. 1E)* is toxic in the planting phase, entering the tube and emitting inflorescences, especially on soils rich in nitrogenous compounds, as well as in dry soils, after rain in heat or cold, in drought, after frost. In order to prevent intoxication it is recommended not to feed in the planting phase, to the tube and to emit inflorescences, especially on soils rich in nitrogenous compounds, as well as on dry soil, after rain in heat or cold, in drought, after frost. Terrestrial parts of Sudanese grass *(Sorghum bicolor subsp. Drummondii) (Fig. 1E)* contain nitroglycosides, which are converted into hydrocyanic acid. To prevent poisoning farmers should limit grazing after flowering, hay fed no earlier than 2 months after harvesting. To date, it has not yet been established which compounds are responsible for external fla vors and smells in milk.

Most scholars and practitioners believe that feed flavors of milk due mainly dimethyl sulfide, ketones (acetone, butanone and alcohol (isopropanol, ethanol, propanol). Moreover, in milk with fodder flavors dainties can detect esters and aldehydes [8].

Poisonous plants in grassland of Polissia

Poisonous plants include those which are eaten will causes in animals serious poisoning of the body, and in some cases leads to death. The toxicity of plants is due to the content of special chemical compounds: alkaloids, glycosides, saponins, organic acids (oxalic, zinc), lactones, toxalbumin, phytotoxins (ricin, robin), essential oils (terpenes, camphor), dyes (gossipol, hypericin), resinous substances [11].

Poisonous plants are classified according to the clinical picture that occurs in the animal's body as a result of poisoning. Plants that cause excitation of the central nervous system in animals include: snakeroot *(Cicuta virosa L),* roundleaf henbane *(Hyoscyamus niger),* roundleaf belen *(Hyoscyamus albus L.),* belladonna *(Atropa belladonna),* jimson-weed *(Datura stramonium L.),* ephedra *(Ephedra distachya L.), Apiales and others* [5].

To plants that suppress and paralyze the central nervous system, include: field poppy *(Papaver rhoeas),* opium poppy *(Papaver somniferum),* killwort *(Chelidonium majus L),* bee nettle *(Galeopsis speciosa),* darnel *(Lolium temulentum),* poison hemlock *(Conium maculatum),* bulbous-rooted chervill *(Chaerophyllum temulum),* globe thirstel *(Echinops ritro),* comfrey *(Symphytum officinale),* pine grass *(Equisetum arvense L.)* cat-whistles *(Equisetum palustre)* [4; 7; 11].

Plants that cause depression and paralysis of the central nervous system and at the same time affect the gastrointestinal tract include: colchicum *(Colchicum autumnale L)* meadow saffron *(Colchicum serpentinum),* bitterworm *(Menyanthes trifoliata L.),* priest's-pintle *(Aconitum napellus),* barnyard-grass *(Echinochloa crus-galli l.),* comfrey and kniback *(Symphytum Delphinium elatum L.),* birthwort *(Aristolochia clematitis),* fern *(Aspidium filitmas),* brake *(Pteridium aquilinum (L.)),* cicely *(Aethusa cynapium L.),* broom *(Cytisus scoparius),* alpine rose *(Rhododendron luteum), box tree (Buxus sempervirens L.),* fals lupin *(Thermopsis rhombifolia),* arrow grass *(Triglochin maritima),* european white helebore *(Veratrum album L)* [4; 7; 11].

Plants that cause damage to the respiratory and gastrointestinal tract of animals: charlock *(Sinapis arvensis),* bankweed *(Sisymbrium officinale),* tarrify *(Erýsimum cheiranthoídes),* marsh cress *(Rorippa sylvestris),* goat's rue *(Galega officinalis),* white charlock *(Raphanus raphanistrum)* [4; 7; 11].

Plants causing damage to the gastrointestinal tract of animals**:** duramen *(Gratiola officinalis L.),* moorwort *(Andromeda polifolia L.),* cuckoopint *(Arum maculatum),* wild calla *(Calla palustris),* common milkweed *(Asclepias syriaca L.),* syrianrue *(Peganum harmala),* vincetóxicum *(Vincetóxicum acutum L.) i* milk vine *(Vincetóxicum hirundinária),* purple pedicularis *(Pedicularis palustris),* turnip cabage *(Brassica napus L.),* houseleek *(Sempervivum ruthenicum),* sengreen *(Sempervivum marmoreum),* deadly nightshade *(Solanum nigrum),* hepatica *(Hepatica nobilis),* moor grass *(Drosera rotundifolia),* blue devils *(Echium vulgare L),* water plantain *(Alisma plantago-aquatica)* [4; 7; 11].

Plants that cause heart disease in animals include*:* louseberry *(Euonymus europaeus),* four-leaved grass *(Paris quadrifolia L.),* adonis *(Adonis vernalis),* sealwort *(Polygonatum odoratum (Mill.) Druce),* lily of the valley *(Convallaria majalis),* helleborus *(Helleborus purpurascens),* christmas rose *(Helleborus niger),* foxglove *(Digitalis grandiflora Mill),* silk vine *(Periploca graeca) and others.* Plant that causes liver damage in animals is *old-man's-beard (Senecio vulgaris L)* [4; 7; 11].

Plants that simultaneously excite the central nervous system and affect the heart, kidneys and digestive tract in animals are: nibleweed *(Anemone sylvestris),* snowdrop *(Anemone*

nemorosa) and windflower (Anemone pratensis), kingcup *(Caltha palustris),* henbane *(Ranunculus polyanthemos L), celery-leaved (Ranunculus sceleratus)* tall buttercup *(Ranunculus acris),* mugwort *(Artemisia taurica),* sheep bur *(Agrimonia eupatoria)* and other. A plant, that is mainly poisonous for horses knapweed *(Centaurea diffusa Lam)* [4; 11].

Poisoning as a result of eating poisonous plants

Animal poisoning often occurs when eating poisonous herbs. Cases of the disease become more frequent with adverse changes in the species composition of plants due to improper grazing. Clinical manifestations of fodder poisoning depend on many factors and, above all, on the characteristics of poisons contained in poisonous plants.

When poisoning by plants that contain atropine, atropamin, skopalamin, ephedrine, tsykutotoksyn prevail symptoms of nervous system excitation – marsh tea *(Ledum palustre L.,* henbane *(Hyoscyamus),* poison hemlock *(Conium maculatum),* snakeroot *(Cicuta virosa), jimson-weed (Datura stramonium L), kingcup (Caltha palustris),* cicely *(Aethusa cynapium L),* buttercups *(Ranunculus),* field poppy *(Papaver rhoeas),* fine-leaved dropwort *(Oenanthe aquatica),* ginger plant *(Tanacetum vulgare L.),* broom *(Chamaecytisus ruthenicus).* The animals are noticed to have restlessness, uncontrollable movement forward, seizures. Sometimes there are signs of riot, throwing the neck and head back. Breathing is intense, heartbeat is accelerated. Develop hypotonia or atony of the premontans and intestines, often colic, timpany of the scar. However, it should be borne in mind that poisoning by these plants after excitement often comes in oppression and even paralysis of the nervous system. When poisoning with ginger plant *(Tanacetum vulgare L.),* mugwort *(Artemisia),* buttercups *(Ranunculus)* excitation of the nervous system is accompanied by symptoms of severe effects of the digestive, heart and kidney organs. Many poisonous plants cause a clinical picture of the suppression of the nervous system, the impression of the digestive system and hematopoiesis. These include European white helebore *(Veratrum album L.),* poison hemlock *(Conium maculatum)* and many others [4; 7; 11].

Poisoning with lupine (*Lupinus*) is observed in sheep, cattle, horses, and rarely in pigs. The poisonous substance of lupine is the alkaloids – lupine, lupinidine, lupanintine. Poisoning by lupins in animal occurs on pastures that are littered with alkaloid lupins, as well as when feeding the food that has been clogged with lupine. Alkaloids of lupine irritate the mucous membranes of the stomach, intestines and cause their inflammation. Along with this, they cause fatty degeneration of the liver, fatty myocardial degeneration, nephrozonephritis, skin lesions, paralysis of central origin, lowering blood pressure. During a pathologic-anatomical study, icterus of mucous membranes, serous coverings are found. Skeletal muscles of yellow-gray color. In the area of the lips, nose, and ears are the focal points of dermatitis and skin necrosis. In acute cases, poisoning of the liver is enlarged, yellow, easily broken. Kidneys are degenerated. The mucous membrane of the stomach, intestines, the bladder is inflamed, marked hemorrhages. Cardiac muscle is brittle, pale color, in endocardial – hemorrhage. There is a swelling of the larynx, the lungs, the membranes of the brain. Poisoning with lupine in cattle and young animals clinically runs the same way. Sheep are more sensitive. Symptoms appear suddenly, they are characterized by intermittent fever, loss of appetite, oppression, shortness of breath. Subsequently, severe jaundice occurs, diarrhea is observed with impurities of blood. By this time, the body temperature is lowered to subnormal. In animals there are muscular trembling, the desire to move forward, and disorders of the nervous system. Subsequently, slavery, weakness, heart failure, exhaustion develop. Such animals are lie more. They detect swelling of the ears, lips, nose, eyelids, and also centers of necrosis of the skin. Yellow urine contains protein, bile pigments, hyaline and granular cylinders, renal epithelium cells and bladder. In horses and pigs, the symptoms of poisoning are characterized by a lack of appetite, oppression, grinding of teeth, uncertain moves.

Then develop general weakness, jaundice, strangulation, paralysis. In pigs, the damage to the nervous system is more pronounced. Poisoning with lupine may be acute, subacute and chronic, and depends on the number and timing of poisoning in the body. Forecast cautious, in sheep – often unfavorable, especially in acute cases of poisoning. Diagnosis can be put on the symptoms, pathological and anatomical changes, taking into account the data of anamnesis and data on the botanical composition of feed. It is necessary to anticipate leptospirosis and other diseases that go through jaundice and liver damage. Exclude lupines from the diet. Chemical antidote is diluting acids (acetic, chloride, phosphorous, etc.) that convert alkaloids into insoluble states. Thus, large animals are given 1–2 l of a 0.5% aqueous solution of acetic acid. For the destruction of alkaloids, an intravenous 0,1–0,2% solution of potassium permanganate is given to large animals at 500–1000 ml, small ruminants and pigs at 50–100 ml. For feeding animals should be grown varieties of lupine without alkaloid [4; 5; 7].

Poisoning with buttercups *(Ranunculus).* The buttercups population includes a significant number of species, but only a few of them are poisonous: celery-leaved *(Ranunculus sceleratus)*, tall buttercups *(Ranunculus acris)*. The poisonous substance of the buttercups is lacto-protoanemonin, which is formed from glycoside ranunculin with its hydrolysis. This substance has a sharp smell and burning taste. Cattle are sensitive to buttercups, just like young animals and horses. Pigs are less sensitive. Animals are more often poisoned on pastures that are clogged with buttercups. The plant is poisonous only during the flowering period. When drying herbs on hay, the toxin from the plant disappears. Lactone-protoanemonin irritates and causes inflammation in the digestive tract, kidneys, narrowing blood vessels, impairs cardiac activity, disrupts the functions of the central nervous system. The poison is excreted with milk, so it can cause poisoning of newborn animals. During a pathologic-anatomical examination was detected the jaundice of serous coverages and mucous membranes. Mucous membranes of the stomach, gut is inflamed, swollen with hemorrhage. The liver is enlarged, yellowish, brittle. The gall bladder is stretched with dense bile with a brownish tinge. Kidneys are enlarged, hyperemic. Under the capsule and in the parenchyma there are hemorrhages. The bladder is full of thick, dark-colored urine. At the beginning of the disease, the animal does not eat, it sees salivation, thirst, urge to vomit, colic, difficult breathing, increased body temperature. Immediately developing symptoms of acute gastroenteritis (severe diarrhea with admixture of blood). Urination is frequent, painful (the thus animal groans). Detected protein and blood are in the urine. In the final stage, there are symptoms of central nervous system damage: muscle trembling, nystagmus (involuntary rapid movements of the eyeballs), stroke, and loss of perception. Poisoning mainly runs sharply. The forecast is cautious or unfavorable. With inhomogeneous and chronic flow, the forecast is more favorable. The diagnosis is based on the symptoms, pathologic-anatomical changes, anamnesis data and the study of pastures on the presence of buttercups. You should immediately change the diet. Rinse the stomach (scar) to quickly remove the poison. In the middle give vegetable oil, mucus decoctions, milk, 2–3% solution of sodium bicarbonate, 0,1% solution of potassium permanganate, intravenously 10% solution of giposulfite – 150–200 ml twice a day (large animals). It is important to avoid grazing animals in pastures littered with buttercups at the time of its flowering. It is expedient to collect the grass from such pasture in the hay [4; 7; 11].

Poisoning with deadly nightshade *(Solanum nigrum).* The active (poisonous) substance of the pastels is the toxic glycolaloid solanine. Large and small cattle, pigs, horses get ill most often. Alkaloid solanine contained in the stems and berries of deadly nightshade, the tops, greenish sprouts and potato vines *(Solanum tuberosum)*, which persisted for a long time. Solanin is an irritant and hemolytic poison that causes inflammation of the mucosa of the membranes of the stomach and intestines, leads to hemolysis of red blood cells, disrupts renal function, suppresses the central nervous system.

During the pathologic-anatomical study, there are many hemorrhages in various organs and tissues, hemorrhagic inflammation of the stomach and intestines with severe hyperemia, hemorrhages and swelling of the mucous membrane. In addition, there are detected inflammation of the kidneys and degenerative changes in the myocardium and liver. Typical symptoms are gastroenteritis, possible colic. At the beginning of the disease the animal does not feed, there is a salivation, in the ruminants – a timpany of the scar, diarrhea. In pigs, there is vomiting, severe diarrhea with an unpleasant smell of fecal matter. Later it affects the skin, itching is observed. Poisoning can be acute, subacute and chronic.

In the acute course of toxicosis, the animal dies in two to three days. Subacute and chronic poisoning lasts for weeks and has a favorable prognosis. When diagnosis is established, data from the anamnesis, symptoms, pathologic-anatomical changes and the presence of deadly nightshade (potatoes) in feeds or pastures shall be taken into account. From the diet, exclude feeds that contain Solanum (potatoes, beetles), stop grazing livestock in pasture where deadly nightshade plants grow. Animals convert hunger to a diet and take steps to remove the contents of the stomach. In case of acute poisoning, rinse the stomach (rumen) with a solution of potassium permanganate (1:5000). Inside there are adsorbent, astringent and enveloping means. Treat eczema and dermatitis. You cannot graze animals in pastures with a large presence of plants of the family of Solanum. Avoid feeding animals potato sprouts, drinking water where was cooked unpeeled potatoes [4; 5; 7].

Poisoning with turnip cabage and charlock. Turnip cabage *(Brassica napus)* and charlock *(Sinapis arvensis)* are plants from the family of cruciferous plants. They are grown as technical crops for the production of oil. Turnip cabage and charlock flour are used for animal feed. The cause of poisoning of animals is aliquotoglycerides, which are formed from synjugrin under the action of the enzyme myrosin. Before bloom, *turnip cabage* and charlock do not contain oil and therefore not toxic. Animals are eating the poisoned plants after their flowering, as well as when eating a lot of turnip cabage or charlock cake (not depleted), especially when fed with plenty of water. Poisoning is also observed when eating charlock and turnip cabage seeds. Alilnogurchichni oils, which come from food in the digestive canal, cause hemorrhagic inflammation of his mucous membrane. They cause defeat of kidney parenchyma and promote the development of acute nephritis, because their allocation is through the kidneys. The selection of oils through the lungs is accompanied by pulmonary edema and asphyxiation. The oils suppress the central nervous system. During a pathologic-anatomical examination, foamy fluid is found in the nasal cavity, trachea and bronchi (pulmonary edema). The dark cherry bloodshed is hemolytic, poorly absorbed. Mucous membranes of the stomach and intestines are hemorrhagic inflammation. The liver is enlarged, with necrosis hearths. Kidneys are stagnant. In the bladder, the urine is dark. Mucous membrane of the bladder is inflamed. The stomach and gut are hemorrhagic. Heart muscle is brittle, under the endocardium of hemorrhage. There are symptoms of gastroenteritis, nephritis, pulmonary edema, central nervous system damage. In ruminant animals, there is a rumen timing, a phenomenon of gastroenteritis, constipation; in swine – diarrhea, pain in the abdomen, groin. In animals a foamy pink liquid flows out from the nostrils. Breathing becomes frequent, difficult, and intermittent. Visible mucous membranes are bluish. In young animals occur are nervous phenomena – the desire to move forward, the manege movements. Many animals have convulsive contractions of individual muscle groups, as well as convulsions characteristic of acute nephritis (eclampsia uremia). Pregnant animals abort. Blood contains urine. The course of the disease is acute. The forecast is often unfavorable. If the process develops slowly, there is no foamy leakage from the nose, the prognosis is cautious (approaching favorable). The diagnosis is based on the data of the anamnesis, symptoms, and data of the botanical study of the forage on the presence of seeds of cruciferous flowers or onions of turnip cabage and charlock, and also taking into account

pathological and anatomical changes. When establishing a diagnosis, it should be borne in mind that in large and small cattle, poisoning with charlock does not have diarrhea, high body temperature and excitement are not observed. They have more pronounced anemia and hemoglobinuria. The first aid to animals in poisoning should be submitted immediately, because the process develops very quickly.

The stomach (scar) is washed through a probe followed by the introduction of mucous membranes and laxatives.

Immediately give cardiovascular drugs (caffeine, camphor oil). Intravenous administration of 30–40% glucose solution (several times a day). When symptoms of pulmonary edema are detected, they make bloodletting (1–1.5 liters), and then 10% solution of calcium chloride (150–200 ml) is injected into the vein. Conduct a survey of pastures and analysis of cake and pastures. Fields and pasturelands that are littered with turnip cabage, charlock and other crosses should only be used until the flowering of herbs. Rape and charlock cake are fed to animals in small quantities after boiling them at high temperatures [4; 5; 7].

Poison by corn campion. Corn campion *(Agrostemma githago)* is a one-year weed in crops of winter and spring crops and legumes. The puppet seeds fall into the grain, clog it, because it does not fall from the boxes in the fields. If the amount of the puppet in the flour is more than 0.5%, the flour will be not only bitter, but also poisonous. It is especially dangerous to feed floury feeds and fodder containing in corn campion. If the animal swallows the whole seed of a corn campion with grain, poisoning is rare, because the shell of the corn campion seed is resistant to the action of digestive juices. Poisonous same substances are contained only in the seeds of the corn campion. The poisoning of the corn campion seeds is due to two saponin-like substances – guitajum and agro-acidic acid. The highest sensitivity to them is seen in horses, pigs, dogs and birds. Saponin-like substances irritate the mucous membranes of the stomach and intestines. Sucking into the blood, they lead to hemolysis of red blood cells (even in dilution 1 : 50 000). During the pathological anatomical study were found catarrhal inflammation of the stomach and intestines, hemorrhage in the subcutaneous tissue, muscles, kidneys, and the shells of the brain and spinal cord. Blood is watery (no coagulation).

Dystrophic changes in the liver, myocardium and kidneys are also revealed. In pigs, symptoms of the disease are observed three days later after eating the food littered with the puppet. Particularly sensitive to the plant are piglets. In pigs, there is a strong salivation, vomiting and diarrhea with the release of pancreatic feces. Affects the nervous system (circular movements, agitation, which is replaced by depression, loss of sensitivity, etc.), the cardiovascular system (hemorrhages in the skin, weakening of the cardiac activity), hemoglobinuria is observed. In horses there are salivation, colic, depression, anemia. In poultry, poisoning manifests itself in abnormal movements of the head and neck (pulling out the neck, shaking their heads), diarrhea, vulgarity, jaundice of the mucous membranes, drowsiness. Poisoning is acute and chronic. The prognosis is cautious, and when acute poisoning of young animals is more often unfavorable.

Diagnosis can be put in detecting the degree of litter with a corn campion of unmalted grain, which is intended for flour or feed, taking into account the symptoms, anamnesis and pathological and anatomical changes. Poisoning by a corn campion the change of a fort, which contains in it seeds, washing of a stomach, application of vomiting, mucous and enveloping means, symptomatic therapy is shown. It should be excluded from the diet of young animals of all kinds, as well as adult pigs and horses, feed containing the corn campion. Strictly control the purification of grain from the corn campion seed, because even a small amount of it in the feed (more than 1%) is considered harmful [4; 5; 7].

Sweet clover poisoning *(Melilótus).* The poisonous substance of the sweet clover is dicumarin, which is formed in all parts of the coumarin plant, if the bark is inhibited. Poisoning occurs when feeding the animals of the hay, the silage, made from the sweet clover. The most sensitive to sweet clover are cattle, less – sheep, horses. Dikumarin acts as an antivitamin of vitamin K. It disturbs the formation of prothrombin in the liver and reduces the ability of the blood to clot. Calcium is in the blood, increased vascular permeability. Dikumarin, moreover, has a cumulative ability (accumulated in the body).

During the pathologic-anatomical study, the phenomena of hemorrhagic diathesis are found – hemorrhages in the pleural and abdominal cavity, bruises, and hematomas. Symptoms are reduced blood clotting, weakness, staggering gait associated movements lameness. Unexpectedly formed hematomas often occur on the neck, along the back. To the touch they are, warm, painful and tasty at first, and later – cold, painless, in the center – fluctuating. Pulse and breathing become more frequent. Visible mucous membranes are pale. Body temperature lower than normal. The course is acute, the disease lasts from a few days to 20 days. Recovery comes slowly. The forecast is cautious, and in severe cases, it is unfavorable. Data on anamnesis, symptoms, pathological and anatomical changes make it possible to diagnose. From the diet immediately exclude feed containing sweet clover. Assign foods rich in vitamin K (alfalfa, nettle). Inside, enveloping mucus decoctions are prescribed. Intravenously enter 5–10% solution of calcium chloride. Therapeutic effect provides vikasol (oral or intramuscular) cattle to 0.1–0.3 grams two or three times a day. Conduct symptomatic therapy. In order to prevent poisoning, it is not necessary to allow the feeding of dried silage or hay, in which there is an impurity of sweet clover [4; 5; 7].

Horsetail poisoning *(Equisetum).* Toxic effects are caused by marsh, forest and field horsetails. They are sensitive animals of all species, especially young animals. Poisonous substances of the horsetail are alkaloid equisetin and saponin-like substance – ekizetonin. Poisoning occurs when eating horsetail in the pasture or mixed with forage (hay). Drying of the horsetail does not change their toxicity. Poisoning is also associated with the presence of thyaminase enzymes in the horses that break down thiamine (vitamin B_1). Toxic substances irritate mucous membranes of the stomach and intestines, cause damage to the digestive canal, liver, and kidneys. Sucking into the blood, they lead to toxemia. In the liver, causing dystrophic processes and leading to the development of parenchymal jaundice. The enzyme thiaminease promotes the destruction of thiamine and the development of hypovitaminosis B_1. During the pathologic-anatomical study, icterus is found in the subcutaneous tissue, exudate in the pleural and abdominal cavities, the stomach and intestines, hemorrhages in the serous and mucous membranes. The heart is enlarged, the myocardium is brittle; liver of brittle, dark brown color; the lungs are full of blood. Spinal cord, cerebellum are hyperemic. In horses, the symptoms of poisoning show increased excitability, rage, convulsions, dilation of the pupils, and further – weakness of the back of the body, shaky stroke, bending of the limbs during turns, paresis and paralysis of the extremities, loss of sensitivity. In cattle, sheep and goats are disturbed by the functions of the digestive canal. There are cessations of gum, strong diarrhea, fecal masses are black and a bad smell. Abortions are possible. Depending on the number of horsetails eaten with food, poisoning can be severe and chronic. In case of acute flow, the forecast is unfavorable. The animal dies quickly. If it recovers, then slowly. The diagnosis is based on the symptoms, pathological and anatomical changes, the presence of horsetail in feed (hay), on pastures, data of anamnesis. First of all, it is necessary to remove from the diet of the feed, clogged with horsetails. Enter intravenous or intramuscular thiamin bromide or thiaminchloride to 500 mg per day (large animals) and up to 100 mg (calves and horses). Paresis, paralysis using strychnine nitrate subcutaneously horses 0.05–0.1 g, cattle 0.08–0.15, small ruminants 0.03–0.05 g; veratrine – 0.05–0.1 g and sodium caffeine benzoate – 3 to 5 g large animals.

With pronounced depression, which changes with excitation, intravenous horses injected 10% aqueous solution of sodium thiosulfate (5–15 g) for several days twice a day (in an increasing quantity): on the first day 150 ml is administered and after 4 hours – another 200 ml, the next day 250 ml and after 4 hours – another 300 ml, the third day – 350 ml and after 4 hours – another 400 ml. The prevention of horsetail poisoning is reduced to the exclusion from the diet of the fodder that has been clogged by these plants. However, the best way is to combat weeds (horsetails) by draining lowlands and liming the marshes [4; 5; 7].

Snakeroot poisoning *(Cicuta virosa L).* Poisonous substance is cyctotoxin. Poisoning is more common in cattle and sheep. Animals are poisoned by eating green plants. For cattle, the poisonous dose is 200–300 g, and for sheep – 60–80 g of green plant. The whole plant is poisonous, especially the rhizome. When drying the plant, the cytotoxin does not collapse. In addition, this plant is especially insidious due to its taste. Cycutotoxin is easily absorbed and quickly spread in the body, affects the centers of the vasomotor and vagus nerves, causing changes in the nervous system. At autopsy the corpse is inflated, the blood is dark, liquid (does not swell). In the subcutaneous tissue a lot of hemorrhages. They are also on the mucous membranes and serous coverings. Extreme hyperemia of the brain and pulmonary edema. Symptoms of poisoning manifest quickly: the animal is worried, trembling. There is an increased excitability, salivation, abdominal inflammation, frequent urination and defecation. There are clonic seizures that go into epileptic seizures with the presence of opistotonuses. Poisoning runs out sharply. The animal may die at the time of seizures. The forecast is cautious. The presence of poisonous tickles on grapes, in forages, symptoms, anamnestic data, pathological and anatomical changes allow to diagnose. Immediate action should be taken to remove poison from the digestive tract. For this purpose, the scar is washed with a solution of potassium permanganate, and if necessary, the contents of the scar are removed by ruminotomy. Inside, prescribe adsorbing and enveloping agents. It is recommended to introduce 5–10% solution of dilute hydrochloric acid per 1 liter of adult animals and 0.5 liters – young animals. In the phenomena of asphyxiation, intravenous cytotine is administered at a dose of 5–10 ml for large animals or subcutaneously 1% lobelin hydrochloride in a dose of 0.05–0.15 g for large cattle, 0.01–0.03 g for small ruminants. Conduct symptomatic therapy. For the prevention of poisoning, special attention is paid to the advocacy work aimed at the removal of poisonous crickets from pastures and onions. Destroy plants everywhere, wherever they grow [4; 5; 7].

Poisoning with European white helebore *(Veratrum album L.).* Poisoning of European white helebore causes the content of alkaloids in it – protovaterrine, hermerin, and others. Tiller to European white helebore are cattle, sheep, pigs, horses, birds are sensitive. Poisoning occurs when eating European white helebore to fold or winter stall period with hay or silage if they are contaminated by this plant. All parts of the plant are poisonous. European white helebore doesn't lose toxicity before drying or after ensiling. Alkaloids, helers initially excite, and then paralyze the central nervous system and the end of the parasympathetic, sensory and secretory nerves. During pathological and anatomical researches are found in the stomach and intestines blood, lesions of mucous membranes. In the large intestines, there are hemorrhages, vascular injections. The liver is stagnant, the kidneys are inflamed, and the bladder is empty. In large and small cattle, poisoning is accompanied by a waiver of forage, salivation, vomiting, timpanon of a scar, diarrhea with admixture of blood.

Characteristic is that the saliva around the lips is shaken in the foam, and vomiting can last for several hours or even within 2–4 days. Body temperature is reduced to 36 ºC; lactation is stopped; abnormal sweating is observed. Urination is frequent, but in small portions. There is muscle trembling. In pigs, the symptoms of poisoning are fast and characterized by prolonged vomiting. Poisoning with European white helebore in horses is manifested by excitation, pupil dilation, intense sweating, muscle trembling, colic, and sometimes vomiting. Breathing and pulse become more frequent. The animal dies from paralysis of the respiratory center with

pronounced seizures and the development of pulmonary edema. Poisoning runs out sharply. Forecast is often unfavorable. The diagnosis is based on the symptoms, botanical analysis of the feed, pathological and anatomical changes. As therapeutic agents are recommended tannin and preparations containing tannin, as well as alkali solution, enveloping agents. Conduct symptomatic therapy. To prevent poisoning of animals in pastures and hayfields, poisonous plants (hellebore) are destroyed, especially in early spring, and also do not allow clogging of hellebore forage, which are harvested for the winter [4; 5; 7].

Poisoning by plants that have photodynamic effects. In the period of flowering and fruiting under appropriate meteorological conditions, some cultural and wild plants accumulate a fluorescent substance (pigment philoreetrin, which is characterized by toxic and photodynamic properties). At the heart of poisoning is the increased sensitivity of the skin to the action of sunlight due to the accumulation of fluorescing substance in it. Get sick such animals: pigs, sheep, cattle, goats, horses and poultry. Sensitivity to sunlight is increased after eating plants containing photodynamic agents. From cultivated plants – are buckwheat *(Fagopyrum esculentum)*, clover *(Trifolium)*, millet *(Panicum miliaceum L.)*, and from wild-growing – common St John's-wort *(Hypericum perforatum L.)*, puncture vine *(Tribulus terrestris)*, lover's-pride *(Polygonum persicaria L.)*, bankweed *(Sisymbrium officinale)*. So the toxic substance of the buckwheat seed (as well as other plants of this group) is a pigment philoreetrin – derivative of chlorophyll. If the skin has an agent (phyllomethrin), and if the skin of the animal is not immune to ultraviolet irradiation, there is an increased sensitivity of the skin to light. Fileroetrin is oxidized by the action of sunlight, causing severe irritation of the receptor apparatus of the skin. There are changes that are similar to burns. There is a release of histamine from cells, swelling of the skin develops, then photosensitivity, in addition to skin lesions, there are violations of the functions of the central nervous system. Animals are affected by skin, catarrhal gastroenteritis, liver hyperemia, kidneys and dystrophic changes in them. On non-pigmented areas of the skin, most often in areas less protected by wool (eyelids, ears, neck, perineum, etc.), there is redness, swelling, tenderness, severe itching. Animals worry about rubbing affected areas about various objects, which leads to damage to the skin. Ears, lips nostrils, eyelids get swollen. Difficulty breathing and appetite disrupted. The affected surfaces are covered by a multitude of small vesicles, which burst, forming the wet places, and then – scabs and cracks. Swollen places are necrotized and rejected. In some animals ears and lips fall off. The pulse becomes more frequent. Body temperature rises. In severe toxicosis there may be shock. Sometimes poisoning is accompanied by excitement, spasms, which are replaced by oppression. Poisoning can be acute and chronic. Recovery depends on the duration of exposure to the sun, the degree of necrosis of the skin. In severe form the animal may perish. Take into account the specificity of the symptoms, the presence of plants, as containing photodynamic agents, meteorological conditions (sunny weather) that preceded the disease. It is necessary to exclude from the diet of feed plants that have a photodynamic effect, replacing them with other feeds. Animals are transferred to a darkened room, as a laxative means prescribe vegetable oil. The affected areas of the skin are cleaned of contamination, washed with lubricating softening and disinfectant ointments (ihtiolovoy, carbolic, salicylic, Laser paste, menthol with zinc, etc.) To prevent septic processes used antibiotics. You should not graze animals in areas with plants that exhibit photodynamic effects in sunny weather. Do not give them feed from these plants in sunny weather and add them in a mixture with other feeds. It is important to carry out explanatory work among livestock about the characteristic features of fodder plants [4; 5; 7].

Poisoning with fodder containing synthetic acid. There are plants (sudan grass *(Sorghum bicolor subsp. Drummondii)*, vetch *(Vicia)*, sorghum *(Sorghum bicolor)*, velvet grass *(Holcus lanatus)*, manna grass *(*Glyceria maxima *(C.* Hartm.*)* Holmb*)*, flax *(Linum usitatissimum)* etc.) which contain nitroglycosides. Under certain conditions nitroglycosides can

decompose with the formation of bile acids. Eating such plants (fodder) leads to poisoning. Accumulation of cyanic acid in plants occurs under the influence of meteorological conditions, as well as when the beveled grass is warmed up in heaps, entrapped or fermented after eating in the prehistoric ruminant. Under the influence of the enzymes of the plants themselves can also accumulate hydrochloric acid in an amount dangerous to the life of animals. Thus, poisoning can occur when young animals eat plants or shoots of these plants after mowing, feeding a lying mass or fresh hay (sudangrass, vetch, etc.). Cinnamic acid inactivates cell enzymes, which leads to the development of tissue anoxia. Oxygen, which is not absorbed by the tissues, accumulates in venous blood, giving it a bright red color. To the oxygen fasting, the most sensitive cells of the brain (neurons), therefore, poisoning is first and foremost a violation of the functions of all vital centers. During a pathoanatomical examination, it is found: a liquid, bright red color of blood that did not coagulate; to the oxygen fasting, the most sensitive cells of the brain (neurons), therefore, poisoning is first and foremost a violation of the functions of all vital centers. During a pathoanatomical examination, it is found: a liquid, bright red color of blood that did not fall off; hyperemia and pulmonary edema; small hemorrhages under the epicardium, endocardium and in all parenchymal organs. Mucous membranes of the stomach and intestines are hyperemic, covered with mucus. The content of the stomach during the day retains the almond scent. In animals, shortly after taking large amounts of food containing cyanogen, there is a concern, more often and difficult breathing, loss of strength. Visible mucous membranes are hyperemic. Animals are badly kept on their feet. Noticed cramps pupils expanding. Body temperature is lowered. In bovine animals, there is an atony and a tympanium of the scar, and in swine – vomiting. Skin sensitivity is reduced. Animals die when they are comatose. Poisoning runs out sharply. The forecast is cautious, often unfavorable. For the diagnosis of symptoms into account, pay attention to the results of feed. Pay attention to the bright red color of the mucous membranes, bright red, liquid venous blood. The contents of the stomach are examined for the presence of hydrocyanic acid. Mark a specific almond smell of gastric contents. To dispose of the hydrocyanic acid in the digestive tract, a 1% solution of hydrogen peroxide is given in a dose of 800–1000 ml to a large animal or a solution of potassium permanganate (1 : 1000) – 500–1000 ml. Hydrocyanic acid, which has grown deep in the blood, neutralizing the introduction of intravenous sodium thiosulfate in dose, horses and cattle 5–15 g, small ruminants for 1–4 hours. In addition, 25% glucose solution is injected intravenously in a dose of 500 ml for large animals; 1% solution of methylene blue for horses and cattle for 100–200 ml, small ruminants for 20–50 ml. Forages that contain synthetic acid are excluded from the diet, disposing of cattle for another pasture. Plants that are able to accumulate hydrocyanic acid are recommended to mow early in the morning, when their presence in them is the smallest. The green mass (undersized hay, grass after frostbite), which contains cyanogenic substances, is treated with iron sulfate and sodium bicarbonate by 1 kg per 1 ts of feed [4; 5; 7].

The purpose of research

The research was conducted in 2016–2018, during the pasture period, from April to October. During the study, the study of the botanical composition of the natural pastures of the Western Polissya of the Volyn region was carried out. In particular: the Mosor area of Kovel district, the area of pasture makes 12 hectares. In the village Podlisky of Rozhysche district, the area of pasture is 15 hectares and the town of Rokini, Lutsk district, the area of pasture is 11 hectares. In view of the above, the purpose of the study was to detect harmful and toxic plants in experimental samples, selected on natural pastures of the Western Polissya of Ukraine.

Results and discussion

Research and species determination of plants were carried out according to generally accepted methods [6; 9; 12; 16–19]. As a result of research on component composition, it has been established that 85% of herbs are herbs of the family of cereals, 10% of the component

composition of the selected samples – beans and 5% – others, including poisonous and harmful plants. It was also established that during the past 10 years no agro-technical measures were carried out on the studied pastures.

As a result of the conducted research it can be stated that surveyed pastures can be divided into three conditional groups:

- floodplain meadows;
- lowland grasslands;
- lands of wetlands.

Component composition of grasslands of floodplain areas of investigated pasture consisted of the following components: colonial bent *(Agrostis tenuis)*, meadow fescue *(Festuca pratensis)*, awnless brome *(Bromus inermis)*, timothy *(Phléum praténse L.)*, kentucky bluegrass *(Poa pratensis)*, red clover *(Trifolium pratense)*, alfalfa *(Medicago sativa)*, witch grass *(Elymus repens (L)*, maidenhair *(Geum rivale)*, silverweed *(Potentilla anserina L)*, meadow crane's bill *(Geránium praténse)*, reed grass *(Calamagrostis canescens (Web.) Roth)*, sedge *(Carex)*, blue *devils (Echium vulgare)*, horse sorrel *(Rumex confertus)*, cow parsnip *(Heracleum sosnowskyi Manden)*.

For lowland fodders at the time of research was characterized by cereal vegetation and shallow small herbaceous vegetation of damp onions. It consisted of the following plant species: colonial bent *(Agrostis tenuis)*, meadow fescue *(Festuca pratensis)*, white clover *(Trifolium repens)*, жовтеці *(Ranunculu)*, carnation grass *(Carex panicea)*, cotton grass *(Eriophorum angustifolium)*, wire-bent *(Nardus stricta)*, timothy *(Phléum praténse)*, meadow foxtail *(Alopecurus pratensis)*, meadow fescue *(Festuca pratensis)*, timothy *(Trollius europaeus)*, maidenhair *(Geum rivale)*, kingcup *(Caltha palustris)*, bitterworm *(Menyanthes trifoliata L.)*, cat-whistles *(Equisetum palustre)*, manna grass (*Glyceria maxima (C.*Hartm.*) Holmb*) and others.

In wetlands in the period of research observed marsh sedge-grasshopper grasse. The species composition was as follows: sedge (carnation grass, heath sedge, hoary sedge) *Carex Panicea vesicaria, Carex Panicea cespitosa Carex Panicea praecox*), cotton grass *(Eriophorum angustifolium)*, bur reed *(Phragmites communis)*, maidenhair *(Geum rivale)*, dropwort *(Filipendula vulgaris Moench)*, marshlocks *(Cómarum palústre)*, bush grass *(Calamagrostis epigejos (L.) Roth.) canescens (Web.) Roth)*, true mosses *(Bryales Sphagnum squarrosum)*.

In experimental specimens, poisonous plants have been found that can cause life-threatening abnormalities in grazing animals. The list of these plants is presented in *Table 1*.

It should be noted that on the studied sites, annual ragweed *(Ambrosia artemisiifolia L.)* was revealed, which is characterized by significant harmfulness. It affects the reduction of crop yields, the clogging of their crops, the deterioration of feed quality, the decrease in the productivity of pastures and the negative impact on human health. Developing a powerful overland mass and root system, annual ragweed strongly suppresses crop plants and consumes a very large amount of nutrients from the soil. In the case of severe clogging of crops by annual ragweed, the yield of crops is sharply reduced. When harvesting weeded late crops (sunflower *(Helianthus annuus)*, cannabis *(Cánnabis satíva)*, alfalfa *(Medicago sativa)*, vegetable seed) it gets annual ragweed seeds, which is quite difficult to separate. In such cases, additional costs are required for the cleaning of the seed material. When crops are littered with perennial grasses (clover, alfalfa, etc.) and annual herbs on green feed, as well as meadows and pastures, the quality of the forage harvested is reduced.

Consequently, irrespective of the keeping of animals in pasture and mowing, or in the presence of stool, poisoning is possible.

Table 1

Poisonous plants of natural pastures of Western Polissya

Plantname	Picture	What parts of plants and in what form it is poisonous	What organs are struck
Duramen *(Gratiola officinalis L.)*		All parts of the plants in fresh and dry state	Gastrointestinal tract
Амброзія полинолиста *(Ambrosia artemisiifolia L.)*		Ground parts in fresh form	Gastrointestinal tract
Marsh tea *(Ledum palusre L)*		Fresh leaves	Central nervous system
Henbane *(Hyosciamus niger L.)*		Ground parts in fresh form	Central nervous system
Cow parsnip *(Heracleum sosnowskyi Manden.)*		Juice contacting with the animal's body may cause burns of varying degrees	Usually, on the affected areas of the skin there is a burn of the second degree (blisters filled with liquid)
Wild calla *(Calla palustris L.)*		Ground parts	Gastrointestinal tract
Poison hemlock *(Conium maculatum L.)*		Leaves and inflorescences	Central nervous system
Snakeroot *(Cicuta virosa L.)*		Rhizomes and young green shoots both fresh and in the hay	Central nervous system

Jimson-weed *(Datura stramonium L.)*		The whole plant, including flowers, seeds and roots	Central nervous system
Kingcup *(Caltha palustris L.)*		Ground parts in fresh and dry form	Central nervous system
Cicely *(Aethusa cunapium L.)*		Ground parts	Central nervous system
Faires-horse *(Senecio jacobaea L.)*		Ground parts	Liver
Lily of the valley *(Convallaria majalis L.)*		Green leafs	Heart
Buttercup *(pió Ranunculus)*		Ground parts in fresh form	Central nervous system
Field poppy *(Papaver rhoeas L.)*		Ground parts in fresh and dry form	Central nervous system
Manna grass *(Glyceria maxima (Hartm.) Holmb)*		Leaves, stems and inflorescences	Signs of asphyxiation
Devil's-milk *(Euphorbia)*		Ground parts in fresh and dry form	Gastrointestinal tract

Figwort *(Scrophularia nodosa L.)*		Ground parts	Heart
Fine-leaved dropwort *(Oenanthe aquatica (L.) Poir.)*		Leaves, seeds, roots	Central nervous system
Petty morel *(Solanum dulcamara L)*		Greens and immature fruits	Gastrointestinal tract
Ginger plant *(Tanacetum vulgare L.)*		Green mass	Central nervous system
Broom *(Chamaecytisus ruthenicus Fisch.ex Woloszcz)*		Bark, leaves, flowers and seeds	Central nervous system
Horsetail *(Equisetaceae)*		Ground parts in dry form	Heart
Unicorn root *(Veratrum lobelianum Bernh.), (V. nigrum L.)*		Rhizome, stems, leaves, flowers	Heart

Therefore, in order to avoid frequent cases of death of animals from poisoning, it is necessary to carry out regular monitoring of the condition of animals in forage areas, where poisonous and harmful herbs grow.

Conclusions

After the end of the winter period and the keeping of the cattle in the first days before and after the grazing of animals, it is necessary to additionally give food (hay, silage, haylage, concentrated feed, etc.). This is due to the fact that hungry and depleted animals without parsing will eat all herbs, and the consequences of this can be unpredictable. Almost all areas in the pastures are littered with harmful and poisonous herbs, therefore, a small group (graft inspections) should be bred on such sites and, based on the analysis of the animals in this group, (if safe to do so) graze other groups of animals.

For this purpose, prior to the grazing of pastures and pastures, farm workers, tenants and other interested persons, the most appropriate manner is to conduct a survey on the detection of poisonous and harmful plants and to inform livestock owners of the danger of animal poisoning in these areas.

In the early days, pastures should be monitored to determine the ratio of animals to dangerous and poisonous herbs. And when detecting cases of eating poisonous herbs it is necessary to transfer animals to another plot or pasture where there are little or no poisonous herbs in the grass.

In the case of detecting poisoning or even one head of an animal, steps must be taken to eliminate the massive disease (poisoning). Thus, all interested persons (specialists in the field of animal husbandry, veterinary doctors, shepherds, shepherds, etc.) are obliged to constantly monitor the growth and development of poisonous and harmful herbs to prevent the disease and incidence of livestock from plant toxins.

It should be noted that in the "Integrated Program of Agro-Industrial Complex Development of Volyn Oblast for 2016–2020" measures for combating polystyrene with annual ragweed are foreseen, and the necessary financing is foreseen. In the coming years, in order to provide balanced and complex measures for the control of polystyrene, priority will be given to: mechanical, agrotechnical, and chemical methods of combat, which will be applied simultaneously. The implementation of the Program in one stage for a five-year term implies the destruction of quarantine drill by 85% of the total infection area.

The main measures of combating harmful and poisonous plants and measures for the prevention of poisoning on natural pastures are the application of measures for surface and radical improvement of pastures. If the above requirements and recommendations are followed, the investigated pasture land can meet and be used as a transition to the system of organic livestock management, primarily the meat and dairy.

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Chapter 9. MONITORING OF TUBERCULOSIS INCIDENCE IN DIFFERENT POPULATION SEGMENTS OF LVIV REGION FOR THE PERIOD FROM 2012 TO 2017

A. IVASIVKA, V. FIL,
S. MONASTYRSKA, Ya. PAVLYSHAK
Drohobych Ivan Franko State Pedagogical University,
24, I. Franko Str., 82100 Drohobych, Ukraine
e-mail: angelikka17@ukr.net
e-mail: fillvitalij@gmail.com
e-mail: svitlanamonastyrska@gmail.com
e-mail: pavlyshak2210@ukr.net

Abstract*. The article describes the epidemic situation of tuberculosis in the Yavoriv district and provides statistical data for the period from 2012 to 2017. The indicators characterizing the epidemic situation on tuberculosis – morbidity, mortality, and their components (gender, age and the place of residence (village, city) were studied. The largest spread of TB incidence rates is characteristic for men aged 15 to 54. The gender aspect showed that among the cases of tuberculosis in 2017, men make up 83.3%, whereas in 2013 the number of men was 73.3%. Among women, the largest number was registered in 2013 – 25%, the smallest was in 2017 – 16.6%.*

It was found that the number of patients for the analyzed period (2012–2017) decreased by 17% in 2017 in comparison with the year 2012. These figures show the ongoing high-quality treatment and prevention work.

Keywords*: Pulmonary tuberculosis; Extrapulmonary tuberculosis; Epidemiological analysis; Tuberculosis incidence; Dispensary record.*

Introduction

Tuberculosis is an urgent medical and social problem. According to world statistics, every year around 2 million people die of tuberculosis [4]. According to WHO estimates, between 2000 and 2020, nearly one billion people will be infected, 200 million will get sick and 35 million will die of tuberculosis, if the epidemic control will not be strengthened [11; 12].

The role of social factors in the emergence and spread of tuberculosis is so significant that it is considered particularly dangerous disease, which is an indicator of the economic well-being for the population of any country.

In Ukraine, the situation associated with the spread of tuberculosis began to worsen since 1990 [3]. This situation reached the most critical level in 1995. From this period, an epidemic of tuberculosis was registered in Ukraine, which is constantly progressing and becoming threatening [7; 8]. The highest rates of morbidity for all forms of tuberculosis are noted in the most industrially developed southeastern regions of Ukraine. In 1995, the number of patients with tuberculosis exceeded 1% of the entire population [9; 10], by 2012 the number of patients increased by 0.4% and constituted 1.4% of the population in the country [2]. Today, tuberculosis leads to the largest number of deaths from infectious diseases in Ukraine [1]. The socially unprotected population accounts for up to 70% of the disease.

According to WHO, in Ukraine, prevalence and TB incidence in 2007 tend to decrease by an average of 4.4% and 3.3% each year, respectively.

In 2014, Ukraine entered for the first time and continues to be among the five countries with the highest burden of multi-drug resistant tuberculosis. The result of the successful treatment for this type of tuberculosis is one of the lowest in the European region and is 46%.

In order to formulate a sustainable response to the problem of tuberculosis in Ukraine, a draft National Program on TB Control for 2018–2021 was developed. The main components of the new program meet the common European approaches. Ukraine will continue to implement patient-oriented health care delivery models, reform the anti-TB service in the concept of a comprehensive health care reform and optimize financial costs in line with current epidemic trends, and introduce new diagnostic and treatment facilities in line with the WHO recommendation [5].

Achieving the goal should be based on the implementation of the three key elements of the strategy. The first element is the optimal use of existing and new medicines, ensuring public access to health care and social protection. Its implementation will allow reducing the incidence of TB by 2025 by an average of 10% annually. The second element is the introduction of new preventive measures and treatment regimen, diagnostics directly at the place of medical aid provision. Due to this, by 2025, the reduction in the incidence rate will occur on average by 17% per year. Anti-TB care, prevention and use of systems supporting the intensification of research and innovation as a third element of the strategy's implementation will allow achieving the ultimate goal of the strategy by 2035 – to end the global TB epidemic in the world [6].

The purpose of research was to conduct a retrospective analysis of the tuberculosis incidence for the population of Lviv region for 2012–2017.

Material and methods

The epidemiological analysis of the epidemic process manifestations on tuberculosis was conducted based on materials of the Municipal Nonprofit Enterprise of the Yavoriv Regional Council of the Lviv region of the Yavoriv Central District Hospital (anti-TB clinic department) for the period 2012–2017. The indicators characterizing the epidemic situation on tuberculosis – morbidity, morbidity, mortality, as well as their components (gender, age and place of residence (village, city)) were studied.

The obtained data are subject to mathematical and statistical processing, according to which the dynamic statistical analysis was conducted. The statistical analysis for the data obtained was carried out using the Statica 10.0 software (Statsoft, USA).

Results and discussion

As it is seen from *Diagram 1*, in Yavoriv district, the highest incidence of tuberculosis was observed in 2013 and amounted to 494 people. During the next 2014–2017, a tendency was observed in reducing the number of registered cases, namely: 413 persons – in 2014; 370 persons – 2015, 358 persons – 2016, and 329 persons in 2017.

According to *Diagram 1*, for the reporting period, the number of registered rustic residents is higher than the incidence for urban residents and is 38%, which may indicate a low availability of services for the identification and treatment of TB among the rural inhabitants. Among the rural residents, there is also a tendency to reduce the incidence of TB during this period: from 325 persons in 2012 to 190 people in 2017 *(Diagram 1)*.

The peak in the total number of newly diagnosed TB patients *(according to Diagram 2)* is 2013 and amounts to 83 people. During the last 5 years, the TB incidence in men is 3–3.1 times higher than the TB incidence in women. The proportion of men constantly exceeds the proportion of women in the overall structure of TB morbidity. This tendency is observed in all age groups of the population. Among those who became ill with TB in 2012, men make up 72.2%, with the growing share of men in the overall structure of patients in age groups. If the highest number of women was registered in 2013 – 21, the lowest number (8) was registered in 2017, then it was 62 and 40 persons among men in the same years, respectively.

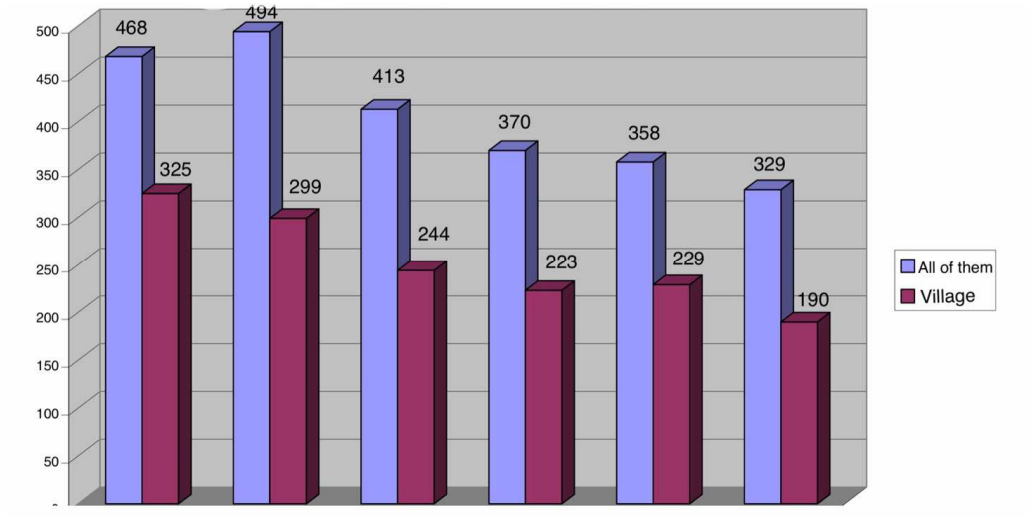

Diagram 1. Number of registered tuberculosis patients for 2012–2017

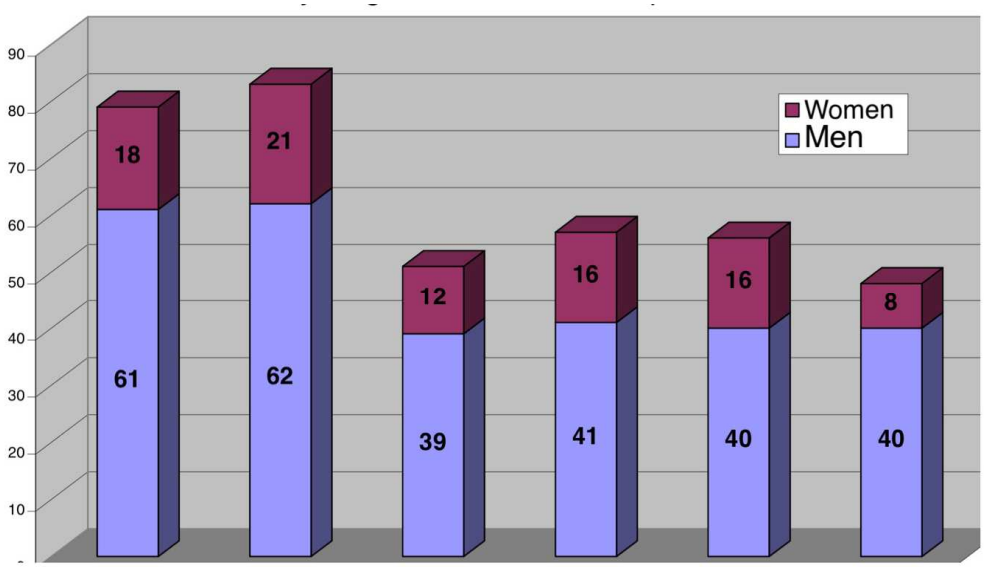

Diagram 2. The number of newly diagnosed tuberculosis patients for 2012–2017

The total contingent of patients with active tuberculosis at the end of 2016 *(Table 1)* was 64 people, among them: adults – 58 people, 2 teens and 4 children, while in 2017, *(Table 2)* it remained at the level of 50 people, of which – 44 were adults; 1 adolescent and 1 child.

Table 1

Number of patients under dispensary supervision for 2016

Active TB – 64			**Women – 14**		
Adults	*Teens*	*Kids*	*Adults*	*Teens*	*Kids*
58	**2**	**4**	**11**	**1**	**2**
active lung tuberculosis – 58			**Women – 13**		
Adults	*Teens*	*Kids*	*Adults*	*Teens*	*Kids*
53	**2**	**3**	**11**	**1**	**1**

Table 2

Number of patients under dispensary supervision ("D") in 2017

Active TB – 50			**Women – 7**		
Adults	*Teens*	*Kids*	*Adults*	*Teens*	*Kids*
48	**1**	**1**	**6**	**0**	**1**
Active lung tuberculosis – 46			**Women – 7**		
Adults	*Teens*	*Kids*	*Adults*	*Teens*	*Kids*
44	**1**	**1**	**6**	**0**	**1**

The number of patients under the dispensary supervision with active pulmonary tuberculosis among the rural population at the end of 2016 *(Diagram 3, Table 3, 4)* was 35 persons. Among them were 32 adults, 1 adolescent and 2 children, while at the end the reporting period in 2017 it was kept at the level of 20 people, of which were 19 adults, 1 child; and there were no teens. In 2016, 1 child and 2 adolescents had recurrence of tuberculosis.

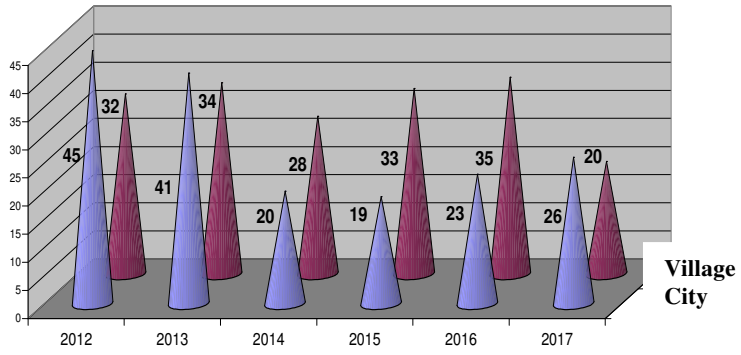

Diagram 3. Number of patients with active tuberculosis for 2012–2017

The number of patients with active pulmonary tuberculosis at the end of the reporting year is shown in the following *Tables*.

Table 3

Number of patients from rural areas under dispensary supervision in 2016

Active TB – 37			**Women – 9**		
Adults	*Teens*	*Kids*	*Adults*	*Teens*	*Kids*
33	**1**	**3**	**7**	**0**	**2**
Active lung tuberculosis – 35			**Women – 8**		
Adults	*Teens*	*Kids*	*Adults*	*Teens*	*Kids*
32	**1**	**2**	**7**	**0**	**1**

Table 4

Number of patients from rural areas under the dispensary supervision ("D") in 2017

Active TB – 24			**Active TB – 2**		
Adults	*Teens*	*Kids*	*Adults*	*Teens*	*Kids*
23	**0**	**1**	**1**	**0**	**1**
Active lung tuberculosis – 35			**Active lung tuberculosis – 8**		
Adults	*Teens*	*Kids*	*Adults*	*Teens*	*Kids*
19	**0**	**1**	**1**	**0**	**1**

One of the important epidemiological indicators of the success in the elimination of TB in the country is the trend of the age structure in TB morbidity.

According to *Table 5*, 76% of persons who became ill with TB, able to work by age – 18 to 54 years old (358 persons), 34% of patients (67 people) were in 2016 in the age group 55 and older. These indicators show a high social significance of tuberculosis, and the economic unprofitableness of tuberculosis for the state. The losses are due not only to the cost of treatment for patients, but also due to the fact that a significant number of patients in working age is eliminated from the production process for a long time. If the average age of people who became ill with TB increases, this indicates positive changes in the epidemic process.

Table 5

Number of registered patients by 2016

Adults aged 18 to 56						
Totally registered		*For the first time*		*Removed from the register "D"*		*"D"*
All	*Men*	*All*	*Men*	*All*	*Men*	*Men*
358	**268**	**54**	**40**	**84**	**64**	**274**
Adults 55 (60) and older						
Totally registered		*For the first time*		*Removed from the register "D"*		*"D"*
All	*Men*	*All*	*Men*	*All*	*Men*	*Men*
67	**46**	**8**	**5**	**17**	**11**	**50**

Analyzing the age structure of TB incidence in 2017, there is a tendency towards a slow decrease in the incidence among the age group of 18–54 (329 people), which indicates a shift to positive dynamics of the TB epidemic *(Table 6)*. This age category is the main working resource of the country and the largest taxpayer, so it is obvious that this makes it possible to reduce the negative impact of the TB epidemic on the economic situation in the country.

Table 6

Number of registered patients by 2017

Adults aged 18 to 56						
Totally registered		*For the first time*		*Removed from the register "D"*		*"D"*
All	*Men*	*All*	*Men*	*All*	*Men*	*Men*
329	**247**	**48**	**40**	**68**	**52**	**261**
Adults 55 (60) and older						
Totally registered		*For the first time*		*Removed from the register "D"*		*"D"*
All	*Men*	*All*	*Men*	*All*	*Men*	*Men*
63	**45**	**7**	**5**	**23**	**17**	**40**

Positive dynamics in the age group is observed among the village inhabitants who became ill with TB *(Tables 7, 8)*. If 229 people the age group of 18–54 were in 2016, 43 people were in the age group of 55 and older, whereas in 2017 these data were: 190 and 32 persons, respectively.

Table 7

Number of registered patients living in the countryside by 2016

Adults aged 18 to 56						
Totally registered		*For the first time*		*Removed from the register "D"*		*"D"*
All	*Men*	*All*	*Men*	*All*	*Men*	*Men*
229	**171**	**39**	**27**	**66**	**45**	**163**
Adults 55 (60) and older						
Totally registered		*For the first time*		*Removed from the register "D"*		*"D"*
All	*Men*	*All*	*Men*	*Al*	*Men*	*Men*
43	**29**	**5**	**3**	**16**	**10**	**27**

Table 8

Number of registered patients living in the countryside by 2017

Adults aged18 to 54						
Totally registered		*For the first time*		*Removed from the register "D"*		*"D"*
All	*Men*	*All*	*Men*	*All*	*Men*	*Men*
190	**157**	**24**	**20**	**43**	**34**	**147**
Adults 55 (60) and older						
Totally registered		*For the first time*		*Removed from the register "D"*		*"D"*
All	*Men*	*All*	*Men*	*All*	*Men*	*Men*
32	**24**	**3**	**3**	**10**	**7**	**22**

A vivid example of the reduction for the tuberculosis morbidity in the Yavoriv district is the number of patients removed from the dispensary record *(Diagram 4)*. If this figure was 154 persons in 2012, it corresponded to 52 people at the end of the reporting period in 2017.

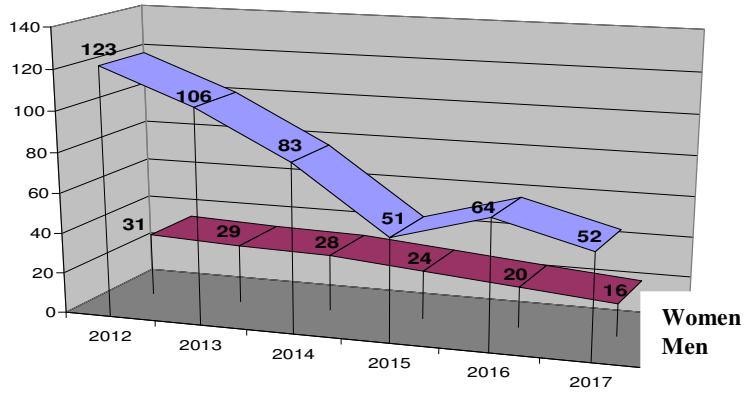

Diagram 4. Number of patients removed from the register "D"

Regarding the rural population, this tendency is also remaining *(Diagram 5)*: 73 persons in 2012; 34 persons in 2017.

The number of patients living in countryside removed from the register D.

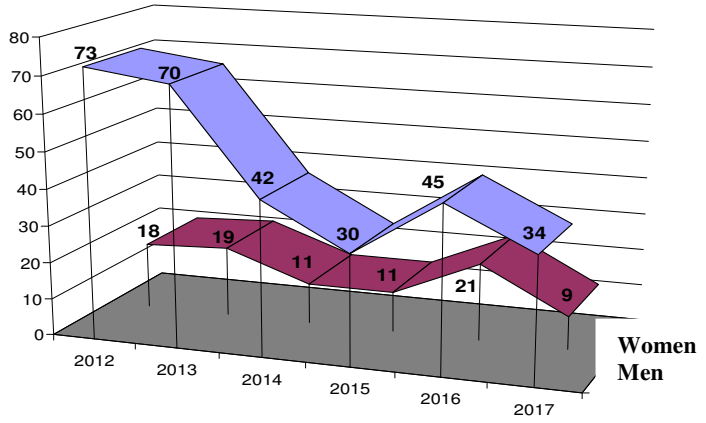

Diagram 5. Number of patients from countryside removed from the register "D"

The given data shows the tendency to decrease the main indicators of the tuberculosis incidence in Yavoriv district. However, the overall epidemiological situation remains difficult with the remaining significant number of patients, which are the source of infection with microbial tuberculosis, especially dangerous for the most vulnerable contingents of the population – children and adolescents.

The conducted statistical analysis of tuberculosis in Yavoriv district, the number of patients for the analyzed period (2012–2017) decreased by 17% in 2017 compared to 2012. These indicators testify to the carried out high-quality treatment and preventive work, which consisted in the immunization of the population, the examination of the tuberculosis centers, the competent treatment of dispensary patients, the control of the health of children and adolescents.

Conclusions

Analyzing the age structure of tuberculosis incidence in 2017, there is a tendency towards a slow decrease in the incidence among the age group of 18–54, which indicates the transition to a positive dynamics of the tuberculosis epidemic. This age category is the main working resource of the country and the largest taxpayer, thus, it is obvious that this makes it possible to reduce the negative impact of the TB epidemic on the economic situation in the country.

The gender aspect revealed that men account for 72.2% among those who became ill with TB in 2012. The share of men in the general structure of patients in age groups is increasing. If the highest number of women was 21 in 2013, the lowest was 8 in 2017, then these figures are 62 and 40 persons, respectively, among men in the same years.

The most pronounced example of the reduction of tuberculosis in the Yavoriv district is the number of patients removed from the dispensary record. If this figure was 154 persons in 2012, it corresponded to 52 persons at the end of the reporting period in 2017. The obtained indicators of tuberculosis incidence for the period of 2012–2017 indicate a significant improvement in the situation in Yavoriv district, which is explained by conducting work on the prevention of mass cases of tuberculosis diseases, which includes immunization of the population, conducting inspection of tuberculosis outbreaks, control of health status for children and teens.

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Chapter 10. ECOLOGICAL AND MORPHOLOGICAL PECULIARITIES OF MOTHERWORT *(L. VILLOSUS),* CULTIVATED IN THE CONDITIONS OF THE PRECARPATHIAN REGION

M. SHPEK[1], V. STAKHIV[1,2], H. KOSSAK[1], O. LUPAK[1], O. LYTVYN[2], V. PETRUNIV[3]

[1]Drohobych Ivan Franko State Pedagogical University,
24, I. Franko Str., 82100 Drohobych, Ukraine
e-mail: vasylstakhiv@ukr.net
[2]Lviv National Agrarian University,
1, V. Velykyi Str., 80381 Dubliany, Ukraine
e-mail: lytvyn.olha@gmail.com
[3]S. Z. Hzhytskyi Lviv National University of the Veterinary Medicine,
50, Pekarska Str., 79010 Lviv, Ukraine

Abstract. *The article presents the results of research conducted during 2018 on the influence of concentrated organomineral humic fertilizers Dobryn-Stymul-S and Stymovit Ferti on morphological indices, yield and content of biologically active substances of the motherwort (L. villosus), cultivated in the conditions of the Precarpathian region of Ukraine.*

According to the research results, concentrated organomineral humic fertilizers Dobryn-Stymul-S and Stymovit Ferti had a definite influence on plant growth and development, morphological indices, yield and content of biologically active substances of motherwort (L. villosus) cultivated in the soil and climatic conditions of the Precarpathian region of Ukraine. The best results were obtained in the variant with double applying Stymovit Ferti fertilizer (for the first time – in the phase of shoots 5 l/ha and for the second time – in the phase of budding 5 l/ha).

Keywords: *Motherwort (L. villosus); Concentrated organo-mineral humic fertilizers; Morphological indices; Biologically active substances; Photosynthetic pigments.*

Introduction

The study and use of medicinal plants in our country is extremely important. In order to ensure the continuity of the chemical composition and reproducibility of the quality indicators of medicinal raw materials, more types of medicinal plants in Ukraine are grown in culture. The complexity of the cultivation of medicinal plants in the world as a whole, and in Ukraine in particular, is related to their special requirements for growing conditions.

The refinement and improvement of existing technologies with the new agro measures can not only reduce the cost of growing raw materials due to innovations but also significantly increase both yield and quality of raw materials.

Widespread use in the modern traditional and non-traditional medicine of phytopreparations leads to the study of agrobiological features of cultivation of medicinal plants, in particular, of motherwort *(L. villosus)* [1; 2; 6].

An important reserve for increasing the yield of medicinal plants and improving the quality of plant pharmaceutical raw materials is the use of biological preparations, namely, concentrated ecologically friendly organo-mineral humic fertilizers. They are increasingly becoming an integral part of the technology of growing various cultures.

Thus, the use of biological products contributes to the most possible implementation of the potential of plants, inherent in the genome by nature and selection, to regulate the terms of ripening, improve quality and increase the productivity of crops [3].

That is why the study of the effect of concentrated ecologically friendly organo-mineral humic fertilizers on the quantitative and qualitative indices of motherwort *(L. villosus)* is relevant.

The purpose of research

To investigate the influence of concentrated organomineral humic fertilizers of Dobryn-Stymul-S and Smymovit Ferti on the morphological indices, yield and biologically active substances of motherwort *(L. villosus).*

Material and methods

The research was carried out in the field crop rotation of the educational-research area of the Drohobych Ivan Franko State Pedagogical University during 2018.

Soils of the field where the research was carried out were sod-podzolic medium loamy ones with the following agrochemical parameters *(Table 1).*

Table 1

Agrochemical characteristics of the soil of the experimental site

Indicator	The content of nutrients in the soil
pH saline	5.8
Humus (by Tyurin), %	2.77
Nitrogen (according to Tyurin-Konov), mg/kg of soil	84.0
Phosphorus (according to Kirsanov), mg/kg of soil	147.0
Potassium (according to Maslova), mg/kg of soil	63.0
Bor, mg/kg of soil	0.98
Manganese, mg/kg of soil	12.4
Copper, mg/kg of soil	1.44
Zinc, mg/kg of soil	4.02

As it can be seen from *Table 1*, the content of humus in the arable layer is 2.77; the reaction of the soil solution is slightly acidic, nutrient supply is average.

The climate of the Precarpathian region (Drohobych district) is moderately warm with sufficient rainfall.

Winter is predominantly mild, the summer is less hot than in other parts of Ukraine, the rainfalls increases 1.5–2.0 times a year. Winter and summer are dominated by winds of the western and southwest directions, which considerably soften the temperature regime and create conditions for sufficient moisture.

The sum of active temperatures during the period of active vegetation of agricultural crops with an average daily temperature of more than 10 ºC is 2400–2600 ºC. Without a frosty period is quite long and is 160–165 days.

The sum of annual precipitation in the Carpathian region is 800–900 mm. 72% of these ones fall in the warm period (April-October), the rest – in cold months (November-March).

The amount of precipitation prevails over the amount of evaporation, but in some years there is a deviation in one direction or another.

Spring begins in the second – the third decade of March, in some years, even in April and lasts 60–75 days. In the first decade of April, the average daily temperatures exceed 5 ºC, and in the third decade 10 ºC, which contributes to the intensive growth of most plants. In the spring, there is frostbite, which damages the vegetable, fruit crops, as well as potatoes.

Summer is always warm, with sufficient moisture. Begins in the first decade of June, when the average daily air temperature exceeds 15 ºC and lasts until the end of August. In the warmest month – July the average temperature fluctuates from +17 ºC to +22 ºC and the maximum – from +30 ºC to +35 ºC. In summer, there are heavy rains with thunderstorms,

sometimes hail. As a result of the storm, grains, flax, and the upper layer of soil are washed away. In some years there is a drought in the summer.

Autumn begins at the end of September or early October when the average daily temperature is lower than +10 ºC. In September, the cloudy dry weather predominates, in some years there is even frostbite.

The vegetation period ends in late October when the average daily air temperature becomes lower +5 ºC.

Consequently, the pre-Carpathian climatic conditions are generally favorable for the cultivation of regionalized crops, including motherwort *(L. villosus)*.

As for the meteorological conditions of 2018, they differed from the average perennials, especially during the vegetation of plants. During this period, the average monthly temperature was slightly different from the average perennial. Frost and dry weather in May – June influenced the growth and development of the motherwort *(L. villosus)* and the formation of a crop. However, the temperature regime of August-September was quite favorable for motherwort *(L. villosus)*, the average daily temperature was in average – 19.5 ºC.

The program of our research was to study the effect of Dobryn-Stymul-S and Stymovit-Ferti on the morphological and yield characteristics of the motherwort *(L. villosus)*, as well as the content of biologically active substances in these plants.

Repeat triple play. The accounting area of the plot is 5 m^2.

The research was carried out in accordance with the methodology of conducting field experiments to study the main methods of cultivating crops [7].

To conduct research, we have laid out three experiments with this scheme:

Experimental options		**Spraying of plants in the phase of shoots (regrowth) (per 1 hectare)**	**Spraying plants at the beginning of the budding (per 1 hectare)**
No.	*The use of biological preparations*		
1	Control – (without applying biological preparations)	–	–
2	Stymovit Ferti	10 liters	–
3	Stymovit Ferti	–	10 liters
4	Stymovit Ferti	5 liters	5 liters
5	Dobryn-Stymul-S	10 liters	–
6	Dobryn-Stymul-S	–	10 liters
7	Dobryn-Stymul-S	5 liters	5 liters

The study of the influence of the norms and time of the applying of biological formulations of Dobryn-Stymul-S and Stamomat Ferti on the morphological parameters, yield and the content of biologically active substances in the motherwort *(L. villosus)* was carried out by laying out field experiments, phenological observations, biometric and laboratory analyses in accordance with common methodology.

Mathematical processing of data was carried out by the method of variational statistics B. A. Armor [7].

Biological preparations Dobryn-Stymul-S and Stymovit Ferti were manually added according to the experimental scheme in the form of a solution – a paddle sprayer (the working solution was 400 liters per hectare).

Materials and objects of research. Dobryn-Stymul-S – universal concentrated environmentally friendly organomineral humic fertilizer on the basis of lacustrine sapropel "STYMUL S" intended for:

- *Stimulation of plant growth.* Gumates Dobryn-Stymul-S with Oxygen Activators and Hydrogen Carriers. Due to this, they increase the energy potential of the plant cell, promote more complete absorption of carbon dioxide from the air, increase the intensity of photosynthesis and metabolism in the plant, which leads to rapid growth and development, especially in the initial phases of development of plants.
- *Protection of plants from adverse environmental factors.* Dobryn-Stymul-S is especially effective when plants are in extreme conditions. Dobryn-Stymul-S affects metabolism and the development of special enzymes that increase the resistance of plants to adverse environmental factors (drought, freezing, various diseases, plant treatment with pesticides, etc.).
- *Reduction of mineral fertilizer application rates.* Dobryn-Stymul-S allows the plant to absorb more of the components of mineral nutrition from the soil: nitrogen – due to the intensification of metabolic processes, potassium – due to the selective increase in the cell membrane, phosphorus, which prevents the formation of insoluble phosphates.
- *Improving the quality of agricultural products.* Dobryn-Stymul-S guarantees reduction of nitrate content; improvement of appearance; increase nutritional value and taste due to increasing the content of vitamins, microelements, proteins, sugars, etc.

Stymovit Ferti – highly effective concentrated environmentally friendly organic fertilizer made on the basis of extract from the biohumus. Enriched with macro- and microelements and a complex of biologically active substances of natural origin. Due to its special composition, Stymovit Ferti fully satisfies the needs of crops in organic and mineral nutrients.

Purpose: root and foliar fertilization of agricultural crops during the period of active vegetation for equal development, stable immunity, oval growth and improvement of quantitative and qualitative characteristics of the crop.

Composition: humic substances up to 1.5%, N – 2.8%, P – 2.8%, K – 2.8%, Ca – 0.5%, Mg – 0.3%, and Mn, Cu, Zn Co.

Determination of the content of photosynthetic pigments in leaves of motherwort (L. villosus)

The content of chlorophylls a, b and carotenoids in leaves of *L. villosus* was determined in the total extract of pigments without prior separation [12].

The course of analysis. The weighed plant material of 50 mg was shredded with scissors and placed in a porcelain mortar. A small amount of $CaCO_3$ was added to the tip of the scalpel (to neutralize cellular acid acids in order to prevent the pigmentation of the pseudophytonation), quartz sand, 2–3 ml of 80% acetone was added and carefully triturated.

The resulting extract was poured into a measuring tube at 10 ml. The stool was rinsed several times in small portions of acetone and the volume of pure acetone was measured in a volumetric vial to the label. Then, acetonium extract is centrifuged for 10 minutes at 3 000 rpm.

The optical density of the extract was determined at wavelengths corresponding to the absorption maxima of chlorophylls ani b, for 80% acetone – 663 and 646 nm respectively, and for the number of carotenoids at 470 nm. The solvent was used as a control.

The concentration of pigments was calculated by Lichtentaler:

$$\mathbf{C_{chl.\ a,\ mg/l} = 12{,}21 \cdot D_{663} - 2{,}81 \cdot D_{646},}$$

$$\mathbf{C_{chl.\ b,\ mg/l} = 20{,}13 \cdot D_{646} - 5{,}03 \cdot D_{663}.}$$

$$\mathbf{C_{car.,\ mg/l} = (1000 \cdot D_{470} - 3{,}27 \cdot C_{chl.\ a} - 100 \cdot C_{chl.\ b})/229}$$

The content of pigments (A) in plant material, calculated by the following formula:

$$A_{,\ mg/g} = \frac{C \cdot V}{H \cdot 1000},$$

where C – concentration of pigments, mg/l,
V – the volume of extract, ml (10 ml),
H – weight loss plant material, g.

Determination of ascorbic acid content in motherwort (L. villosus)

The content of ascorbic acid (AA) in leaf extracts of *L. villosus* was determined by Murry using a Tylmans reagent (2,6-dichlorophenolindophenol), the aqueous solution of which was deactivated under the influence of AK [10].

Preparation of the extract. The weight of 5 g of fresh plant material was homogenized by rubbing in a porcelain cup in the presence of 2% metaphosphoric acid and bringing the volume to 100 ml with the same acid. The homogenate was centrifuged at 700 g.

The course of analysis. In the test samples, 5 ml of extract and 0.5 ml of 0.025% solution of 2,6-dichlorophenolindophenol were introduced. The stopwatch was immediately switched on and after 35 s photometric at 530 nm in a cuvette with a working length of 1 cm against 2% acid. As a control, a sample containing 5 ml of 2% acid and 0.5 ml of dye was used. The change in the intensity of the color of the experimental solution is proportional to the amount of AA.

According to the calibration graph we found the mass concentration of AA in the photometric samples, mg/ml.

The content of AA in leaf extracts of *L. villosus* was calculated by the formula:

$$X = \frac{C \cdot n \cdot V}{m},$$ where

X – the amount of AA, μg/g of raw mass;
C – the content of AA, mg/ml extract found on the calibration graph;
n – dilution of the initial extract in the photometric sample;
V – volume of extract, ml;
m – the weight of weight loss, g.

Results and discussion

An important reserve for increasing the yield of medicinal plants and improving the quality of plant pharmaceutical raw materials is the use of biological preparations, namely, concentrated organic cleaner organomineral humic fertilizers. They are increasingly becoming an integral part of the technology of growing various cultures.

As our studies conducted in 2018 showed, concentrated organo-mineral humic fertilizers had a definite effect on the morphological parameters of motherwort *(L. villosus) (Table 2).*

The best of these indicators were found in the variants with fertilizer application Dobryn-Stimul-S and Stefanovic Ferti in two terms (for the first time – when spraying plants in the phase of stairs and the second time – when spraying plants at the beginning of the budding).

The highest rate of this indicator was in the variant with the use of Fertilizer Slimovot Ferti in the spraying of plants in two terms (the first time – when spraying plants in the normal range of 5 l/ha in the phase of stairs and the second time – 5 l/ha when spraying plants in the phase of budding). In this variant, the plant height was 108 cm. The smallest plant height (85 cm) was established in plants *L. villosus* in the control variant.

Regarding the average number of stems in the plant and the mass of the plant, these indices were also the highest in the application of concentrated organomineral humic fertilizers of Stymovit Ferti and Dobryn-Stymul-S in two terms (for the first time – when spraying plants in the phase of shoots and for the second time – when spraying plants in the phase of budding).

The largest number of stems in a plant – 10 pcs. With an average weight of the plant, 469 g was installed in the variant with the use of Fertilizer Fertilizer in two terms (for the first time – when spraying plants in the phase of stacks of 5 l/ha, and the second time – when spraying plants in the phase of budding 5 l/ha).

Somehow lower these indicators were set in variants with one-time application of fertilizers.

Table 2

Influence of biological preparations on morphological indices of the medicinal plant *L. villosus*

Experimental options		**Spraying plants in the phase of stairs (per 1 hectare)**	**Spraying plants at the beginning of budding (per 1 hectare)**	**Plant height, centimeter**	**Number of stems, pieces**	**Weight of the plant, grams**
No.	*The use of biological preparations*					
1	Control (without applying preparations)	–	–	85	6	340
2	Stymovit Ferti	10 litres	–	102	9	460
3	Stymovit Ferti	–	10 litres	97	7	452
4	Stymovit Ferti	5 litres	5 litres	108	10	469
5	Dobryn-Stymul-S	10 litres	–	95	8	451
6	Dobryn-Stymul-S	–	10 litres	92	7	443
7	Dobryn-Stymul-S	5 litres	5 litrs	101	9	458

The medicinal effect of medicinal plants is conditioned by the presence of a number of biologically active substances which, when introduced into the human body, reveal physiologically active properties and affect various functions in the body [8; 9].

The productivity of plants, mainly, is determined by the process of photosynthesis, due to which solar energy is accumulated in the form of organic matter. During photosynthesis, chlorophylls absorb light, among which chlorophyll a is the base. Biological agents affect the content of pigments in plants.

Investigation of the content of pigments and ascorbic acid in the leaf of plants L. villosus grown under the influence of biological preparations. We determined the content of pigments in a leaf of *L. villosus* plants cultivated for the introduction of biological preparations. It was determined that the highest content of chlorophyll a, b and carotenoids in comparison with the control are characterized by *L. villosus* plants, grown for two-fold applying Stimovit Ferti and Dobryn-Stymul-S *(Table 3)*. In particular, the content of chlorophyll a in the control was 0.91 ± 0.04 mg/g of crude mass, and for the two-fold application of Stiimovit Ferti increased by 23% and by 19% for the double application of Dobryn-Stymul-S. The content of chlorophyll b in the leaf of plants of the control variant was 0.27 ± 0.01 mg/g of crude mass, and in experimental variants, it increased by 21% and 17% respectively. Regarding carotenoid content, their amount also increased for the above-mentioned preparations by 18% and 16%, respectively, compared with the control (0.17 ± 0.01 mg/g of crude). The introduction of preparations into the staging phase contributed to an increase in the content of pigments in the leaves of *L. villosus* plants compared with plants grown in control but was lower than that of plants grown for two-fold administration of these drugs. Analyzing the content of pigments in

plants grown for the introduction of preparations at the beginning of the budding phase, we can state that no significant effect on the content of chlorophyll biologics was not. Only carotenoid content increased by 12% compared with the control of the introduction of Stymovit Ferti at the beginning of the budding.

Table 3

The content of pigments in leaves of plants *L. villosus* depending on the influence of biological preparations (M ± m, n = 5)

Experimental options		Spraying of plants in the phase of shoots (per 1 hectare)	Spraying plants at the beginning of budding (per 1 hectare)	Pigment content mg/g of crude mass		
No.	*The use of biological preparations*			**The content of chlorophyll a**	**The content of chlorophyll b**	**Carotenoid content**
1	Control (without applying biological preparations)	–	–	0.91 ± 0.04	0.27 ± 0.01	0.17 ± 0.01
2	Stymovit Ferti	10 litres	–	1.02 ± 0.05	0.31 ± 0.02	0.19 ± 0.02
3	Stymovit Ferti	–	10 litres	0.97 ± 0.04	0.29 ± 0.01	0.19 ± 0.02
4	Stymovit Ferti	5 litres	5 litres	1.12 ± 0.05	0.33 ± 0.02	0.20 ± 0.03
5	Dobryn-Stymul-S	10 litres	–	1.01 ± 0.04	0.31 ± 0.02	0.192 ± 0.02
6	Dobryn-Stymul-S	–	10 lites	0.96 ± 0.04	0.28 ± 0.01	0.175 ± 0.02
7	Dobryn-Stymul-S	5 litres	5 litres	1.08 ± 0.05	0.32 ± 0.02	0.197 ± 0.03

Ascorbic acid is interrelated with glutathione, tocopherol, is involved in the oxidation of endogenous substances, stimulates the activity of the cytochrome cycle, the process of hydroxylation. At the same time, it promotes the activity of cytochrome P-450, macrophages, phagocytosis, exhibits antibacterial properties, increases the nonspecific resistance of the organism [4; 5].

Therefore, we investigated the content of ascorbic acid in a leaf of plants *L. villosus*, cultivated for the introduction of biological preparations. It has been shown that the highest content of ascorbic acid in comparison with the control (1.45 ± 0.07 μg/g of crude mass) by 22.8% is characterized by plants *L. vilosus*, grown for two-time introduction of Stymovit Ferti *(Diagram 3)*. The applying preparations in two stages and in the phase of shoots promoted an increase in the content of ascorbic acid in the leaves of *L. villosus* plants compared to the plants grown in the control. Instead, the introduction of biologics during plant cultivation at the beginning of the budding phase did not affect the content of ascorbic acid in the leaves of plants *L. villosus*.

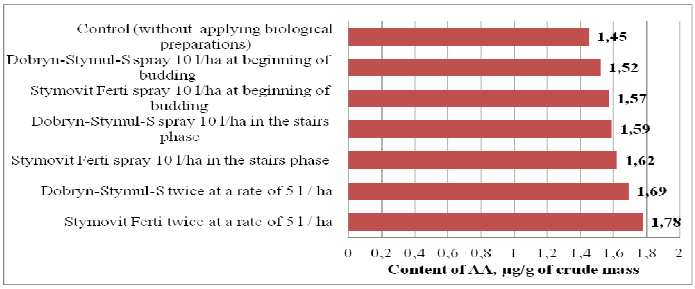

Diagram 3. Content of ascorbic acid in leaflets of plants L. villosus depending on the effect of biological preparations

Conclusions

Soil and climatic conditions of the Precarpathian region are favorable for the cultivation of motherwort *(L. villosus)*.

Studies have shown that concentrated organomineral humic fertilizers, Stymovit Ferti, and Dobryn-Stimul-S, have significantly influenced the morphological characteristics of motherwort *(L. villosus)*. The highest rates were set for variants using Stimovit Ferti and Dobryn-Stimul-S fertilizers in two terms (the first time – when spraying plants in the phase of shoots 5 liters per hectare and the second time – when spraying plants in the budding phase of 5 l/ha), which significantly influenced the height of plants, the number of stems and shoots per plant and the length of the flowering part of the plant (inflorescence).

Humic fertilizers Stymovit Ferti and Dobryn-Stymul-S also influence the increase of the content of biologically active substances in the leaflets of medicinal plants of the motherwort *(L. villosus)*. The highest of these indicators were found on the variants with the use of Fertilizers Stymovit Ferti in two terms (for the first time – at spraying of plants in the phase of shoots 5 l/ha, and for the second time – when spraying plants in the budding phase of 5 l/ha), which was 22.8% higher than control (without fertilization).

The one-time introduction of biologics during plant cultivation at the beginning of the budding phase did not affect the content of ascorbic acid in the medicinal plants of the motherwort *(L. villosus)*.

Thus, the motherwort *(L. villosus)* is the best cultivated in the soil-climatic conditions of the Precarpathian region of Ukraine with the use of biomaterials of Stymovit Ferti and Dobryn-Stymul-S in two additions: (the first time – when spraying the crops in the phase of the shoots and the second time – at the spraying crops in the phase of budding).

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Chapter 11. CREATION OF EFFECTIVE PHOTOCATALITIC SYSTEMS WITH EXPANDED LIGHT SENSITIVITY RANGE

L.ODOSII[1], L. KROPYVNYTSKA[2], I. KOBASA[3], M. MIKHLYOVA[4]

[1]Hetman Petro Sahaidachnyi National Army Academy,
32, Heroes of Maidan Str., 79000 Lviv, Ukraine
odosiu@ukr.net
[2]Drohobych Ivan Franko State Pedagogical University,
24, I. Franko Str., 82100 Drohobych, Ukraine
kropliliya@ukr.net
[3]Yuriy Fedkovych Chernivtsi National University
2, M. Kotsyubinskogo Str, 58012 Chernivtsi, Ukraine
I.Kobasa@chnu.edu.ua
[4]Hetman Petro Sahaidachnyi National Army Academy,
32, Heroes of Maidan Str., 79000 Lviv, Ukraine
galmih@ukr.net

Abstract. *The search for effective photocatalytic systems is in the phase of intensive research which mostly focuses on such urgent human problems as photocatalytic transformation and the storage of solar energy. Solar power belongs to one of the most promising areas of the rapidly developing eco-power industry. In particular, the studies in this area also provide an environmental aspect, which is to preserve the stocks of traditional energy sources, fossil fuels, the consumption of which will lead to the inevitable exhaustion accompanied by pollution of the environment.*

Despite the large number of studies carried out in the field of photocatalysis, the problem of creating highly efficient, cost-effective and energy-efficient photocatalytic systems is still unresolved. The most important prerequisite for the success in these areas is to create such photocatalytic systems that would ensure the flow of appropriate chemical reactions with high quantum yields. This gives grounds to regard topical the research aimed at increasing the activity of photo catalysts and expanding the range of their photosensitivity, on the development of such materials and on the application of their peculiarities in the course of various chemical transformations.

Keywords*: Photocatalyst; Heterostructure; Sensitizer; Polymethinedye.*

Introduction

The construction of photocatalytic systems is based on the principles of classical photocatalysis; however, a more actual is nanocatalysis aimed at the creation of an energy-balanced photocatalytic system for both nano- and micro-sized catalysts; is very effective for semiconductor and metal-complex materials and nanosystems.

The simplest redox photocatalytic system should contain a semiconductor photocatalyst (PC) and two reagents, one of which is an electron acceptor (A) and the other – electron donor (D). A closed photocatalytic cycle is realized in the case when after photogeneration of the pair electron-hole acceptor takes an electron from the conduction band while the hole is transferred to the donor. Subsequent reactions of intermediate products A^{-} and D^{+} can take place without the participation of the photocatalyst and the action of light [20, 21].

$$(PC \xrightarrow{h\upsilon} e^{-} + h^{+})$$

$$(e^- + A \rightarrow A^{\overline{\cdot}}_{+})$$
$$(h^+ + D \rightarrow D^{\cdot +}).$$

A necessary condition for the functioning of the photocatalytic system is the balance of the thermodynamic and energy characteristics of the components of the system, which leads to the formation of products that in turn would lead to the oxidation of D and the restoration of A. Thus formed ion-radicals enter into further dark interactions leading to obtaining finite stable products (P):

$$A^{\overline{\cdot}} \rightarrow P_1; D^{\cdot +} \rightarrow P_2,$$

or after the inter-combination conversion to the triplet state of T_1. The energy diagram of the simplest photocatalytic systems and the electronic processes occurring in them are presented in *Fig. 1*. [19].

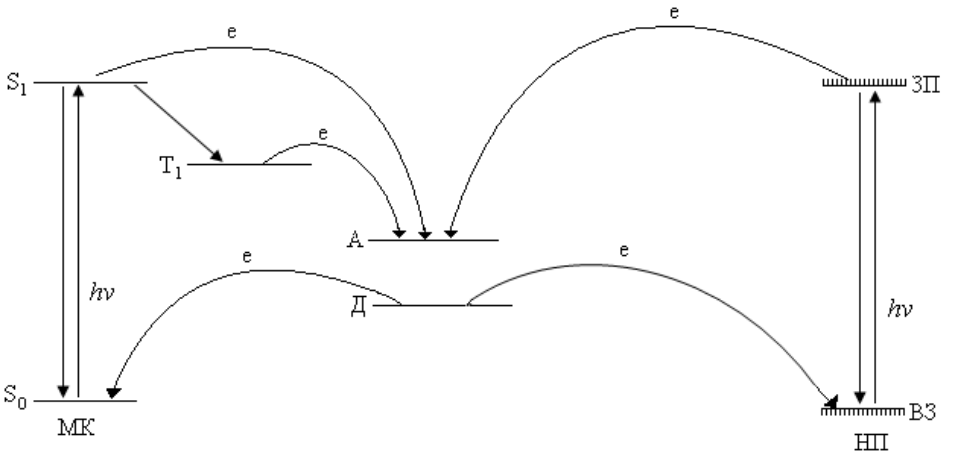


Fig. 1. Mutual arrangement of energy levels of photocatalyst zones and two reagents (acceptor A and donor D) and directions of electronic processes that arise in the simplest photocatalytic system [19]

A closed cycle in a semiconductor photocatalytic system can be realized providing that the potential of the conduction band (E_{CB}) is more negative than the recovery potential of the acceptor (E_A^{red}), and the valence band potential (E_{VB}) is more positive than the potential of the oxidation of the donor ($E_{Д}^{ox}$), that is:

$$E_{CB} < E_A^{red}, \; E_{VB} > E_{Д}^{ox}.$$

The effectiveness of oxidation-reduction reactions according to [20] should increase with increasing energy clefts that characterize the moving force of reactions, which is confirmed by the results of studies [16, 9, 6].

$$\Delta E_{red} = E_A^{red} - E_{CB};$$

$$\Delta E_{ox} = E_{\text{VB}} - E_{Д}^{ox}.$$

This approach to construction is confirmed by numerical studies of photocatalytic activity in the redox reactions of a number of colorants with the participation of TiO_2 [2,17].

From the above-discussed regularities it is clear that a photocatalyst plays the key role in redox processes and the increased efficiency of its activity is crucial for the wide introduction of photocatalysis into practice. With this in mind, it is advisable to consider the requirements for semiconductors as photocatalysts and the main factors that determine their activity. When choosing a semiconductor photocatalyst for this or that reaction, the following requirements must be taken into account: [19]

- ability of photocatalysts to absorb the light of a corresponding spectral range with the transition to excitatory states, to be reactive with respect to the donor and the electron acceptor;
- coherence of the energy levels of the photocatalyst and the energy correspondence of the oxidation-reducing characteristics of the excited photocatalyst and the components of the reaction mixture corresponding to the oxidation and recovery potentials of both photocatalytic system reagents (the bottom of the conduction band and the valence band ceiling, as well as the relative positioning of the energy levels of the zones of the two donor D reagents and acceptor A);
- relative stability of the system, which excludes the most obvious possibilities of irreversible ones, including destructive changes of the photocatalyst when it interacts with the main or excited states with the reaction participants, primary, intermediate and end products.

In particular, factors that determine the activity of photocatalyst should be taken into account since the rate and quantum yields of the oxidation-reduction reaction can be low. To ensure the necessary conditions, according to [19-21], it is necessary:

1. That during its lifetime, the excited state photocatalyst should collide with at least one of the components of the reaction mixture so that the electron transfer could take place. Such transitions can be $S_1 \rightarrow S_o$ and $T_1 \rightarrow S_o$ in the molecular photocatalyst and electron-hole recombination in a semiconductor photocatalyst. Consequently, one of the factors determining the speed of the total process of obtaining end products is the frequency and effectiveness of the collisions mentioned above.
2. The influence of thermodynamic and kinetic characteristics of reactions that are not related to the closed photocatalytic cycle, that is, the transformations of the primary products D and A, which result in the formation of end products.
3. The factor associated with the properties of the photocatalyst itself, namely: the type of electronic transitions under the action of a quantum of light, the orbital nature of excited states, and the time of their life.
4. A factor that adversely affects the efficiency of the photocatalytic process is the possibility of reactions of the radical ions $D^{+\cdot}$ та $A^{-\cdot}$ with ionic radicals of the molecular photocatalyst $M^{-\cdot}$ та $M^{+\cdot}$ or an electron or hole of the photo-excited semiconductor, which in many cases proceed much faster than the reactions leading to to the formation of end products.
5. Give a photocatalyst the appropriate form and look, where it will exhibit the highest photocatalytic activity, which also depends on the size of the semiconductor par ticles, their surface condition, the presence of impurities, the use of carriers of different nature, etc.

Consideration of such principles is also relevant for further search, studies and development as they have not yet been sufficiently clarified and require a more detailed study.

Thus, the above principles of the organization of photocatalytic systems allow us to "construct" an optimal photocatalyst with the highest photocatalytic activity and increase the efficiency of its photocatalytic action.

According to [8; 12; 19-21; 22] semiconductor photocatalytic materials should absorb light in the near UV – or in the visible area and the position of their conduction zones (CZ) and valence (VZ) zones in the potential scale should be such that there would be thermodynamically winning processes of photogeneration of electrons and holes with a large number of substances, both organic and inorganic.

The location of the valence band of the semiconductor determines the oxidizing capacity of the photogenied holes, and the arrangement of the conduction band is the restorer power of electrons excited to this zone.

For the effective conversion of solar energy, the materials are required with width of the band gap E_g = 1.3 ± 0.3 eV, corresponding to the absorption of light with a wavelength of 1000±250 nm. If E_g is small, semiconductor stability is unsatisfactory. In addition, taking into account the values of the overvoltage, value $E_g \geq$ 2eV is required to carry out electron transport reactions.

Fig. 2 shows the location of different semiconductor zones in a solution at pH = 1 in comparison with the standard potentials of some redox pairs [19].

The location of the valence band of the semiconductor determines the oxidizing capacity of the photo-generated holes whereas the arrangement of the conduction band is the restoring property of the electrons photo-excited to this band. The analysis of the diagrams (Figure 2) shows that the semiconductor compounds SnO_2 (E_g = 3.6 eV), TiO_2 (E_g = 3.2 eV), ZnO (E_g = 3.2 eV), WO_3 (E_g = 2.8 eV), CdS (E_g = 2.5 eV) and others are wide-band and may be suitable for use as photocatalyst in contrast to narrow-band, such as GaAS (E_g = 1.4 eV), CdSe (E_g = 1.7 eV).

They cannot be used as photocatalytically active substances, since the electrons of the conduction band of narrow-band semiconductors are weak restorers, and valentine holes are weak oxidizers, and as a result, the photocatalytic cycle cannot be completed.

Therefore, the most active broadband semiconductors proved to be metal oxides (SnO_2, TiO_2, ZnO) [8; 12; 22].

However, most studies are devoted to TiO_2, therefore, let us dwell in detail on a number of publications related to the study of its characteristics.

Titanium (IV) oxide exhibits the properties of a broadband semiconductor. The width of the bandgap of direct transitions in the bulk material is 3.1-3.2 eV for the anatase, for the rutile 2.96-3.03 eV, for the brookite about 3.04 eV. Of the three major structural modifications of TiO_2 (rutile, anatase and brookite), the crystalline structures of which are depicted in *Fig. 3*, the most used are anatase and rutile, but the highest photocatalytic activity is the crystalline modification of anatase [31; 32].

Transitions in anatase at a band gap of 3.2 eV are indirect. In accordance with the modern view, electrons can be in two states: free and bound. In the first state electrons move along a crystal lattice formed by cations Ti^{4+} and oxygen anions O^{2-}.

In the second state – basically the electrons are bound with some ion of the crystal lattice and take part in the formation of the chemical bond.

For the transition of an electron from a bound state to a free energy, it is necessary to use energy greater than 3.2 eV (the width of the anatase band gap). This energy can be delivered by quanta of light with a wavelength $\lambda \leq$ 390 nm.

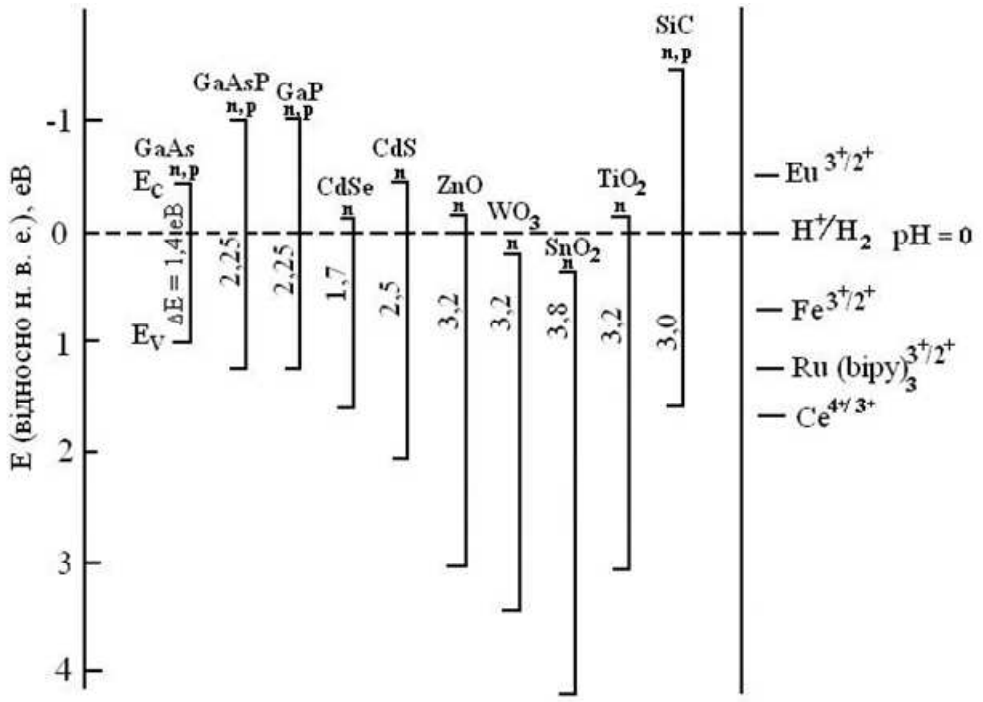


Fig. 2. The positions of energy levels (valence band and conduction band) for a number of semiconductors along with redox potentials [19]

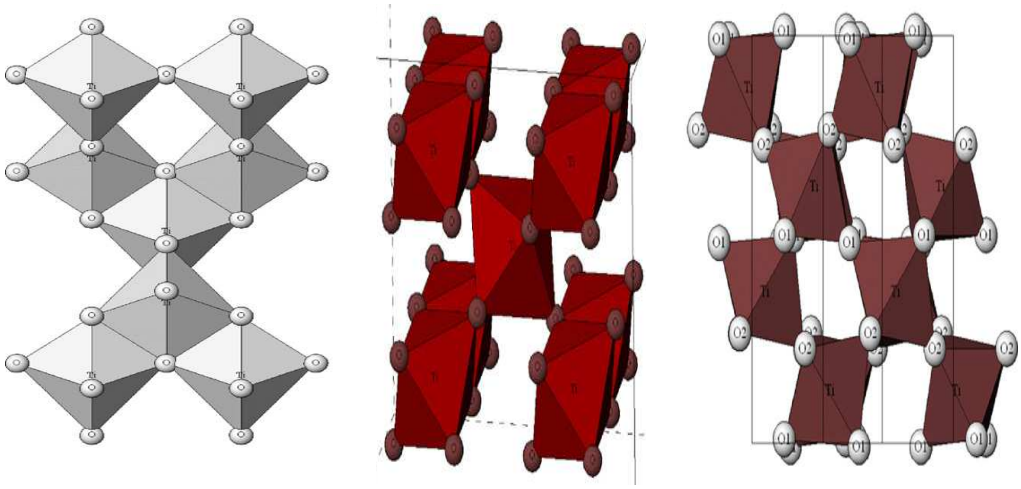


Fig. 3. Projection of the crystalline structure of anatase (a), rutile (b) and brookite (c)

Accordingly, only a small part of the sunlight can be used to carry out photocatalytic processes involving anatase. Nevertheless, among a wide range of semiconductor materials TiO_2 is most often used as a photocatalyst due to its stability in aqueous solutions, cheapness, harmlessness for living organisms [25], and also due to the large oxidizing capacity of photo-generated holes (E = 2.9 V at pH = 0) [24].

The possibility of using semiconductor materials as photocatalyst is also determined by structural parameters that influence photocatalytic activity, namely: phase composition, morphological properties, pH-medium, composition of surface groups, and the presence of defects in both surface and volume of crystals. It was determined [4; 18; 27] that photocatalytic activity of TiO_2 is rather sensitive to its particle size, degree of crystallinity and phase composition.

The physicochemical properties of a semiconductor according to [5; 29] are influenced by a collective factor (the position of the chemical potential of electrons and holes), which is the driving force of charge transfer to a semiconductor, as well as a local factor – the nature and concentration of defects taking part in the formation of active centers. The interaction of the two factors affects the electronic system of the conductor changing the adsorption and catalytic properties. Unfortunately, there are no reliable correlations that connect the activity with the property of the surface of the semiconductor to this day. The efficiency of the catalyst can be increased by the method of sensitization of the photocatalyst in the long-wave area with the initial separation of the photogenerated particles and the catalysis of the dark stages of the photocatalytic process.

There are two known ways to implement the process:

- creation of compositions (addition of a reagent to a photocatalyst);
- creation of the HS.

In the first case, kinetic problems are created for the implementation of electronic processes that involve the need for convergence and connection of components over a short period of time of the excited state of a photocatalyst or sensibilizer for the possibility of their interaction. The photocatalyst only partially reacts with the addition to absorption of a quantum of light, which promotes rapid recombination of the electron and hole and reduces the catalytic process in general.

The second, more effective method of constructing systems is based on the creation of composite materials (hetero-structures), which in their composition contain additional components – photocatalytic blocks [16], which prevent or reduce the negative effect of the recombination process. In particular, for such systems, the convergence of components is not required, since the direct deposition of the component (colorant) takes place directly on the surface of the semiconductor particles and the component in the conditions of photo-excitation easily enters the electron interaction with the photocatalyst. The use of photo blocks makes possible to exclude the process of light-filtering due to the presence of a component (colorant) in an optimal amount. Some components of the hetero-structures are primary mediators that can capture the hole and pass on the reagent contained in the solution volume.

Non-metals, metals and metal oxides, electrically-conductive polymers, colorants that are capable to enter the oxidation-reduction reaction are used as additional components that play the role of photocatalytic units.

Doping with dyes. This method is used to improve photocatalytic properties and relates to nanocatalytic systems. Among the photosensitive semiconductor materials, a special place is occupied by systems consisting of a semiconductor and a dye-sensibilitizer retained on its surface due to chemisorption or physical adsorption, which occurs due to weak Van der Waals forces between the dye molecule and the TiO_2 surface. The quantum-dimensional effect is manifested in increasing the width of the band gap with the corresponding shift of the

absorption band into the short-wave region.

Sensibilitizers, which are used in sensitized dyes in photosensitive systems, can be conveniently divided into two groups: organic and inorganic [3]. The latter include polypyridine complexes of ruthenium and osmium, porphyrins, phthalocyanines. Organic sensibilitizers include natural and synthetic anthocyanins, chlorophylls, which are less thermally and chemically stable than inorganic ones.

The general structure of a typical organic sensitizer: "donor – π-bond – acceptor" is that its absorption region is shifted to the IR region of the spectrum, which causes increased absorption of light. Other advantages of using organic dye as sensibilitizer are: high absorption coefficient due to intermolecular π-π^*-transitions, low cost and lack of expensive components. This direction is rapidly evolving and is effective in converting energy into solar cells using organic dyes. The effectiveness of such cells is already equivalent to those constructed using polypyridyl ruthenium sensibilitizers, most often Ru (II), Ru (III)), which central ion is surrounded by neutral and (or) anionic ligands [28]. The advantage of ruthenium complexes is the wide absorption band in the visible area of the spectrum, due to photo-induced electronic transitions of metal ions/ligands, which leads to the formation of excited states of dye molecules with their lifetime being tens of picoseconds.

The authors [1] developed sensitizers based on coumarin derivatives and achieved the efficiency factor of 7.6%. A group of researchers [10] reached the efficiency of energy conversion at the level of about 9.0% using complex indolinium dyes.

In the paper [13], the implementation of chlorophyll is proposed, which use allowed to obtain the value of the solar energy conversion efficiency of 2.6%. In [11] natural anthocyanin cyanine dye was used as an organic dye-sensibilitizer, the absorption properties of which can be altered by the formation of complexes with polyphenols, pectins, and ions Al^{3+}, Fe^{3+}, Cr^{3+}, Ti^{4+}, Sn^{4+} shifting the absorption spectrum to the long-wave side.

Polymethine dyes have proved to be active transducers of solar radiation energy, which is of great importance when used in highly-effective solar cell sensibilitized dyes [15]. The first dye in this series was synthesized in 1856, which was named "cyanine", the chemical structure of which was established in 1906 but found its practical application as a dye-sensibilitizer only in the 20th century. The studies in this field were initiated by Academician A.I. Kiprianov and later were continued by his students: V.M. Zubarovskiy, G.T. Pilyugin, G.G. Dyadyusha, A.I. Tolmachov, O.O. Ishchenko and others [15] who sought to find dyes with given spectral and chemical properties.

It is polymethines with the widest assortment in the whole visible and near infrared range of the spectrum of photophysical and photochemical properties of organic dyes that are promising for the creation of photosensitive materials by introducing into their chromophore bridge formations [33], which has solved a number of practical issues linked with the transformation of solar energy.

An important study in the transformation of solar energy is the simultaneous adsorption of several different dyes with different absorption maxima on TiO_2 electrode, which increases the efficiency of absorption of solar radiation. It was found in [7] that the efficiency of TiO_2-electrode is increased, which is stipulated by the use of a mixture of two dyes, $Ru(dcbpy)_2(NCS)_2$ and scarred cyanine dye (in a molecular ratio (100:1) that the photocurrent and efficiency drastically decreased when the ratio of the two dyes is 1:1. However, this approach has a limit. Using a mixture of three different dyes, yellow, red and blue to attract the entire spectrum, the quantum yield of products was very low (10%) in the entire long-wave re gion [34]. The combined sensitizing effect of using several dyes is very interesting but not at all simple. It is established that the efficiency of the photocurrent is high if there is a strong interaction between different dyes as the electron and energy transfer is ensured much better.

Thus, the analysis of the above facts indicates the relevance of the study aimed at increasing the activity of photocatalysts and expanding the range of their photosensitivity, the development of such materials and the search for ways of their practical application.

The purpose of the study:

- determine photocatalytic activity;
- establish connections of photocatalytic activity depending on the composition and nature of the interaction of components; to find out the features of their participation in photo-catalytic processes and the possibilities of their practical use;
- design and obtain new photosensitive materials on the basis of titanium (IV) oxide and dye-sensibilitizer with the extended range of photosensitivity.

Material and methods

The research material is the physico-chemical organization of effective redox systems with an extended range of photosensitivity, which provides them with the intended necessary set of properties; redox photocatalytic processes involving these systems.

Methods of research – spectrophotometry, spectroscopy of diffuse reflection.

Results and discussion

To study the sensibilitizing effect of the dye (B) on the semiconductor, heterostructures were constructed using titanium (IV) oxide type P25 (Degussa), polymer polyepoxypropylcarbazole (PEPC) and various dyes. The structure of these hetero-structures is shown in *Fig. 4*

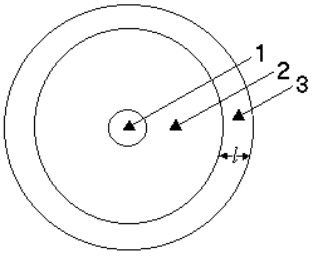
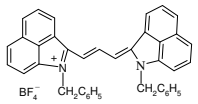
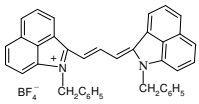


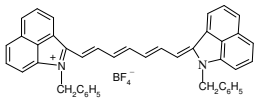
Fig. 4. The structure of the HS TiO_2/B/P: 1 – the particle of the TiO_2 semiconductor, 2 – dye-sensibilitizer; 3 – polymer film (l – thickness of the polymer layer)

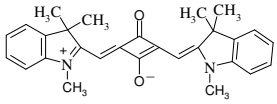
The method [26] was used, which consisted in processing their dispersions with alcoholic solutions of a certain concentration followed by complete evaporation, which lead to the precipitation of the dye on semiconductor particles. After drying the resulting hetero-structures at 40°C, to remove the solvent completely a similar procedure was carried out using a solution of PEPC in benzene in which the dye does not dissolve. As a result, the hetero-structure was covered with a thin film of the polymer, which protected them from dissolution and, at the same time, did not interfere with electronic interactions with the components of the solution. During the experiment it was found that the optimum content of PEPC in HS is 0.02 – 0.2 mg/g. Due to protection from the action of the solvent, we obtained hetero-structures with a very wide content of applied biscyanin containing the amounts at which poly-molecular layers are formed. The studied dyes were synthesized in the Color and Organic Compounds Department at the Institute of Organic Chemistry of the National Academy of Sciences of Ukraine under the direction of Prof. Ishchenko O.O. and provided for research of their photocatalytic properties to the Department of Chemical Analysis, Expertise and Food Safety at Yuriy Fedkovych Chernivtsi National University.

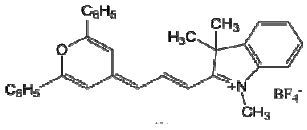
Synthesis and optical characteristics of the studied polymethine dyes given below are described in [14; 23].

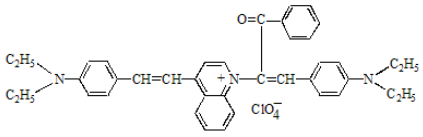

D1


D2


D3


D4


D5


D6

Spectral analysis of cationic symmetrical colorants D1-D3 was carried out. Among them are: cationic symmetric D1-D3 and cation-anionic (flower-ionic) D4 containing one conjugate chromophore and cationic asymmetric D5-D6 with two conjugate chromophores. The structure of the squaraine type D4 dye contains a quaternary cycle with a substituted cyclobuthenone oxygen atom in the middle of the polymethine chain, which should enhance the conjugation of the system. However, a smaller number of methane groups in the D4 molecule can simultaneously reduce conjugation [31].

It was studied that the structure of the dye and the location of the functional groups substantially affects its sensibilitizing ability, and, accordingly, the photocatalytic activity of the hetero-structures on its basis. The analysis of absorption spectra of cationic symmetric dyes D1-D3 shows that they contain an intensive absorption band in the long-wavelength region of the spectrum corresponding to the transition $S_0 \rightarrow S_1$ with a characteristic shoulder of oscillatory nature. Such linear conjugate systems that contain the same finite groups but differ in the number of vinylene groups in the conjugation chain form the so-called vinylogous series, in which, when the polymethine chain extends, the maximum absorption moves to the long-wave region. Symmetrical PBs have the greatest value of the vinylene shift when lengthening the conjugation circuit. It was established that the extension of the polymethine chain in the studied cationic symmetrical dyes D1-D3 to one vinylene group leads to a regular linear bathochromic displacement of the maximum absorption band for 110 and 117 nm, respectively *(Fig. 5).*

To establish the nature of photoreactions that run on the surface of semiconductors sensibilitized with dyes, it is necessary to know the spectral sensitivity of these photo-processes. However, due to the light scattering process, optical measurements of surface absorption spectra are difficult and the obtained results are inaccurate. In order to obtain the correct values, Halman and his colleagues used the method of diffuse reflection spectroscopy to determine the band gap width and spectral sensitivity of semiconductor dispersions. For all the investigated HS diffuse reflection spectra were obtained, which are listed by the Kubelka-Munk method in the absorption spectra for comparative analysis.

Figs. 6-7 show absorption spectra of dye D1 in DMF ($C = 1.0\times10^{-5}$ mol/l) (a) and HS TiO_2/D1/P (b). Dye-sensibilitizer content in HS: 1 – 0.02; 2 – 0.1; 3 – 0.2; 4 –1.0; 5 – 2.0 mg/g. The absorption spectrum of the dye solution D1 with a maximum λ_{max} = 766 nm is expanded in the absorption spectrum of the hetero-structure with the coverage of the ultraviolet, visible and part of the near infrared region. The same pattern is observed for HS with the use of dyes D2 and D3 which have similar narrow spectra with intense peaks at a maximum λ_{max}= 876 and λ_{max}= 993 nm respectively.

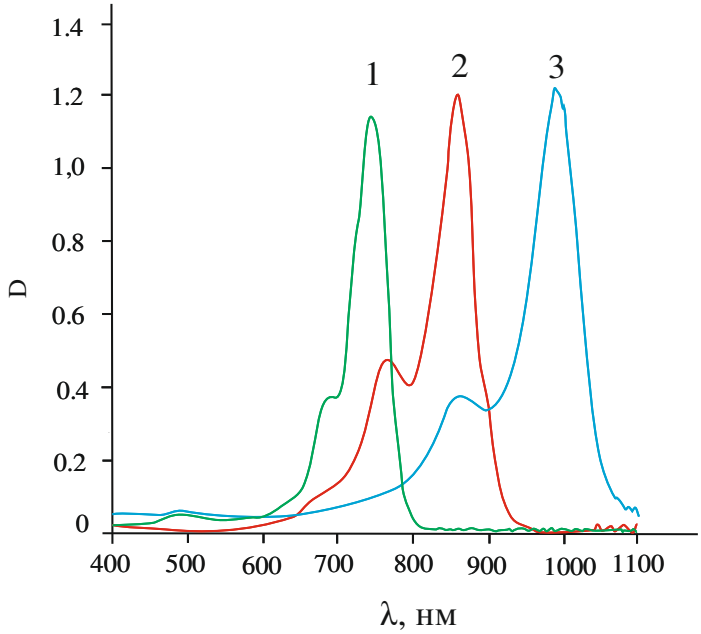
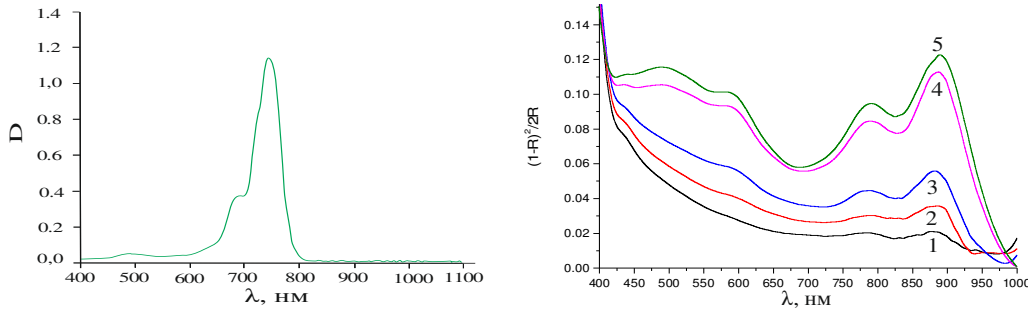


Fig. 5. Absorption spectra of dichloromethane solutions of symmetric cationic dyes D1-D3. The concentration of the dye solution is $2.5 \cdot 10^{-5}$ mol/dm^3



a b

Fig. 6. Absorption spectra of dye D1 in DMF (C = 1.0×10^{-5} mol/l) (a) and HS P/D1/TiO_2 (b). Dye content in HS: 1 – 0.02; 2 – 0.1; 3 – 0.2; 4 –1.0; 5 – 2.0 mg/g

As can be seen from the comparison of the spectra *(Figs. 7 and 8),* depending on where the dye is (in solution or as a part of the hetero-structure), there is a different spectral arrangement of the absorption bands of the dye. In the spectrum of dimethylformamide solution of dye D2 (*Fig. 7),* the maximum absorption band is at λ = 876 nm and in the absorption spectrum of the HS with a content equal to 1 - 0.02; 2 - 0.1; 3 - 0.2; 4 -1.0; 5 - 2.0 mg/g, shifts in the gap λ = 880-895 nm respectively. The largest shift of the absorption band is observed in the case of a dye concentration equal to 0.2 mg/g.

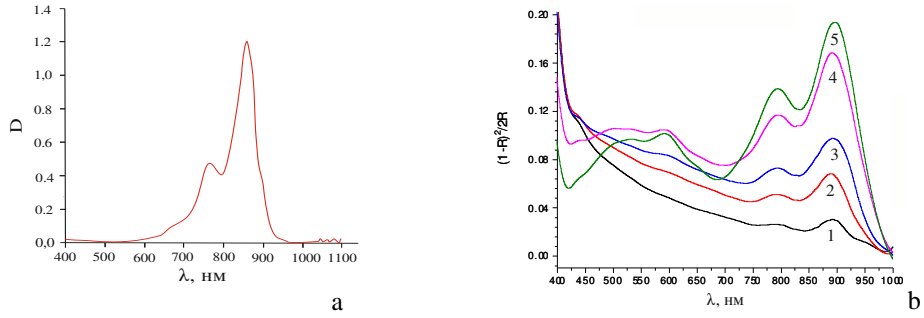


Fig. 7. Absorption spectra of dye D2 in DMF (C = 1.0×10^{-5} mol/l) (a) and HS P/D2TiO$_2$ (b). Dye content in the HS: 1 – 0.02; 2 – 0.1; 3 – 0.2; 4 –1.0; 5 – 2.0 mg/g

For dye D3 *(Fig. 8),* the maximum absorption band is located at λ_{max} = 993 nm, which allows it to attract light from the near infrared region.

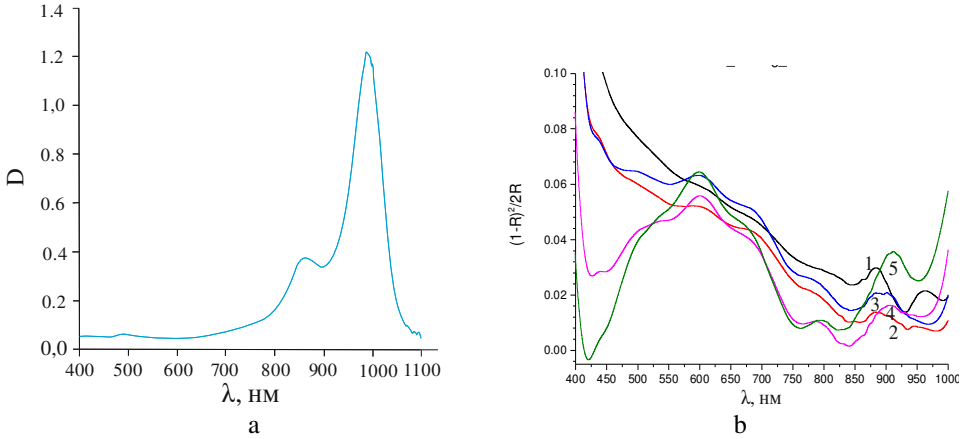


Fig. 8. Absorption spectra of D3 dyes in DMF (C = 1.0×10^{-5} mol/l) (a) and HS П/D3/TiO$_2$ (b). Dye content in HS: 1 – 0.02; 2 – 0.1; 3 – 0.2; 4 –1.0; 5 – 2.0 mg/g

When applied to the surface of titanium (IV) oxide, the absorption band expands and covers almost the entire band of the visible and near-infrared absorption spectrum (from 450 to 950 nm). This creates a potential for use in the photocatalytic process of light quanta of a wide energy band. The results of the analysis of absorption spectra of the HS testify to the significant influence of the semiconductor on the electronic system of dye molecules. This clearly illustrates the use as a sensitizer biscyanine dye D4.

Absorption spectra of dichloromethane dye solution of D4 squarine type with a dye solution concentration of $2.5 \cdot 10^{-5}$ mol/dm^3 is shown in *Fig. 9.* The maximum of its spectrum λ_{max} = 632 nm, which is an order of magnitude greater than the TiO_2 absorption region, indicates that this dye works in the visible region and therefore can attract light of a wider range. In particular, the dye structure of D4, which contains a quaternary cycle with a substituted cyclobuthenone oxygen atom in the middle of the polymethine chain, which should ensure its sensibilitizing ability, and, accordingly, also the photocatalytic activity of the hetero-structures on its basis.

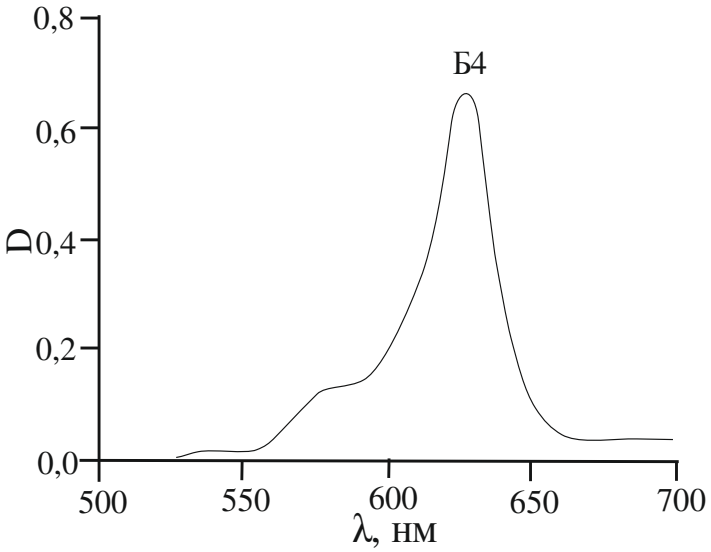


Fig. 9. Absorption spectrum of dichloromethane solution of dye D4. Dye solution concentration is $2.5 \cdot 10^{-5}$ mol/dm^3

Comparison of absorption spectra of D4 dye contained in the solution *(Fig. 9)* and included in the HS *(Fig. 10)* shows that applying it to a solid substrate leads to an increase in the association processes. On the TiO_2 surface, presumably, associates are formed, namely excimers (J- and H-states), which is quite characteristic for this type of dyes. The above is confirmed by the fact that in the case of the formation of associates, new additional bands are usually formed in a region with smaller wavelengths than the dye-monomer. At the same time, the intensity of the narrow band λ_{max} = 632 nm ($\varepsilon = 10^4$ l·mol^{-1}·cm^{-1}) changes, it expands strongly and covers most of the visible band. This creates the potential for use in the photocatalytic process of light quanta of a wide energy range.

Fig. 10 shows the spectrum of absorption of acetonitrile solution of biscyanine dye D4 ($C = 1.25 \cdot 10^{-4}$ mol/l, l = 1 cm) and HS P/D4/TiO_2 with different dye content: 2 – 0.02; 3 – 0.1; 4 – 0.2; 5 – 1.0; 6 – 2.0 mg/g.

Similar dependences are observed for samples of HS containing other studied dyes, in particular, biscyanine dyes D5 and D6, their spectra are shown in *Fig. 11*.

The analysis of the results shows that the application of dye to the TiO_2 surface leads to an increase in the association processes, which results in a change in the intensity ratio of the narrow bands with absorption maxima of the dye solution λ_{max} = 587 nm i λ_{max} = 626 nm. In the absorption spectrum of the hetero-structure, they expand and almost merge into a single band that covers most of the visible region *(Fig. 11).* On the surface of the titanium (IV) oxide, it is likely that aggregates (associates) are formed. They cannot be called polymers because they are not chemically bonded. These associates can be called J- and H-aggregates. Their formation is characteristic of this type of dyes, and they are described in the literature. The width of the absorption band was determined (at 2/3 of the height of the maximum) for the short-wave (sw) and long-wave (lw) band and the values were obtained – 45 and 38 nm respectively. Ratio of intensities I_{sw}/I_{lw} = 0.93. In the spectra of the HS P/D5/TiO_2lw the band is wider than the one observed in the absorption spectra of the solution (*Fig. 11).*

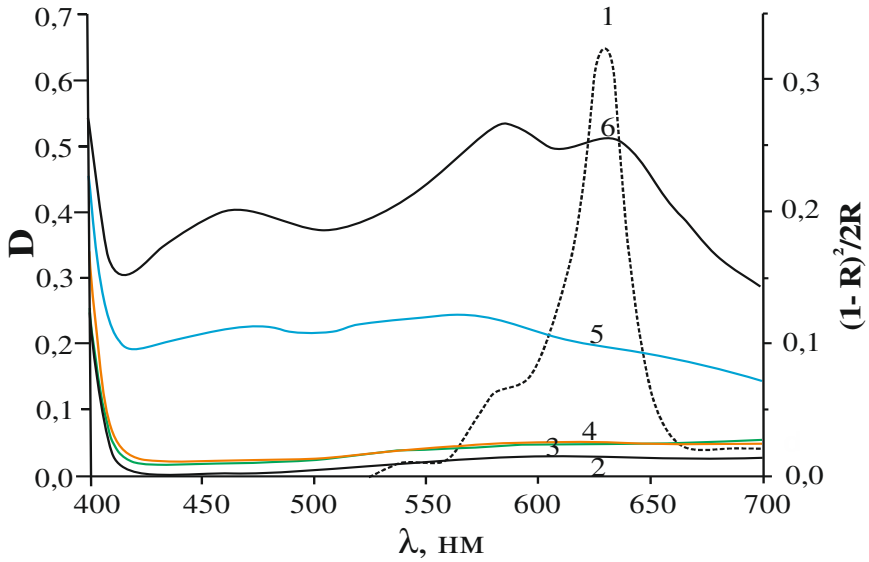


Fig. 10. Absorption spectra: 1 – D4 in acetonitrile (C = 1.25 • 10^{-4} mol / l, l = 1 cm) and HS P/D4/ TiO_2 with different dye content: 2 – 0.02; 3 – 0.1; 4 – 0.2, 5 – 1.0; 6 – 2.0 mg/g

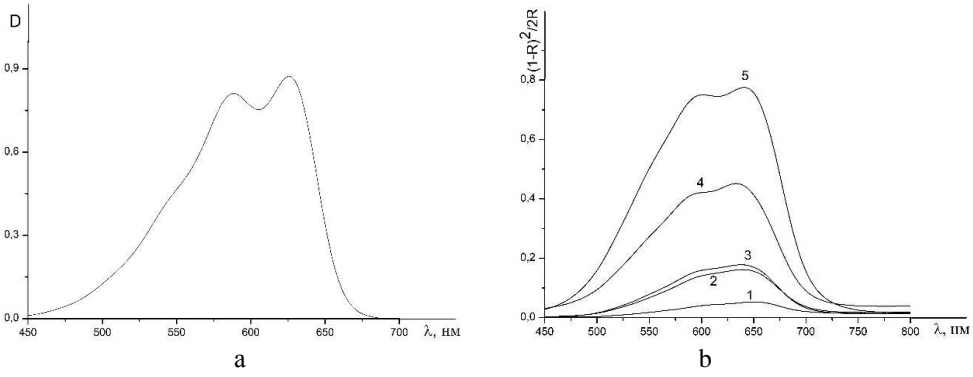


Fig. 11. Absorption spectra of dye D5 in alcohol solution (a) and hetero-structures P/D5/TiO_2 (b). Dye content in the HS (mg/g): 1 – 0.02, 2 – 0.1, 3 – 0.2, 4 – 1.0, 5 – 2.0

The absorption spectra of the HS can trace changes in the most important parameters that occur when the dye is deposited on the titanium (IV) oxide particles and when its content is increased in these materials. The analysis of spectral data showed, firstly, that the position of the two bands depends on how much dye is in the HS. It is shown that λ_{max} of the sw band in samples 5, 4, 3 containing a sensibilitizer in the amount of 2.0, 1.0, and 0.2 mg/g are placed, respectively, at 599, 602, and 606 nm and the position of the lw band for the same samples are located, respectively, at 641, 633, and 637 nm. We failed to determine the position of λ_{max} of sw and lw bands for samples 1 and 2 containing a sensibilitizer in the amounts of 0.1 and 0.02 mg/g due to their large blurring.

The second important change that occurs when switching from solution to HS is a significant increase in the absorption bandwidth, which increases their overlap. Thus, in the sample 5, the width of the sw band is 1.5 times larger than in the spectrum of the solution and similarly, the lw band is characterized by no less smaller value.

A characteristic feature of biscyanines is the presence of the two absorption bands that arise as a result of the interaction of chromophore and the resulting splitting due to this singlet level S at a level with greater and lesser energy. It is shown *(Fig. 12)* that the precipitation of D6 on the surface of TiO_2 leads to a bathochromic displacement of both absorption bands, the magnitude of which is in the antibiotic dependence on its content in the HS. In the case of the HS of the dye D6 from TiO_2 *(Fig. 12),* the short-wave band (λ_{max} = 432 nm) undergoes a shift of 19 and 24 nm, while the long-wave (λ_{max} = 603 nm) is 27 and 21 nm with a dye content of 2.0 and 1.0 mg/g respectively. It was also established that during the application of the dye on the surface of TiO_2 the ratio of the intensity of the short-wave (I_{sw}) and the long-wave (I_{lw}) absorption bands changes, which, according to the theory of biscyanine spectra, indicates a change in the angle between the directions of chromophore from the obtuse ($I_{sw}/I_{lw} < 1$) to acute ($I_{sw}/I_{lw} > 1$) *(Table 1).*

Besides, we found the inverse relation of the degree of change of the parameters of the spectrum λ_{max} and I_{sw}/I_{lw} on the quantity of dye molecules in the HS, which is explained as a result of the decrease of the influence of TiO_2 on their electronic system, that is, weakening of the interaction of the components resulting in deterioration of the conditions for the electron transport photoconductive processes and, consequently, decrease in photocatalytic activity. In all cases as has been established the initial increase in photocatalytic activity is caused by an increase in the number of dye molecules that absorb visible light. With the increase of dye content in the HS the displacement decreases. This is due to the gradual filling of the surface of the semiconductor particles and the transition from the monomolecular layer to the polymolecular coatings.

We also note that even with a hundredfold increase in the amount of dye, the small margin of location of the maximum bands remains, and the mutual influence of the HS components is not completely eliminated. Comparison of the intensity of the bands in the spectrum of absorption of the alcoholic solution of the test bisquinocyanine (*Table 1*) gave the value of $I_{sw.}/I_{lw}$ = 0.76, indicating that the chromophore are arranged at a obtuse angle relative to one another. The analysis of the spectra of the hetero-structures (*Fig. 12*) showed for samples 5, 4, and 3 the values of $I_{sw.}/I_{lw}$, which equal, respectively, 1.02, 1.38, and 1.8, which shows that for a precipitated dye, conformations with acute angles between the directions of chromophore are more advantageous. Changes in the parameter $I_{sw.}/I_{lw}$ as well as the displacement of the maximum bands, are in the inverse relation on the number of its molecules in the HS, and this is satisfactorily explained by the weakening of the influence of the electronic system of titanium (IV) oxide on them.

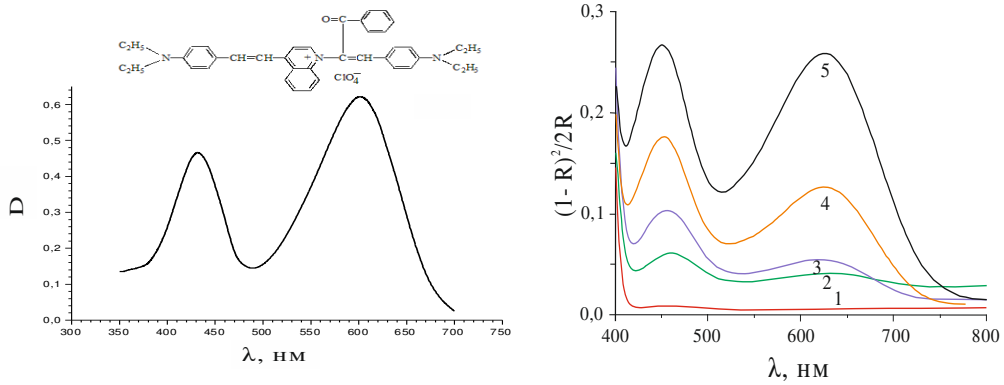
Therefore, proceeding from the above-discussed regularities one can see that deep-colored dyes significantly affect the photosensitivity and increase the efficiency of the photocatalyst and play a decisive role for the wide introduction of this type of photocatalysis into practice.

Conclusions

We have studied the spectral characteristics of different polymethine dyes: cationic symmetric D1-D3 and cation-anionic (flower-ionic) D4 containing one conjugate chromophore and cationic asymmetric D5-D6 with two conjugate chromophores. And we have also established the regularities that connect the spectral properties of polymethine dyes with the length of the polymethine chain and various end heterocyclic groups.

The possibility of predicting photocatalytic activity of semiconductor – dye-sensibilitizer – polymer film heterostructures is shown on the basis of the spectral characteristics of titanium (IV) oxide and polymethine dye.

It has been found that during the application of polymethine dye on the surface of titanium (IV) oxide, the ratio of the intensity of the short-wave and long-wave absorption bands changes, which is accompanied by the expansion of the light sensitivity range.



a b

Fig. 12. Absorption spectra of dye solution (a) and HS P/D6/TiO_2 with different dye content: 1 – 0.02; 2 – 0.1; 3 – 0.2; 4 – 1.0; 5 – 2.0 mg/g

Table 1

Spectral parameters of D6 dye in solution and samples of HS P/D6/TiO_2: maximum of short-wave (sw) and long-wave (lw) absorption bands and their intensity ratios.

Sample	Dye content, mg/g	λ_{1max}, nm	λ_{2max}, nm	I_{sw}/I_{lw}
3	0.2	456	630	1.87
4	1.0	452	626	1.38
5	2.0	451	624	1.02
Solution	$C = 1.0\times10^{-5}$ mol/l	432	603	0.76

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Chapter 12. USE OF VASCULAR PLANTS AS ENVIRONMENTAL PHYTOINDICATORS

H. KRECHKIVSKA, Ya. PAVLYSHAK
Drohobych Ivan Franko State Pedagogical University,
24, I. Franko Str., 82100 Drohobych, Ukraine
e-mail: gkrechkivska@gmail.com
e-mail: bioddpu@ukr.net

Abstract. *Phytoindication is a system for assessing the environmental condition by physiological, morphological, ecological changes in plant-indicators, which are sensitive to changes in environmental factors.*

The use of plants as indicators compared with tests in other organisms has several advantages: relatively inexpensive, short-lived, easy to use, highly sensitive, do not require complicated laboratory equipment.

On the research site (village of Hroz'ovo, Staryy Sambir district), phytodynamic studies were carried out using vascular plants.

The research results showed that vascular plants 9 species can serve as indicators for soil acidity (Equisetum arvense L., Equisetum sylvaticum L., Equisetum palustre L., Mentha laxiflora L., Mentha arvensis L., Plantago major L., Plantago media L., Plantágo lanceoláta L., Melampyrum nemorosum L.); 6 species are indicators for neutral soil conditions (Matricaria recutita L., leucanthemum vulgare L., trifolium repens L., trifolium montanum L., raphanus raphanistrum L., tussilago farfara L.); 2 species are indicators for alkaline soil conditions (sinapis arvensis L. and symphytum officinale L.).

It is proved that in natural ecosystems (meadows, forests, edges and swamps) soils are wet, slightly marshy and have acidic properties. In artificial ecosystems (agricultural lands, fields, gardens), soils are dried, have mostly neutral properties.

Keywords: *Fitomonitoring; Natural ecosystems; Artificial ecosystems; Soil pH.*

Introduction

Due to the deep transformation of the natural environment, which takes place under the influence of anthropogenic influence, which in its scale went to the planetary level, but with the force and speed ahead of the effect of natural factors, the problems of preserving the ecosystem and the biosphere as a whole become more urgent.

The determination of biologically significant anthropogenic loads based on the reactions of living organisms and their groups is associated with phytoindication. The significance of the vegetation as an indicator of the state of the ecosystem is that it is very responsive to the environmental factors, and this reaction is recorded in many cases visually. It is important enough that it reflects the evident nature of changes in the properties of ecosystems, depending on the level of their organization. These three characteristics (sensitivity, visuality, the emergent nature of the change in plant cover) determine the suitability of phytoindication for environmental research, expertise, prediction of behavior, condition and development of ecosystems. The indicator function is performed by the species that has a narrow amplitude of environmental tolerance for any factor. The basis of phytoindication evaluation is the ecological specificity of species growing only in particular zones of the change for an ecological component [9].

The greatest influence of human economic activity is experienced by the ecosystems in a city or a village. Therefore, it is important to monitor the state of the environment and to timely analyze the contamination of the territory. To a certain extent, bioindicative evaluation allow us to solve these questions [2].

All ecological systems – no matter what organisms, populations or biocenoses – in the course of their development are adapted to a set of factors, place of existence. They seized within the biosphere a certain area, an ecological niche, in which there are appropriate conditions of existence, but can normally feed and reproduce. Each organism in relation to any active has a genetically determined, phylogenetically acquired, unique physiological range of tolerance, within which this factor is optimal for it. If this factor is very high or very low intensity, but do not leads to death, then the body is in physiological pessimism.

Beyond the limits of a certain minimum or maximum value of a factor, further life is impossible. In a limited region of the factor intensity, which is particularly conducive to the given individual, the organism exists in a physiological optimum. In the wide tolerance amplitude, organisms are called euripotent, with narrow – stenopotent. In accordance with these organisms or the grouping of organisms which vital functions are so closely correlated with certain environmental factors that can be used to evaluate them, they are called phytodynamics. This meaningful definition also refers to the indication of the natural conditions of the place of residence in general, for example, in agriculture and forestry, in the presence of plants, which are characteristic for a particular ecotope [11].

In phytoindication, changes in the biological system always depend on both anthropogenic and natural environmental factors. This system responds to the action of the environment as a whole, according to its predisposition, that is, internal factors such as nutrition, age, genetically controlled immunity, and already present abnormalities. If the indicator reacts with a significant deviation of life manifestations from the norm, then it is a sensitive phytindicator. Accumulative phytoindicators, on the contrary, accumulate anthropogenic influences by a large part without the rapid detection of changes.

The functions of the indicator are performed by a species that has a narrow amplitude of environmental tolerance in relation to any factor. In most cases, these plants are organisms that are unable to move actively.

The term "indicator" differs in the countries of the European Union and Ukraine.

According to the European Environment Agency, the indicator is a predominantly quantitative indicator that is used to assess the state of the environment and whose use allows to understand the functioning of complex environmental processes in the environment.

Depending on the goal to be achieved in environmental policy, indicators may play different roles [12]: state assessment; performance evaluation; performance estimation; general welfare assessment.

In the last two decades, the European Environment Agency (EEA) published a list of criteria for assessments and indicators for most of the European environmental problems. Today, it includes 12 sections and more than 200 ecological indicators. The overwhelming majority of these indicators are intended to support environmental policy based on data collected by the EEA as well as statistics from other international organizations [21].

The DPSIR assessment system divides the indicators into six types: indicators of driving force, pressure, state, impact and response. This classification helps to structure the perception of the interaction between the environment and socio-economic activity.

It is used to help develop ratings, identify indicators, report on results, and can contribute to improving the effectiveness of environmental monitoring and information gathering. In our country, indicators are called organisms or community of organisms, which vital functions are closely correlated with certain factors of the environment and can be used for their evaluation.

Since the integral part of biota in urban landscapes are plants, it is quite justified to use them as indicators. The large area of contact and intensive gas exchange with the environment cause their high sensitivity to the action of various pollutants, including anthropogenic [3].

The availability of a wide range of plant bioassays makes it possible to use them to assess the enormous amount of mutagenic – physical, chemical, biological – factors and environmental contaminants (water, air, soil) [20; 21].

High efficiency of application of plant organisms as an indicator in comparison with tests in other organisms has several advantages [44]:

- plant tests are relatively inexpensive, short-lived, easy to use, highly sensitive;
- numerous methods have been developed and standardized for indicator plants;
- they do not require complicated laboratory equipment, therefore the use of plant test systems is particularly promising in developing countries [22];
- the correlation coefficient for data obtained in plant tests with the results of testing on cultured mammalian cells is not lower than the correlation index between the results of testing in other organisms;
- higher plants are susceptible to carcinogenic agents [24], etc.

Wild plants, by means of which scientists can determine the nature and condition of the soil on which they grow, called indicator plants. Soil properties, such as moisture content, structure, density, oxygen content, and the content of nutrients, heavy metals and salts, determine the habitat of plants. In exchange for this medium, they react with an increase in the number, vice versa, lack, lush growth, or suppressed development [18].

Materials and methods

Subjects of research

The objects of research were the natural and anthropogenic ecosystems of the village of Hroz'ovo.

There are the following natural ecosystems in the study area: forest, meadows, river, swamps.

Artificial ecosystems in the study area are represented by agrocoenoses (agricultural lands, gardens, fields, countryside courts) and artificial reservoirs (wells and ponds).

Methods

To determine the diversity of bioindicator plants in the village of Hroz'ovo, test sites were selected in the area based on the principle of finding.

7 trial sites were allocated in places with both anthropogenic loading and natural landscape, the selected areas were investigated.

At each of them, research on the diversity of plant indicators, sampling was carried out.

By external attributes, they determined the affiliation with the department, the class of the family, the species.

The study of flora begins with the establishment of species diversity, that is, from the compilation of a list of plant species. For this purpose, literary and herbarium data was used. Field work was carried out during 2016–2018 by the route method. The expedition routes covered evenly the whole territory of the village of Hroz'ovo. As a result of these works, the lands of the State Forest Fund with quarters numbers was investigated in detail. In field studies, special attention was paid to the ecological likeness of species.

The route method covered several stages of the study:

1. Reconnaissance Stage: to study of the features of the area, the main types of vegetation:

1.1. Analysis of the resources use for the studied species in the region;

1.2. Preparation of the plant species list;

1.3. Analysis of the representation for each individual species in the region;

1.4. Definition of terms and amounts of works performance on estimation of resources.

2. Detailed Route Stage: during which we compiled the list of plants that were found, the herbarium material was collected, abundance and location was studied, description of individual associations was conducted.

To determine the abundance, by which it is possible to determine the degree of individuals species participation in the coenosis, a three-dimensional method of direct accounting was used. Such an accounting usually takes place on the scale of the number of species in phytocoenus, in particular, according to the scale proposed by O. Drude [19].

In this system, the following grading was adopted for the assessment of the abundance of the species:

Soc (socialis) 100–81% – plants are connected with aboveground parts;

Cop3 (copiosae) 60–81% – plants are very abundant;

Cop2 40–60% – plants are abundant;

Cop1 30–40% – plants are quite abundant;

Sp (sparsae) 10–30% – plants are rare;

Sol (solitaries) – plants are found singly;

Un (unicum) <1% – one plant in the area of detection.

In the course of the survey, photographs of the area, vegetation groups, and individual plant species were taken. Identification of herbarium specimens was carried out using guide of higher plants [2; 6].

The association of the indicator plant to the soil type was determined by the atlas of indicator plants [1].

Results and discussion

The concept of phytoindication is based on an adequate reflection by the living organism in the environment in which it develops and which reacts accordingly.

These methods have several positive features:

1) cheap and requiring relatively little time;
2) phytoindication data reflect the long-term average state of the atmosphere;
3) in repeated researches (mapping), phytoindication gives an idea of the dynamics for the degree of pollution in the city (village) and other settlements [4].

The main characteristics of the soil can be estimated by wild-growing vascular plant-indicators. They allow the determination of parameters such as acid-alkaline balance, mechanical and chemical composition, nutrition and humidity [10].

pH of soil is an important parameter for farmers and gardeners. High acidity is unfavorable for cultivating most types of cultivated plants, since such a soil contains less useful minerals.

On the territory of the study, 9 species of plants grow, which are an indicator of soil acidity *(Equisetum arvense* L., *Equisetum sylvaticum* L., *Equisetum palustre* L., *Mentha laxiflora* L., *Mentha arvensis* L., *Plantago major* L. *Plantago media* L., *Plantágo lanceoláta* L., *Melampyrum nemorosum* L.), 6 species of plants, which are indicators of the neutral state of the soil *(Matricaria recutita* L., *Leucanthemum vulgare* L., *Trifolium repens* L., *Trifolium montanum* L., *Raphanus raphanistrum L.*, *Tussilago farfara* L.*)*, and 2 species of plants, which are indicators of the alkaline state of the soil *(Sinapis arvensis* L. та *Symphytum officinale* L.*)*.

Land resource potential is one of the main factors of socio-economic development in the region, the primary factor of social development and infrastructure development, an integral part of the natural system. Social well-being and human health are also inextricably linked with land resources. However, at the present stage of socio-economic restructuring of agrarian land use, ecological and economic contradictions became more acute. Degradation of soil cover, erosion, loss of soil humus, rising shortage of nutrients are the main problems of the modern use of land resources.

The greatest danger to the environment is the contamination of soils with radionuclides, heavy metals, pathogens. Under such conditions, the issue of land protection and the creation of prerequisites for the formation of sustainable land tenure in Ukraine is becoming acute [16].

The main reasons for the negative changes in the ecological situation are the lack of progressive technologies, non-compliance with scientifically substantiated crop rotation, the prevalence of monoculture in some agro-enterprises; low rates of organic fertilizer application; violation of the technology of application of mineral fertilizers and pesticides; an increase in the areas of sour, saline, technogenically contaminated lands due to the suspension of works on liming and application of gypsum [13].

The objective definition of the agroecological state for an agricultural land at different levels of land use, as the basis for making managerial decisions regarding the planning of the system of nature and soil protection measures, requires theoretical substantiation and development of the appropriate assessment method [8].

Analysis of world and national experience regarding the conservation use of land resources, as well as the results of previous studies by the Institute of Agroecology of UAAS on the development of methodological approaches to the ecological assessment of lands and soils [2; 5], testify that only a systematic approach that takes into account the interrelationships between agroecological state of land for the agricultural purpose and the complex of natural and anthropogenic factors forming it can become the methodological basis for the ecological evaluation of land use systems.

The quality of the environment and land resources depends to a large extent on the level of general economic development of the territory, which characterizes the intensity of anthropogenic impact on the environment. That is why the regulation of land use is considered as a criterion for the valuation of anthropogenic load on landscapes.

The formation of environmentally sustainable landscapes requires the determination of the optimal ratio of natural and changed economic activities of the land, since their relationship is the main criterion for assessing the ecological state of agro-landscapes. In the system proposed of proposed activities, aimed at increasing the stability of the entire agrarian landscape, a special place belongs to the substantiation of norms that determine the optimal ratio between arable land, forest, meadows and waters depending on local conditions [15].

At the same time, the analysis of many domestic and foreign sources shows that the ratio of environmentally hazardous lands (arable land, gardens, vineyards, etc.) to environmentally sustainable (forests, meadows, swamps, reservoirs) can not exceed one [7; 17].

Reducing the negative effects of extensive land use can be achieved through the introduction of a set of effective measures to optimize the functional structure of modern agricultural landscapes and reduce the anthropogenic pressure on the environment, for which, first of all, it is necessary to assess the ecological balance in relation to the main types of lands [14].

Qualitative and quantitative assessment of ecosystems allows to assess the overall ecological status of the soils in the village of Grozzove and to monitor natural and artificial ecosystems.

During conducting a qualitative assessment, the overall ecological condition of the village of Hroz'ovo can be estimated and the natural and artificial ecosystems can be monitored.

Representatives of acid soil are most common in natural ecosystems: meadows, forests, forest edges and swamps.

Representatives of the neutral and alkaline state of the soil are most common in artificial ecosystems: agricultural lands, fields, gardens.

Table 1

Phytoindicators, their abundance and habitat

Species	Abundance	Habitat
Field horsetail *(Equisetum arvense* L.*)*	plants are found singly	meadow, agricultural land
Wood horsetail *(Equisetum sylvaticum* L.*)*	10–30% (plants are rare)	forest
Marsh horsetail *(Equisetum palustre* L.*)*	60–81% – plants are very abundant	marsh, water reservoirs
Forest mint *(Mentha laxiflora* L.*)*	10–30% (plants are rare)	forest, forest edge
Wild mint *(Mentha arvensis* L.*)*	30–40% (plants are quite abundant)	agricultural land
Broadleaf plantain *(Plantago major* L.*)*	10–30% (plants are rare)	field, meadow
Hoary plantain *(Plantago media* L.*)*	10–30% (plants are rare)	field, garden, meadow
Narrowleaf plantain *(Plantágo lanceoláta* L.*)*	10–30% (plants are rare)	meadow
Blue cowwheat *(Melampyrum nemorosum* L.*)*	plants are found singly	meadow
Phytoindicators of the neutral state of the soil		
German chamomile *(Matricaria recutita* L.*)*	plants are found singly	agricultural land
Oxeye daisy *(Leucanthemum vulgare* L.*)*	10–30% (plants are rare)	field, agricultural land
White Clover *(Trifolium repens* L.*)*	10–30% (plants are rare)	near the river
Mountain clover *(Trifolium montanum* L.*)*	plants are found singly	field, near the river
Wild radish *(Raphanus raphanistrum* L.*)*	plants are found singly	field, agricultural land
Coltsfoot *(Tussilago farfara* L.*)*	40–60% – plants are abundant	near the river
Phytomedicators of the alkaline state of the soil		
Charlock mustard *(Sinapis arvensis* L.*)*	plants are found singly	agricultural land
Common comfrey *(Symphytum officinale* L.*)*	one plant in the area of detection	agricultural land

Conclusions

Phytoindication is a system for assessing the state of the environment by physiological, morphological, environmental changes in a number of plant-indicators that are sensitive to changes in environmental factors.

In the study area, the main part of phytindicative studies were vascular plants.

The research results showed that the main phytoindicators are the following: soil acidity – 9 species of vascular plants; neutral state of the soil – 6 species of vascular plants; alkaline state of the soil – 2 species of vascular plants.

Using phytoindication, the ecological status of the soils in the village of Hroz'ovo in the Staryy Sambir district was estimated.

It is proved that in natural ecosystems (meadows, forests, forest edges and swamps) soils are wet, slightly marshy and have acidic properties. In artificial ecosystems (agricultural lands, fields, gardens), soils are dried, have mostly neutral properties.

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SECTION III

EDUCATIONAL ASPECTS OF ECOLOGY AND HUMAN HEALTH

Chapter 13. INNOVATIVE METHODS FOR THE STUDY OF HEALTH IN THE EDUCATIONAL PROCESS

M. GONCHARENKO, T. KAMNEVA, O. BELLORIN-HERRERA, I. KORZHENKO, T. KUIDINA, A. MELNIKOVA, T. CHYKALO
V. N. Karazin Kharkiv National University,
6, Svobody Sq., 61000 Kharkiv, Ukraine
e-mail: valeolog@karazin.ua

Abstract. *Nowadays, the science of valeology is developing, where human health is considered as a harmonious combination of physical, mental, emotional, intellectual, social, environmental and spiritual health. The Department of valeology in V. N. Karazin Kharkiv National University developed a system of diagnosis of health, which allows you to monitor the state of the body from the cellular level, the level of systems and organs, to the level of energy component, as well as to determine the psycho-physiological and adaptive characteristics of the body. Monitoring is carried out using instrument – computer software systems, developed on the basis of the latest achievements of science and technology, based on modern ideas about man as a complex material and energy-information structure. The diagnosis system is non-invasive, which makes it possible to use it in children's and student groups in the pedagogical process, as well as to determine the level of health and correction of post-traumatic syndrome.*
Keywords*: Health; Adaptation; Energy-informational component of organism.*

Formulation of the problem

The science of the physical body of man develops in the direction of deepening into matter-deepening into the cell, into DNA, molecules and the like. Huge results have been achieved, but despite the fact that the pharmacological industry annually introduces dozens of new drugs into circulation, the incidence does not decrease, but grows [8].

According to Gerber, the fundamental reason for this problem is that: "...Traditional medicine suffers from extreme narrow-mindedness, as it is based on the Newtonian model, which considers a person as a complex biological machine", "...The human being is more than flesh, blood, proteins, fats and nucleic acids. The unique form of fine energy has yet to be thoroughly studied by scientists" [4].

Relevance of the research

It follows from the above that the problems of modern methodology of scientific research and medicine is that it is necessary to change the world in accordance with modern realities, to take into account new theories and discoveries, to approach a person as a complex multi-level material and energy information system.

Professor of Stanford University, William A. Tiller argues that only recently have scientists become aware of the importance of the interaction between the body and the electromagnetic fields, although there is no full understanding of the mechanisms by which electric and magnetic fields are involved in cellular metabolism.

Therefore, relevant are the studies that study human from the point of view of modern worldview.

The problems of training future teachers of the basics of health and the introduction of health-saving technologies in the educational process in Ukraine are urgent.

Analysis of recent research and publications

Recent studies have enriched with new evidence the theory that electromagnetic fields in biological systems play a regulatory and informational role [1–4; 9–11]. In the scientific literature has long been mentioned information that the human body emits electromagnetic fields around the microwave range. Later, a low-frequency electromagnetic field of a person, as well as acoustic and optical waves were registered.

As stated in the introduction to the book [6], from the standpoint of knowledge about the mechanisms of functioning of wave processes in nature and man, the human body is a multidimensional information and energy essence, in which a complex system of fields are in a state of continuous resonance interaction. In the matrix of these fields laid the "programs" that run, supervise and coordinate all functions of the body: hormonal, immune, electrophisiology the like. According to this, health is considered as a dynamic process of formation of the adaptive frequency-resonance matrix in the relationship of energy-wave processes of all morphological structures, carried out on the principle of frequency-resonance bio-feedback.

It is proved by R. Bayevsky that the adaptive capacity of the organism is one of its fundamental properties. First of all, it should be determined that the adaptive capacity – a stock of functional reserves that are constantly spent on maintaining a balance between the body and the environment. The reserve of functional reserves is information, energy and metabolic resources, the expenditure of which is accompanied by constant replenishment [2]. Also in the work of G. Apanasenko it is stated that the energy potential of the biosystem characterizes its viability [1].

In our time, research is carried out, computer systems are created based on the achievements of science and technology to study the human body on the basis of modern worldview [1–7; 10–11].

Modern pedagogy is spend much health of pupils. The urgent need of society and the main priority of the state policy in the field of education should be the creation of optimal conditions for the formation, preservation and strengthening of physical, mental, social and spiritual health of students and young people. The problem of training future teachers of the basics of health, the introduction of the educational process of health-saving techniques require solutions [8].

The relevance of health of the younger generation and the formation of a healthy lifestyle in our time is due to the fact that during the school years the health of children deteriorates significantly. In this regard, there was an urgent need to develop methods for assessing the state of health, the choice of reasonable health strategies and methods of correction body's health. The famous Ukrainian surgeon M. Amosov argued that health should be measured. Seems to be considered a milestone in the development of the doctrine about health was proposed by M. Amosov (1987) on the introduction of such a concept as "the amount of health", which can be determined by the reserve capacity of the organism. According to M. Amosov, health is the maximum performance of organs while maintaining the qualitative boundaries of their functions.

Nowadays, there are diagnostic methods for measuring health. Empirical research methods are used where it is impossible to find objective factors for instrument measurements, such as psychology. The development of science and technology, the change of worldview paradigms gave impetus to the development of new modern methods using the capabilities of computer technology.

Presentation of research material

A diagnostic system for determining the level of students and pupils health was developed at the Department of Valeology of the School of Philosophy, which is in V. N. Karazin Kharkiv National University. This system was created by taking into account the achievements of science and technology, modern world-view ideas about the human organism as a complex ma terial and energy-information structure.

The valeological approach implies that human healthconsists of a harmonious combination of physical, mental, emotional, intellectual, social, environmental and spiritual health.

Comprehensive valeological examination allows assessing the health status based on a wide range of indicators, which cover all essential aspects of human functioning. From one hand they are physiological and energy informational levels, and from the other hand they are psychological and spiritual levels.

The system of hardware and software computer complexes allows to determine the quantity and quality of health at the functioning level of the organism physiological systems, the status of the cardiovascular system regulatory apparatus. In addition, it helps to evaluate the human potential at the cellular level, to determine the macro- and microelement composition of body tissues, to carry out the comprehensive assessment of adaptive systems indicators intensity in human body, to determine energy-information component state of the health and person's emotional component. It is also possible to conduct psychodiagnostic examination. Besides that, the ability to spiritual growth can be determined among students.

Furthermore, the organism's adaptive capability assessment is involved in health system monitoring. adaptive capability of the organism is one of its fundamental properties. First of all, it should be noted that adaptive capabilities it is a stock of functional reserves which are constantly spent to maintain organism – environment balance. The stock of functional reserves is information, energy and metabolic resources, and their spending is accompanied by constant filling [2].

The methodology manual [5], which was written by experts at the Department of Valeology, contains modern valeological methods that allow studying the dynamics of health. The manual can be useful for school teachers and lecturers who teach "Health Fundamentals", "Valeology", "Healthy lifestyle Fundamentals", and also "Computer technologies in Valeology". At the Department of Valeology, during the training of future specialists, who are taught the most up-to-date methods for assessing the level of health. All the methods are non-invasive and can be used in educational institutions to monitor the health of pupils and students during the learning process.

Comprehensive valeological examination includes the following methods:

1. Assessment of organism's physiological systems development level using the health index, which is determined using 5 indexes to assess adaptive abilities of the respiratory and cardiovascular systems and to determine of the "weaknesses" of the organism. As well as adaptive potential by R. M. Baevsky [2], which allows to evaluate the functional capabilities of the organism as a whole.
2. The system of express assessment of the health level at the cellular level and biological age of a person [14] is a non-traumatic method for determining the physiological state of the human organism at the cellular level by examining the electrokinetic activity of buccal epithelium nuclei in cells using an optoelectronic complex and computer equipment.
3. Determination of the macro and microelement composition (K, Na, Ca, Mg, Cu, Al, Pb, Fe, Zn) in saliva can reveal insufficiency or excessive composition of these elements in human organism. Analysis of water and soil samples by atomic absorption spectrophotometry allows identifying anthropogenic pollution of the environment.
4. Psychodiagnostic examination is an assessment of mental health state using commonly accepted tests. It helps to assess the state of the emotional-volitional and cognitive spheres of the organism, its adaptability to micro-social relations, behavioral self-management [12].

5. The hardware and software complex for electropuncture diagnostics "INTA-com-Voll-F" is functional systems diagnostics of an organism, its individual organs and systems by measuring the indices of biologically active points, localized on the hands, feet and head.
6. Screening energy-information adaptometry of the human holographic matrix [3; 13]. It is a method of using electropuncture testing of biologically active points and a computer program allowing to assess the state of the bioenergy field and the adaptive capabilities of the human organism, determine the core pathology and propensity of the organism to certain health disorders. In addition, this method allows determining all trends in changes of the energy resources under the influence of certain factors.
7. Digital analyzer of the human organism functional state APK "OMEGA – M". The computer hardware and software complex allows the diagnostics of the human organism functional state based on heart rate variability, analyzing human biorhythms, as well as the correction through biofeedback.
8. KME is a medical expert complex for computer diagnostics and correction of health, determining the functional state of human organism main systems, psychological factors and some disease development risk prediction [6].
9. The "KSD" device is a spectral-dynamic complex recording the radiation spectrum of the organism and allows assessing of health status by comparing the spectrum with the reference signals recorded in the KSD database [7]. The method can obtain information about the state of the brain, all body systems, hormones, presence of pathologies or calculate risks of disease prediction information. In addition, the equipment can identify the external environment and food for the content of microbes, viruses and harmful substances. Using the "KSD" device it is also possible to carry out correction of the functional and psychological state of the human body.

The diagnostic system, which was implemented at the Department of Valeology of V. N. Karazin Kharkiv National University, covers all (currently known) spheres of human existence. Diagnostic methods include empirical studies, such as assessing the state of mental health by means of commonly accepted tests, Luscher test; the "Self-feeling-activity-mood" test (SFAMS); the "Situational anxiety" test, a tests system for assessing the spiritual health state.

Monitoring, using instrument-software systems, was developed according to the latest science and technology achievements, which are based on modern ideas about the complex material and energy-informational structure of a person. It allows to assess of the health level at the cellular level, the level of systems and organs, to the state of energy-informational psycho-physiological and adaptive properties of the organism. Studies were conducted simultaneously using several methods that allows us to determine the features of the various levels of human organism functioning and the tendency to respond to various factors.

The diagnostic system is non-invasive and can be used in educational institutions to monitor the health of pupils and students during the learning process. Using our health monitoring system, a large amount of research was carried out, so the health state of the adult and child population in Ukraine was conducted. In addition, a huge amount of work was carried out to determine the level of health and correction of the post-traumatic syndrome state.

Valeology Students, future teachers of Health Fundamentals are taught valeological aspects of monitoring the health status, diagnostic methods [5], etc. To correct the health status of pupils and students, a group of valeologists has developed a system of health improvement, which includes complexes of health improvement exercises, fitocorrectors made from plants that grow in Ukraine, self-regulation and self-perfection techniques, a system of valeological nutrition, etc.

Conclusions

Such a wide range of knowledge and opportunities for research helps valeleology students, future teachers of Health Fundamentals, to form a holistic worldview, motivation for a healthy lifestyle, civic attitude and high spirituality in order to carry this knowledge for health care of the nation.

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Chapter 14. APPLIED ASPECT OF "NURSING" TEACHING IN THE HIGH SCHOOL

L. GUDZEWYCH, S. VASILIEVA,
P. SARAFINYUK, O. ZAVALNYUK,
N. BAURKO, I. STEPANENKO
Vinnitsa Mikhailo Kotsiubynskyi State Pedagogical University,
32, Ostrozkuy Str., 21000 Vinnytsya, Ukraine
e-mail: gudzevichluda@gmail.com

Abstract. *The article is devoted to the study and implementation of various forms and methods of teaching students in the "Nursing" classes. In this article, the modern methods of teaching medical disciplines in the high school are thoroughly considered, modern highly effective conducting classes' approaches, introduction with discursive and group methods' elements of work are given. The structure of the "question-answer" and "case study" methods, situational tasks, simulation technologies, modeling, imposition, and their usage in carrying out practical classes that promote the professional competence of the students and significantly increase the efficiency of students' perception of academic materials are elucidated in detail. During "Nursing" teaching, the maximal numbers of information flow channels are based on the theoretical basis; with multiple reproductions of the algorithms of practical skills and the mistakes' analysis allow to transform the knowledge and skills of providing medical care in a short time, that are performed at the subconscious level.*

Keywords: *Teaching methods; Simulation-role modeling; Waxworking; Case study.*

Introduction

The training of a highly skilled specialist-teacher capable for making decisions independently in the framework of professional competence is the main task of each teacher. In the formation of general and professional competences for students, it is important not only to receive theoretical knowledge and skills but also maximize their application in practice. Such training is impossible without modern effective teaching methods.

The aim of the study is to study and justify the effectiveness of various forms and methods of pre-medical assistance' teaching of students of educational establishment.

Material and methods

The students of the Institute of Philology and Journalism of the Vinnytsia Mikhailo Kotsiubynskyi State Pedagogical University were studied 43 students – 22 (control group) and 21 students (experimental group) aged 18 to 21 years. The research was conducted in the dynamics before the beginning of the study of normative discipline "Nursing" and after its completion. For determination of the psychological level of readiness, such techniques as stress-self-esteem test, Eysenck Personality Questionnaire (ERQ), Spielberger–Khanin questionnaire (CK) for assessing reactive and personal anxiety were used.

Results and discussion

The learning process is aimed at bringing theoretical training closer to the practical one. In the indissoluble unity of theory and practice, the practice plays a priority role. The theory and practice are two organically bound sides of a single process of cognition. The first stage of this process is the receiption of information. For better perception of information, all channels of its reception should be used: visual; verbal, tactile. If information is learned, then it passes to the second stage – knowledge. However, for the first aid only knowledge is not enough. The student must be able to perform the simple actions: to carry out a cardiopulmonary resuscitation, to stop a bleeding and so on. Skill is the third stage. However, in an extreme situation, only skill is also not enough, as the proficiency is necessary.

Unfortunately, the process of teaching of first aid is limited to the first, second and rarely the third stage in many educational establishments [11]. For skills' acquiring and their applying by students in any extreme situation, it is necessary to use a multistage method of teaching: 1st grade – the teacher tells and demonstrates how one or another element is correctly executed in the first aid; the 2nd grade – the student lists the order of the actions, and the teacher in the specified sequence performs them, even if the student gives incorrect instructions. At this level, the student must see his mistakes and fix them; the third grade – the student independently repeats the mentioned actions and comments their implementations, this allows to have better memorization of the sequence of actions in the first aid; the fourth grade – the student independently performs all actions without oral support, which helps to turn their acquired knowledge and ability into skills; 5th-student performs all actions in real time, which facilitates the consolidation of the acquired skills. The instructor assesses the correctness of the actions, their assimilation at the fourth and fifth stages. If the student makes mistakes, he starts again action from the third degree.

The modern pedagogical technologies such as modular training, methodology of project, group and individual work, method of reference logic, dynamic schemes, drawings, problem-solving method, partial-search (situational tasks, simulation-role modeling) and etc. are used for the development of first-aid skills [2].

The urgency of providing medical assistance, the desire of saving people's lives on a more qualified level, leads to the qualitative development of practical skills. Practical training has also a great psychological significance:

- for the formation of psycho-emotional tolerance to the stressful effects of emergencies;
- blocking destructive emotional experiences in contact with clinical death;
- assimilation of material in the most complete way by training all the channels of informational access (analyzers) during the development of practical skills.

Practical training of non-medical workers as well as peersons who do not have special medical education should be conducted accourding to the principle of consistency – from the simple and short-term to the more complex. It is impossible to form medical thinking in the short period of training, therefore, according to the experts' opinion; the principles of standardization, algorithmization and practical-blindfolded skills development should be at the basis of training.

Traditionally in the pedagogy, the term "practical training" characterizes learning as an integral part of vocational education [1]. It reflects the patterns, content, methods and forms of organization of the process of forming skills and proficiency that determine the ability of students to qualification**.** It is known that practical training is initiated in the process of mastering the theoretical course of the fundamentals of anatomophysiological knowledge. Practical training together with theoretical, solves problems of a certain content creates the basis for acquiring primary practical skills for provision of emergency medical assistance. Practical training is multifaceted in content, a complex and holistic system that includes such components as the purpose, thr necessity, the motivation, the matter subject, the activity, the meaning of achieving the goal, the result of the activity.

Let's note that the relationship between knowledge and practice is diverse. In psychology, there is the idea that the cognitive activity of a person is due to the urgency and its connection of with practical activity [13; 17]. Consequently, knowledge and practice as one of the successive stages of practical training are closely interconnected and are an organic combination of interaction between subject and object. Despite the enormous variety of human activities, the terms "knowledge" and "skills" can be considered in psychological and pedagogical sense as interrelated "abstract" and "concrete". It is explained by the fact that the

person knows only what he can, and vice versa; ability attests the level of mastering certain knowledge, its ability to perform a certain type of activity.

If the listener is able to tell how to handle one or another manipulation, that does not mean that he can do it. As it is known, a skill is based on the ability to perform an action, which is characterized as skills. It is worth understanding the degree of ability to perform actions under a lower control of consciousness or automatically.

In the process of repeating the action, the ability to perform it is increasingly honed, improved, and lightness and speed, complete mastery of the execution of one or another manipulation depends on the natural instincts and abilities, qualities of the individual, its previous experience. Skills from the angle of view of the degree of their formation are divided into initial, intermediate and final (skill). As an example of training non-medical workers you can see the process of forming skills. The process of skills development and abilities during all stages of practical training in the training center, that is based on the knowledge of specialists about a specific action begins with the formation of their initial skills [5]. It is logical that begining from simple skills go to the formation of complex skills in medical training.

In fact the methods of teaching in practical training are no less diverse than in the theoretical course in particular from the sides at which they act [15; 17]. If the content of training answers the question "Whom should we teach?", The principles determine the basic requirements for the educational process, the methods cover the ways and means of learning, then the forms show the most rational organization. Under the forms of training in this case imply the options for the organization and interaction between the listener and the instructor in the practical classes, the external framework of their interrelated activities.

After the Maidan (2013–2014) there has been a sharp increase in the demand for attending medical assistance, but it is too early to say that people became much more sensitive to someone else's misery. The Ukrainian Research and Practical Center of Emergency Medical Care and Disaster Medicine Ministry of Health of Ukraine developed and presented modern, methodical aids for the mass audience and a training film for providing premedical care. This term (auxiliary care) appeared in the use of doctors relatively recently. Sergiy Guriev, deputy director of the Ukrainian Scientific and Practical Center for Emergency Medicine and Disaster Medicine of the Ministry of Health of Ukraine, states: "This is a new concept introduced by the Cabinet of Ministers Decree 1115 of 21st November, 2012 and corresponds to the Western Classification**.** It refers to the assistance provided to sick and injured persons without medical education who simply found themselves on the scene. That is what we used to call self-help and mutual assistance before. The world went ahead, new technologies and new tricks appeared. Now we are using the best modern first-aid workouts used in world practice. In particular, the American and German systems are that. According to them, the Basic Life Support (base support of life) [6; 7] complex has been developed and modified consisting of series of manipulations that allow maintaining respiration, heart rate, etc.

A striking example of the new technology that has become the norm in the West for a long time is the ability of non-specialists to use automatic defibrillators when suddenly stopping the heart happens. In developed countries, they are installed in all crowded places. In Ukraine, what is the leader among the European countries in the number of deaths because of cardiovascular diseases, they are not enough.

But the effect of this program will only manifest itself when Ukrainians who not only know the existence of such devices, but will not be afraid to use them.

There is an unprecedented public demand to master the practice of medical assistance today. The revolution, military confrontation and full-scale military actions pushed Ukrainians to attend mass courses at both public and private clinics.

Doctors note that overcoming the barriers of personal contact with someone else help lessons with dummies and mannequins. Doctors argue with that if you learn how to make a heart massage for a synthetic "sufferer", then it's still the same for your hands, who is under them – "synthetics" or a living person. Here, only such anthropomorphic simulators, our centers of emergency medical care are staffed only by 15–20%, so what can we already say about educational institutions (schools, colleges, institutes, etc.)

Modeling and imposition are necessary elements of acquiring (developing) medical assistance skills [3; 7]. As it was written above we have studied the students of the Institute of Philology and Journalism: 43 students – 22 (control group) and 21 students (experimental group) aged 18 to 21 years. The study was conducted dynamically before the study of the "Health Education" and after its completion. For determination of the psychological level of readiness were used such techniques as stress-self-esteem test, Eysenck Personality Questionnaire (ERQ), Spielberger-Khanin questionnaire (CK) for assessing reactive and personal anxiety. The data of our research showed that many students had a superficial idea of the premedical help, ethical and deontological aspects of responsibility for the life and health of future pupils, what is evidence of the relevance of the raised problem. Data from conversations and dynamic monitoring was indicated that 73% of respondents have misconceptions about the rules of the first medical aid. According to the preliminary survey 86% of the people received information about the necessary practical skills in scientific literature, some students passed professional psychological training, namely: trainings; modeling; layouts, lectures; method of critical situations. They received significant information that allowed them to acquire the necessary skills. However, only individual candidates studied the method of imposition (artificially reproduced real human damage on mannequins or volunteers).

Our studies have shown that the low level of psychological readiness among the interviewed before the beginning of exercises in the control group was 2.5% compared with the experimental group (1.4%). The average level of psychological readiness was characteristic for 87.1% of respondents in the control group and 89.5% in the experimental group. A high level of readiness was shown by 7.3% of the control group students and 8.3% of the experimental group. Both groups were properly trained according to the approved plan of exercises, but the experimental group in comparison with the control group was involved in practical exercises, which have been used the method of molding (reproduction of traumatic injuries and manifestations of acute illness). Further results of the study indicated that the low level of psychological readiness was characteristic for 2.6% of the control group, but experimental level was not found; the average level of psychological readiness was in 84.7% of the control group and 49.3% in the experimental one; the high level was found to be characteristic for 9.7% of the control group and a significant increase in the experimental ones – 21.5%.

Thus, an affordable and effective method of imposition in the system of purposeful professional psychological specialists' training of risky occupations introduces elements of stress during the process of learning, further improves the performance of professional tasks in an emergency during the provision of medical assistance.

The training of the best assimilation of knowledge and the development of practical skills. During trainings, attention is paid to the coordinated brigade method of work, techniques of manipulations performed during the provision of urgent medical assistance using card equipment and equipment.

The purpose of conducting trainings for non-medical workers is theoretical training, acquiring practical skills in providing first medical aid to victims of emergencies arising as a result of disasters and terrorist acts, psychological readiness of the rescuer to provide premedical care and psychology of behavior under stress conditions [4].

The teaching methodology is based on the respective tasks of the lecturers-instructors and the various types of work of the students.

Types of work for cadets:

1. Listening (listening).
2. Visual perception (viewing of video films, slides).
3. Kinetic perception (practical tasks).

The task of lecturer instructor:

- development and presentation of theoretical material;
- conducting practical classes on dummies and listeners;
- facilitating the discussion and follow-up of the students' practical work;
- guidance of the work of cadets who have difficulty in mastering the material;
- working out of a system of estimation of work of cadets;
- simulation of situations, ways of solving situational problems.

Such a training system based on specific examples has proven its usefulness and effectiveness [13]. The methods of interactive work of cadets, exchange of experience were used. Lecturers-instructors created an atmosphere of positive, unobtrusive, interesting communication, wide opportunities for feedback. The main purpose of the instructor is to develop practical skills for each cadet so that the students learn the necessary software material during the training. Situational practical tasks should illustrate the presented theoretical material, if it is necessary, with the repetition of the main points. In order to make cadets be interested, it is possible to use cases that are widely publicized; photographs and television reports that will emphasize the importance of the system of urgent domedical in everyday life.

Widely used by teachers at classes on normative discipline "Nursing" – there is a case study (case study). Case study method is a non-game simulation method of active problematic situational analysis, based on learning by solving specific problems - situations (cases) [8]. The purpose of this method is to analyze the situation of the case, which arises in a particular coincidence, to find a practical solution, to appreciate all the proposed options and selected the most correct from them, and to dismantle all alternative options by the group of students by joint efforts. Case method includes: 1) description and consideration of a particular clinical situation, that is using the methodology of case study "case study"; 2) a set of specially developed teaching materials on various media (print, audio, video and electronic materials) that are issued to students for independent work. Case is an example taken from real life, from a professional environment, is not just a true description of events, but a single information set that allows you to understand the situation. During designing of the case' text for classes, teachers can use: 1) photocopies of disease history of specific patients, to which tasks or questions are developed; 2) situational tasks for each topic and educational game on this topic; 3) situational emergency tasks; 4) a set of slides showing a different pathology; 5) a set of clinical signs. As a task one can propose the independent collection of additional information by the student, the task of developing a computer presentation or project. Cases can be used both in classroom lessons and extra-curriculum independently with a written report and presentations. The cases can be distinguished classifying: 1) practical, which reflect real life situations, 2) edu cational, the main task of which is teaching, 3) research cases focused on research activities. In laboratory classes, the usage of practical and training cases is widespread. Practical cases reflect absolutely real life situations and form specific practical skills and abilities.

Students work out a method of objective and subjective testing of the patient, resulting in the formation of such skills as the ability to conduct a survey take place, based on relative and reliable clinical signs to determine the types of injuries. During the working with study cases student develops the ability not only to read the proposed material, but also to study and analyze it.

Students are encouraged to comprehend the clinical situation, which description simultaneously reflects not only any problem, but also actualizes a certain complex of knowledge necessary for solving this problem. Usually, the analysis of the situation has 3 stages: at the first stage, students individually study the text of the situation, try to find a problem in it and solve it. The second stage is work in a small group, where students share their thoughts without the teacher on the situation being analyzed at the lesson, while they are looking for a general understanding of the problem and ways to solve it. During the work of small groups, the ability to listen to others, to protect their offer, to find errors (their or other participants) is being developed. Next is the development of a common position, the text of the speech from the group is drawn up, the position of the defense is defended in its open discussion. The third stage is a group discussion, which is already conducted by the teacher.

During the group discussion, an analysis of the content of a particular situation, diagnosis of the problem, the search for solutions of it takes place. Working with an educational case, the teacher's task is to teach the student to systematize and interpret the data. The specific situation outlined in the training case leads the student from facts to problems. An example of a method case in a lesson devoted to the closed body injury: "A man of 35 years old fell on the nonflexed right arm. He felt a lot of pain in the forearm; the elbow was no more functioning. Movements in the latter are sharply limited; in the pursuit of movements he had pain and sensation of the barrier on the anterior-external surface of the joint. Palpation in this area is defined by the appearance of the protrusion. At the extremity of the upper and middle third of the elbow, pain, pathological mobility and crepitis are defined, name the first aid rules. Questions: 1. Analyze this situation 2. What is the preliminary diagnosis? 3. What kind of premedical and therapeutic measures should be taken? 4. What types of transport immobilization should be used? 5. Demonstrate the immobilization of the damaged limb. Classes with using of the case technology allow not only to give students knowledge, but also to ensure the formation of and the development of their creative thinking, skills and abilities of independent mental work. The case method helps to develop the ability to analyze the situation, to choose the best option and to plan its implementation. And if during the study of the professional module such approach is used repeatedly then the learner is made the steady skill of solving practical problems. This method helps to increase students' motivation both directly to studying and to confidently performed practical skills; effectively promotes the formation of not only professional but also the following general competences, namely: a) to make decisions in standard and non-standard situations and to bear responsibility for them; b) to take responsibility for the work in a team members and for the performance of tasks; c) to work in a team and to communicate productively with patients; d) to understand the essence and social significance of premeditated and medical care; e) to organize their own activities.

Thus, in order to achieve maximum efficiency of student learning in higher education institutions, it is necessary to apply the case study method [14]. It is easy to identify the level of basic knowledge of students, after which you can either enter a block of short repetition of material necessary for the development of a new topic, or immediately offer students a new set of cases, including illustrative study situations and applied exercises.

Efficiently simulation learning technologies are implemented in the initial process of teaching medical disciplines [9; 12]. It is necessary to put into the potential rescuer's hands rather solid skills and consciousness confidence in the importance and correctness of his actions to interfere with doubts and fears.

It is necessary to depart from the formalism in the educational process, to take the training out of the desk and put it in a situation close to the real one. Simulation education is one of the main methods of practical training of physicians and paramedics in developed countries [6].

Exercise skills in simulators have proven effectiveness. Simulators range from simple physical models of anatomical structures (for example, a pelvic bone model or simulators for working out individual skills) to complex devices and mannequins with high mechanical reality and computer control [10].

Outstanding psychologist and doctor K. K. Platonov wrote about the peculiarities of training specialists with the usage of simulators: "The simulator is a textbook that allows to create the skills necessary in real conditions". This is the simulator difference from visual aids, which only "facilitate" the formation of skills through the knowledge [7].

The main types of simulators used in the learning process [5]:

- computerized mannequins, on-screen simulators (allowing to simulate the corresponding reaction);
- anatomic models (used to teach individual skills and abilities);
- phantom is a model of a person or part of it in true size, replacing an original that retains only some of its important properties (contributes to the formation of a system of interconnected skills and abilities);
- mannequin is a figure on which you can form a system of interconnected skills and abilities;
- simulator is a device for artificial creation (imitation) of various situations or objects that allows to form separate skills and abilities;
- system of situational tasks.

The simulation form of training is the most appropriate, which is taught in a special artificially created simulated environment using dummies [4]. The main qualities of simulation training are the possibility of using dummies for completeness and realism of object modeling in a given situation; the development of specific practical skills using modern equipment without harming human health; working out team work in a concrete situation.

Extremely important and responsible part of simulation training is the debriefing that is discussion after the implementation of scenarios. For debriefing use a certain set of techniques and rules, a list of questions, etc. [8].

During the debriefing, the teachers, together with the students review and analyze the videos of the team's actions, paying attention not only to the technique of execution, but also to the various points associated with non-technical skills – communication and team interaction, decision-making process, role of the leader, division of tasks, the effectiveness of using all team members, etc. In a stressful situation, the number of errors is growing significantly and it is very important that the discussion goes in a friendly, positive atmosphere. Instead of accusations of mistakes, teachers and students together determine successes and positives, key issues; make the conclusion what it is necessary to change, so that the team worked better and more effectively attained the goal.

In order to fully utilize the potential of simulative learning, it is important to adhere to an effective methodology, to work with simulation centers and to properly train teachers who are capable of organizing the learning process in the light of modern European experience.

Conclusions

Thus, the use of various forms and methods of teaching in studying the discipline "Nursing" with the maximal number of channels of information receipt is based on the theoretical basis; with multiple reproductions of the algorithms of practical skills and the mistakes' analysis allow to transform the knowledge and skills of providing medical care in a short time, that are performed at the subconscious level.

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Chapter 15. FORMATION OF THE RESPONSIBILITY OF THE SUBJECTS OF THE EDUCATIONAL PROCESS: EFFECTIVE WAYS OF HEALTH-SAVING THE UKRAINIAN PEOPLE

S. KIRILENKO
State Scientific Institution "Institute of Education Content Modernization",
36, Metropolitan Vasyl Lipkovsky Str., 03035 Kyiv, Ukraine
e-mail: svkirilenko1107@ukr.net

Abstract. *The article describes the essence of the culture of health-saving, responsibility as a personal significant human quality, a conscious attitude to their own health, which ensures the efficiency and productivity of the educational environment. Considerable attention is paid to comprehension of the main provisions of the Law of Ukraine "About Education", the Concept of the New Ukrainian School for understanding the role of the environment for human health and life, the ability and desire to follow to a healthy lifestyle.*

The definitions of "responsibility", "responsibility of the person", "social responsibility", "responsibility as the main characteristic of the formed person", "health-saving", "healthcare saving environment", "health-saving technologies in the modern educational process", are analyzed, which are extremely important in the teacher's pedagogical activity. Attention is paid to internal processes – "self-consciousness" or "self-responsibility" that stimulate the development of moral qualities that educate a person morally adult and developed, responsible in the sense of their own health-saving.

The issues of choosing effective ways to health-saving the Ukrainian people, formation of responsibility and careful attitude towards the life, health of others and their environment, education, activities, nature, family, etc. are considered there.

Keywords: *Responsibility; Social responsibility of students; Health-saving of the Ukrainian people; Health; Health-saving environment; Health-saving technologies in the modern educational process; Self-determination; Formation of personality.*

Formulation of the problem

In the 21st century, responsibility becomes the main moral value that spreads to all spheres and aspects of private, social and political life, covering the scale of the entire planet and aimed at the future. The development of this quality depends on the direction of civilization and the existence of humanity in general. Responsibility is put forward on the forefront of such sciences as pedagogy, psychology, philosophy, axiology, and others.

In the context of the current trends in the development of education, it should be noted that freedom and responsibility are the most important features of democracy. Caring for the health of the younger generation is one of the most important tasks not only for health workers, but also for those who is involved in the education and upbringing of children. The priority task for each person is to develop a responsible attitude towards their own health and health of others as the highest social and national values, the upbringing of a healthy lifestyle and culture of behavior.

The purpose of the study is to familiarize teachers with the essence of the culture of health-saving and the possibilities of its influence on the educational process; to highlight the dependence of the educational effect of the system of responsibility of the individual on the im plementation of rights and obligations of all subjects in the educational process.

Research results

Over recent years, the interest of famous scientists, researchers in the field of health-saving in educational institutions has increased significantly, as evidenced by the review of scientific literature. An actual subject of research by scholars A. Andryushchenko, T. Boychenko,

N. Bashavets, S. Vasilieva, A. Vashchenko, S. Volkova, G. Dolinsky, O. Dubogai, L. Zhalilo, V. Sukhomlynsky, L. Tatarnikova, T. Shapovalova became a problem of formation of the health-saving competence of students.

The famous Ukrainian scientists I. Bekh, T. Levchenko, O. Savchenko, O. Sukhomlynska express opinions on the necessity of forming a person on the basis of universal moral values, among which a significant place takes responsibility, and therefore, direct efforts to educate a free harmoniously developed personality capable responsibly attitude to life, health, education, activity, nature, family, etc.

Presentation of the main material

With all the sharpness the state faces the problem for saving the health of the nation. Unsatisfactory health in childhood leads to disturbing health throughout the life of a person, which creates social and financial problems, negatively affects on the level of socio-economic development of the country. The problem of health-saving and its strengthening of children and youth in Ukraine has become particularly acute, and the existing statistics are rather disappointing, so this problem is extremely relevant in our time. There is a quantitative increase of functional disorders, acute and chronic somatic morbidity, birth defects, maladaptation syndrome, morphofunctional deviations, and a growing number of children with special educational problems. Of great concern is the fact that the number of children with mental and behavioral disorders increases, a group of healthy children decreases; 90% of students have chronic diseases and physical deviations in development [9].

It is proved that in a developed society, the level of health is to a large extent related to the level of education. The higher the educational level of a particular social environment, the better, as a rule, it summarizes health indicators. So the task of health-saving and its strengthening should be solved, first of all, by means of pedagogy, while education in the aspect of healthcare is understood comprehensively: both as providing information and as teaching methods, techniques and skills of a healthy lifestyle, and as an upbringing in the spirit of the unconditional priority of the values of individual and public health in all its manifestations, spheres, levels [5].

According to the National Strategy for the Development of Education for the period up to 2021, the main lever of the state humanitarian policy regarding national education should be the provision of civil, patriotic, moral, labor education, the formation of a healthy lifestyle and social activity. According to the normative legal documents – the Constitution of Ukraine, the Laws of Ukraine "On Education", one of the priorities of the state educational policy is the creation of optimal conditions for the formation, preservation and strengthening of the health of student youth, the development of a physically healthy and spiritually rich personality.

The priority of the development of the modern educational system of Ukraine in implementing the State policy on strengthening and preserving the health of students is to create a health-preserving environment, so it is very important that the processes of reforming and modernizing education not forget about the health for whom these processes are taking place and by whom they are carried out. The concept of the New Ukrainian School in accordance with the "Recommendations of the European Parliament and the Council of Europe on the development of key competences for lifelong education "defines a dynamic combination of knowledge, views, values, skills, abilities, ways of thinking, other personal qualities that reveal the ability of a person to successfully carry out professional and / or further educational activity. Exiting the situation in our country requires new approaches, a new ideology, based on which is the idea of pedagogy of health-saving, which clearly outlines 10 key competences of the New Ukrainian school, which are the basis for successful self-realization of the student as a person, a citizen, namely: "Environmental literacy and healthy life. Ability to reasonably and rationally use natural resources in the framework of sustainable development, awareness of the role of the

environment for human life and health, the ability and desire to follow to a healthy lifestyle" [10]. Consequently, in the context of educational reform, a competent approach opens up new opportunities for effective formation of healthcare, formation of a responsible attitude of subjects of the educational process to their own health.

Realization of tasks and strategies of pedagogy of health-saving includes:

- providing a healthy lifestyle for all subjects of the educational process through creating an environment that promotes health strengthening;
- determination of the dominant ideological setting for the priority value of health;
- integration of the culture of health into all factors of the daily life of the institution of education;
- the humanization of the educational process, the unity of the universal and national;
- compliance with an integrated approach to saving, strengthening, restoring health and preventing diseases;
- cooperation, co-creation of subjects of the educational process;
- the formation of responsibility in all subjects of the educational process, which is an effective predictive way of healthcare of the Ukrainian people.

Let's take a look of the definitions of "responsibility", "responsibility of the individual", which formation is extremely difficult in the teacher's activity. The necessity to understand this phenomenon from different points, views and statements of scholars will provide the basis for the teacher to build his own educational system for the formation of the responsible personality of the student, in particular, responsible attitude to his own health and the health of others.

The responsibility of the individual is the conscious necessity to correlate his own behavior with social norms, settings, and is a characteristic of any relations in which people are, relates to various aspects of their activities, defining its orientation, it is manifested in consciousness, character, feelings, various forms of prosocial behavior, and freedom of choice; is closely linked with the knowledge of the objective laws of development of society, the level of education and culture, which is based on the attitude:

- to the object of activity (positive, interested in) – especially in working with people;
- to the very activity (as a person performs it – interested, formal, informal, indifferent, etc.);
- to the results of the activity (for which? the positive result contributes to increased confidence in their capabilities, negative – to disappointment) [7].

In pedagogical and psychological literature, there are many approaches to defining the concept of "responsibility" and its main characteristics. This is due to the fact that at the modern stage of development of a society before a person there are new demands on its subjective personal qualities, such as independence, initiative and responsibility, which would help to adapt to constant changes in the environment and promote its personal development.

The term "responsibility" is not juridical, but psychological, therefore can not speak of liability exclusively in a negative sense. This concept is multifaceted, illustrated by examples of its use: "sense of responsibility", "responsible behavior", "increase responsibility", "take responsibility for yourself".

Analysis of the concept of "responsibility" in the domestic scientific literature makes it possible to understand that originally this issue was considered in the philosophical context, taking into account the peculiarities of the era, the understanding of responsibility was a clearly expressed ideological character.

One of the repeaters of the dominant era was philosophy, therefore, the basis of all further psychological studies of responsibility lies exactly on the philosophical works of famous scientists.

In the scientific research of I. Bekh "responsibility as a personal quality" the concept is based on which "the person is conscious of the common sense duty, the duty in the act, the recognition of the person's involvement in society, its own beliefs and moral principles" [2]. Responsibility is a special motive of human actions, which differs from all others, only the characteristic of its ideal. It is the presence of this feature in the personality contributes to its moral development and does not turn responsibility into a means by which the person strives to achieve a purpose useful to her. Thus, moral reflection involves the ability of the individual to comprehend their aspirations, to predict the results of actions, taking into account their own views and views of other people, the ability to agree on the goals of behavior with the means to achieve them.

Famous scientist K. Muzdybayev made fundamental research on the definition of "responsibility as a certain quality", a question that characterizes the "social identity" of the individual. He outlined the main characteristics of responsibility, such as: accuracy, compassion, punctuality, honesty, justice, readiness to be responsible for the consequences of their actions, principledness. In the emotional sphere, the formation of responsibility contributes to the ability to empathy, responsiveness to someone else's pain and joy, the essential features are perseverance, diligence, endurance, courage. The process of awareness of a person's responsibility is influenced by cognitive and motivational factors, features of personality, environment and other assimilated assessments, rules, moral norms, value orientations, and certain frameworks are the basis for further actions of the subject [12].

At the modern stage, the perceptions of responsibility are personally oriented direction. In the center of scientific research are defined issues of spiritual activity and self-perfection of the personality. Responsibility is a characteristic of some real human relationships and concerns almost all aspects of human activity. This is one of the most important characteristics of a person, which is a sign of moral adulthood in the regulation of social relations. The manifestation of responsibility finds in the character of the personality, in her feelings, self-consciousness and various forms of behavior. Responsibility, the main feature of the formed personality, identified K. Rogers, and self-determination, as an essential feature of human nature, therefore, every individual is responsible for what it is.

For categorical foundation of the concept of "responsibility" we turned to philosophical concepts, since the philosophical categories serve as a prism through which a person perceives the surrounding world. Famous philosophers, V. Vindelband, G. Gegel, H. Hertz, G. Jonas, I. Kant, J. J. Russo, L. Feuerbach, E. Fromm., gave considerable attention to the importance of responsibility as one of the highest values.

According to H. Hertz, responsibility is a requirement for a person, which consists in the ability to predict the results of his own choice, objectively evaluate his actions and analyze them. For responsibility, the choice is important as the basis of the action on which personality development depends. Moral choice and responsibility are a manifestation of freedom in the case of serving social progress. The scientist believed that "freedom and responsibility unite the active social actions of people into a single whole" [6].

According to E. Fromm, responsibility relates to humanistic values such as care, respect, freedom, love. He distinguishes the concept of "responsibility" and "duty", drawing parallels with authoritarian and humanistic conscience. Thus, responsibility has a positive sign and is a category of freedom, and a duty is a category of non-freedom [14].

Like any other category, responsibility has its purpose, means and meaning. According to V. Vindelband, there is a legal responsibility that forms the synthesis of two elementary forms of responsibility. In this case, the ultimate goal is a person, manifested through the implementation of a legal minimum or norm, represents the importance of responsibility and observance of which the state requires from its citizens.

A concrete practical goal is to implement this legal norm, which can be achieved by lays responsibility, which is a prerequisite for the formation of a moral person. The scientist introduces the concept of "right of responsibility", which consists in the exercise of moral standards through liability. Each norm has its own value, therefore liability has different degrees, but it is impossible to determine them specifically. Vindelband defines the self-responsibility of conscience as a separate form of responsibility, which allows him to know himself as a person and treats him as a person's responsibility to his own moral and religious consciousness and calls it "the most subordinate form of responsibility" [4].

Self-consciousness or self-responsibility is the internal process of punishment or reward. And although these qualities of the person, on the one hand, can be considered opposite, on the other – they have some common features, for example, the orientation to the future. In the case of internal moral award, it is an incentive for further self-improvement, and moral punishment requires the transformation of the inner essence of man [4]. It is important that in both cases, these processes – the positive and negative forms of responsibility – stimulate the development of moral qualities that make a person morally adult and developed.

The problem of definition of responsibility, as the most important value of technological civilization, has become widespread in the writings of the philosopher G. Jonas, whose scientific and philosophical work has a tremendous influence on the consciousness of our time. According to his definition, responsibility is a category aimed at the future and proclaimed the highest value of the 21-st century. The importance and relevance of the views of G. Jonas is that he took as a basis modern civilization and modern conditions and took into account the most important achievements of science and technology, as well as the place of man in the system "man-technology-technological civilization" [8].

Responsibility is a very cumbersome concept, because it permeates all spheres of life from personal to political. Therefore, certain responsibilities should take into account two factors that complement each other and are integrative components of ethics in general. Such factors are objective, which deals with the mind, and subjective, associated with the feeling [8].

G. Jonas distinguishes the different types of responsibilities that are most widely distributed in society:

- natural and artificial (contractual); horizontal and vertical; legal and moral; responsibility for and behind; responsibility is divided into natural and artificial, depending on the factor causing its appearance;
- natural – responsibility which appear naturally is indisputable, permanent and independent of prior consent; an example of such responsibility is parental responsibility, since it has all of these properties;
- contractual responsibility is determined by the content, preliminary agreement, sometimes task, assignment, competence, for example, the authority of the employee;
- the acceptance of such liability includes an element of choice from which you can refuse;
- an example of "vertical" responsibility can be the responsibility of parents for children, which is by its subject is comprehensive, that is, extends to everything that needs care;
- legal responsibility – set at the level of the law, that is, external;
- moral – internal feelings (feelings of fault, repentance, readiness to redemption of fault), which accompany the subject of the act. The distinction between these concepts is best reflected in the distinction between civil and criminal law, in the divergent development of which the first identified concepts of redemption (through liability) and punishment (for guilt); however, it is common sense that "responsibility" is associated with the commission of an act and determines the responsible action from the outside (this refers to the nature that has its own requirements for a person);

relations between people must have a moral basis, that is to say, based on a moral rather than legal liability (followed by parallel with E. Fromm research on "responsibility" and "duty"). The fact that Mr John calls moral and legal responsibility, according to E. Fromm, is an authoritarian and humanistic conscience;

- responsibility "for" and responsibility "before" important varieties of responsibility that are conditioned by the lexical meanings of the word itself. The word "responsibility" (verantwortung) has two interrelated meanings in German and Ukrainian: responsibility for something or someone, and responsibility "in front" for someone (the first meaning implies the responsibility of a person for his own actions, the consequences of his activities, responsibility for someone, for the sake of something; the second – responsibility to someone: other people, God, society).

For G. Jonas, responsibility for "is" more important than the "front" responsibility. The archetype of this responsibility is the responsibility of a child who can not defend and protect his or her own rights (a helpless child is an archetype of the being where the intersection of being and affiliation: the child should be). Therefore, G. Jonas turns to responsibility, which is caused not by a formal law, but by a sense of responsibility [8].

Some reflection has found the problem of responsibility in psychological studies of domestic scholars. Considering the development of personality, its activity in its various manifestations and forms, a number of researchers believe that full responsibility is inherent, first of all, socially adult personality. In studies T. Titarenko responsibility can't be considered separately from the concept of "freedom". As T. Titarenko observes, responsibility does not contradict freedom, it is a logical consequence, which unites a series of actions into the human way of life.

Responsibility involves freedom of making decision, freedom of choosing the goals and methods, methods and styles of their achievement. Because the choice of the possibility of action stems from the activity of the subject, the level of personal responsibility is determined by its activity directions and social consequences. The direction of such activity is elected freely through a responsible decision-making process. In this sense, responsibility is a measure of freedom. Responsibility determines the necessity to preserve the individual peculiar, non-identity of the world of life, if the space in which the person lives, is closed, then the responsibility, as if it decreases, becomes external.

Studying the "phenomenon of choice" in the context of social behavior, G. Ball believes that "it is evident that the person has sufficient competence and responsibility in the adoption and implementation of a strategic life solution (including the necessary choices in this case) and in the further activity aimed at the implementation of open this solution of opportunities " [1].

According to the researcher, the responsibility that an entity must detect when conducting acts of choice depends essentially on the type of activity performed. "If the object of activity is in the space of models (constructed either ideally or within a well controlled part of material existence), the conditions for the transcendence of choice are more favorable; in addition, the subject is often able to return to the choice, which turned out to be false and replace it with the best. If the subject of activity is immersed in the real-life space, the proportion of the acts of choice is higher, because:

- have to pay more attention to the normative "grid";
- the subject lacks the time to invent non-standard solutions, and therefore he is often forced to restrict the choice of the proposed alternatives.

In the real-life space, each act of choice is more responsible, because it is impossible to "overplay" it. In each case, it is possible to correct its negative consequences to a greater or lesser measure [1].

Theories of formation and development of responsibility in Ukraine and abroad are in the framework of pedagogical, psychological, ethical, sociological concepts. At the level of psychological analysis (I. Bekh, M. Savchin, etc.), responsibility is regarded as one of the most general qualities, the result of the integration of all mental functions of the individual and the subjective acceptance of the world, the assessment of their own sensory resources, the will, emotional attitude to duty. Responsibility is defined as the moral quality of a person, in which his spiritual, psychic and psycho-physiological functions are integrated as a goal of education and quality, which concentrates the conscious personality of a universal duty.

Formation of responsibility among students, determination of educational criteria in institutions of general secondary education has always been the cornerstone of the educational process. Studies have shown that among the most characteristic negative qualities of the student's personality irresponsibility is the first place (80%), followed by low executive discipline, lack of ability, insufficiency (about 72%), falsehood (about 70%), passivity (64%), obstinacy (65%), lack of will (70%).

Responsibility is closely linked to such a person's psychological characteristics as self-control. The ability of a person to take responsibility for events occurring in her life is more on herself, this is an indicator of internal (infernal) control. Conversely, the tendency of attributing responsibility for all external factors (surrounding, environment, fate, case, etc.) indicates that it has external (extra) control inherent to it.

Among the pedagogical theories, the theory of "responsible dependence" occupies a special place in A. Makarenko. The teacher rightly considered responsibility "the most important attribute," emphasizing that the primary authority of a person is a responsibility.

V. Sukhomlynsky, developing and continuing the ideas of A. Makarenko, introduced pedagogical researches on the upbringing of the spiritual culture of the child's personality in the group. Using ethical, psychological and sociological approaches, the teacher enriched the concepts of non-traditional science from the 1960s–1970-s as spirituality, heartfeltness, humanity, compassion, psychic, and so on. V. Sukhomlynsky interpreted responsibility as a personal problem. Person have to be responsible, above all, before his conscience. It characterizes the ability of the individual to formulate their own moral obligations, require them to perform them and exercise self-esteem and self-control. In addition, responsibility significantly is spreading the sphere of intervention in the world around, while the idea of personal responsibility is stated.

Considering the psychological and pedagogical and social nature of responsibility of students through the prism of their attitude to learning, communication, lifestyle, committing offenses, observance of moral norms, we can determine their social responsibility of the growing personality, readiness to perform the functions of a citizen, employee, and family man.

Social responsibility – a concept that expresses the degree of accordance of actions of social actors (individuals, social groups, society) to mutual requirements, as well as historically specific social norms, general interests. Such responsibility comes from the laws of the common life of people, the need to subordinate various social actors, so each of them is an active bearer of certain mutual social obligations. Consequently, the mechanism of social responsibility determines the interaction of the subject (holder) and the object (to whom they are responsible), under which responsibility is exercised control over the fulfillment of such obligations.

The concept of "social responsibility" is associated with other concepts and terms that characterize behavior in the field of social relations (social norm, social control, social action, social phenomenon, etc.). Depending on the results of the exercise and the external environment, we can distinguish the following stages of responsibility:

- *generalized* – the person is responsible for any consequences of the actions in which he participated or was associated in a certain way;

- *own individual* – the subject is responsible only for the fact that it is directly done, with no difference between random intentional and predictable results;
- *differentiated* – the person is responsible for any anticipated result of the action, regardless of whether they were intentional or not;
- *conscious* – a person is responsible not only for his intentions and the consequences of their implementation, but also for the value that it gives to external factors that influence one way or another on the result;
- *full* – the subject is completely responsible for the course, results and effects of the action, regardless of the conditions in which it occurs.

Nowadays, responsibility is often identified with the duty of something connected from the outside, a completely voluntary act, the response to the need for another, expressed or unexpressed. Being responsible means being free and ready to respond. Consequently, the social responsibility of students is a quality that characterizes the social identity of a person, his tendency to observe in his behavior the social norms generally accepted in a given society, the ability to choose a certain line of behavior, to formulate their moral obligations on their own, to demand their fulfillment, to exercise self-esteem, self-control, readiness to be responsible for their actions. Regulator of responsibility is a culture of behavior, requirements and rules that are external controllers.

Many years of experience have shown that the formation of a system of responsibility, interpersonal connections, which act as subject-subject relations, is mediated by the activity important to the child and his powers as a personal responsibility. We associate the experience of moral behavior in the system of social responsibility with the formation of the experience of lawful behavior. Violation of relationships in common activity is a violation of mutual rights and obligations. The displacement of the experience of lawful conduct when performing in the system of students, rights and duties of a student as a citizen will facilitate the realization of the provisions in the relationship between student-teacher, student-student, etc.

In modern world, a healthy person is one who "builds" his or her own health: effectively cope with stress, is able to prevent and resolve conflicts, makes appropriate decisions, first of all, in relation to oneself, self-determines in the surrounding world, not only adapts to existing conditions, but meaningfully rebuilds them, thus improving their public health. Understanding the concept of "health" indicates that the term itself is associated with the success of a person in the modern world, his direct participation in the improvement of life, with an active civic position on social phenomena, personal problems, in particular, "health" [13]. Thus, the importance of health, as the highest universal value and the main factor for success and well-being, the responsibility for maintaining their health and the health of others, makes it possible to determine health preservation as a key factor in the modern educational system. "Caring for the health of the child, V. Sukhomlynsky considered the most important work of the teacher." Therefore, the most important task of every teacher, starting with the first year of school education, is to take care of the saving and strengthening of students' health, using health-saving technologies at lessons and breaks.

Children feel a huge need for movement, which is a means for them to adapt to life, to know the world around them.

Teachers, in close relationship with students, parents, medical staff, practical psychologists, social educators and social workers, all those who are interested in saving and strengthening the health of children, are able to create a health-preserving educational environment. Due to the systematic, consistent and creative work of organizing gymnastics, dynamic pauses and innovative technologies, a sufficient level of functional activity of all organs and systems of the body of children in the classroom is provided, their overall cheerful condition.

The use of health-saving technologies in the educational process allows students to more successfully adapt in the educational and social space. Parents trust their teachers the most valuable thing that they have – their child. The task of the teacher not only to give the student knowledge, but also to save his physical, moral, mental and social health. Health-saving technologies teach children to live without conflicts, teach them to strengthen, save and value others' health. These technologies instill children in the principles of a healthy lifestyle, enhance motivation to study. Effectiveness of the positive impact on the health of students of a variety of recreational activities is determined not by the chaos of methods, but by system work in all areas. Practice shows that the process of formation of a conscious attitude towards own health requires a obligated combination of information and motivational components of practical activity of students, which will facilitate the mastering of children with the necessary health-saving skills.

The activity of the teacher should be aimed at forming a stable position in children that involves the definition of the value of health, a sense of responsibility for the saving and strengthening of their own health, the deepening of knowledge, skills and abilities associated with all components of health (physical, social, psychic, spiritual). Formation of a student's competent attitude to their own health is impossible without the realization of all components of health.

Realization of the physical component is carried out by: morning gymnastics, physical exercises, active games, physical therapy (recreational motor activity); control and self-control for the correct posture during writing, reading, walking, etc.; exercises on the prevention of scoliosis, prevention of hypodynamia, respiratory exercises; gymnastics for the eyes, acupressure of biologically active points of face and head, in order to finally "wake up" children and create an appropriate working mood for the whole school day; use of national remedies for the improvement and prevention of diseases; observance of the regime of education, nutrition, work, rest. Introduction of health-saving technologies requires from the teacher, firstly, to prevent overloading students, determining the optimal amount of educational information and how to provide it, taking into account the intellectual and physiological characteristics of students, the individual language features of each student, trying to plan such types of work that contribute to reducing fatigue.

Health-saving technologies include: change of activities, alternation of intellectual, emotional, motor activity; group and pairs forms of work that contribute to increased motor activity, teach the ability to respect the opinions of others, express their own thoughts, rules of communication; holding games and gaming situations, non-standard lessons, integrated lessons. Responsible attitude of students to their health, according to the opinion of most researchers, is the basis of healthcare, motivation – focused on the activities of children to save and strengthen their own health.

Health-saving technologies combine all areas of activity of the institution of general secondary education with regard to the formation, saving and strengthening of students' health. The classification of existing health-saving technologies was proposed by O. Vaschenko, which makes it possible to distinguish the following:

- *health-saving* – create safe conditions for staying, studying at the school and solve the problems of rational organization of the educational process (taking into account age, gender, individual characteristics and hygiene norms), accordance of educational and physical load with the child's abilities;
- *health-giving* – aimed at solving the problems of strengthening the physical health of students, increasing the potential (resources) of health: physical training, physiotherapy, aromatherapy, hardening, gymnastics, massage, phytotherapy, musical therapy;

- *health education technologies* –education hygiene, formation life skills (emotion management, conflict resolution, etc.), prevention of injuries and substance abuse, sexual education; they are implemented through the inclusion of relevant topics in school subjects, the introduction of new subjects into the variational part of the curriculum, the organization of optional education and additional education;
- *education of the culture of health* – promoting the saving and strengthening of health, the formation of ideas about health as a value, strengthening motivation for a healthy lifestyle, increasing responsibility for personal health and family health, education of students personal qualities.

Thus, the essence of health-saving technologies is the realization of appropriate corrective, psychological and pedagogical, rehabilitation measures to improve the quality of life of the child's personality, the formation of a higher level of their health, skills of a healthy lifestyle, ensuring professional activity and its minimum physiological "value".

Conclusions

In conditions of the process of reforming and modernizing the educational process in Ukraine, one of the main goals is the conscious desire of the individual to a healthy lifestyle, determination of its ability to successfully integrate into educational activity and ensure personal fulfillment and life success during all life.

Responsibility, as the personal quality that is forming and bringing up is the formation of the individual and is determined by the surrounding educational environment and the practice of the child to transform the nature of society and itself. The importance of health, as the highest universal value and the main factor for the achievement of success and well-being, allows us to determine the health-saving environment as the most important direction of modern education, the formation of healthcare as a purposeful and structured process in Ukraine.

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Chapter 16. EDUCATIONAL ASPECTS OF TRAINING SPECIALISTS FOR THE PHARMACEUTICAL INDUSTRY OF UKRAINE

I. HUBYTSKA, A. KRYCHKOVSKA, L. BOLIBRUKH, N. MARINTSOVA, L. ZHURAKHIVSKA, V. NOVIKOV
Lviv Polytechnic National University,
12, S. Bandery Str., 79013 Lviv,Ukraine
e-mail: aelitakrychkovska@gmail.com

Abstract. *A meta-analysis was carried out and higher educational establishments, which specializing in the training of specialists in the pharmaceutical industry in Ukraine on the specialty 226 "Pharmacy, Industrial Pharmacy" at three levels of education, were determined. Two directions are implemented by them: for the segment of industrial pharmacy and the segment of wholesale-retail sale of medicines and medical products. The peculiarities of the training of qualified specialists for industrial pharmacy were worked out and analyzed, and the quality management system (QMS) implementation, functioning and improvement was substantiated at the Department of Technology of Biologically Active Compounds, Pharmacy and Biotechnology at Lviv Polytechnic National University. It is proved that the implementation of a competent approach to the preparation of pharmaceutical staff in accordance with the new Law of Ukraine "On Higher Education" can be provided by highly qualified scientific and pedagogical staff who constantly improve their professional level of the modern lecturer of higher educational establishment, actively participate in research work, publish in journals of scientometric base of data, undergo internships in domestic and foreign higher educational establishments and research institutes, as well as in modern high-tech enterprises.*

Keywords: *Pharmaceutical education; Quality management system; Academic mobility; Institutions of higher education.*

Formulation of the problem

The pharmaceutical industry of each state is strategic, whereas in the new millennium the aggravation of economic crises, global integration, continuous increase in the level of morbidity of the population create new threats and challenges for national security, which contributed to the emergence of a new direction in security science-pharmaceutical safety.

The development of this direction as an important component of the national security system nowadays is multidimensional as it closely correlates with economic, social, food, military, and environmental security [3].

Therefore training of specialists in the pharmaceutical industry of Ukraine is an important task of the state.

In Ukraine, the study of specialists for pharmacy is carried out in two directions: for the segment of industrial pharmacy and the segment of wholesale and retail trade in medicinal products (medicines) and medical products. Education of future specialists is carried out in Ukraine by institutions of higher education in the specialty 226 "Pharmacy, industrial pharmacy" by three levels of education.

The graduation of professionals in this specialty in Ukraine is carried out by 28 educational institutions, namely: Kyiv International University (Kyiv), Interregional Academy of Personnel Management (IAPM) (Kyiv), Higher State Educational Establishment of Ukraine "Bukovinian State Medical University" (Chernivtsi), Vinnytsia National Pirogov Medical University (Vinnytsia), State Establishment "Lugansk State Medical University"

(Lugansk region, Rubizhne),Dnipropetrovsk Medical Academy (Dnipro), Donetsk National Medical University (Donetsk region, Kramatorsk), Donetsk National Medical University, Medical Faculty № 3 (Mariupol), Zaporizhia State Medical University (Zaporizhia), Ivano-Frankivsk National Medical University (Ivano-Frankivsk), Institute Of Chemical Technology Of The East Ukrainian National University (Lugansk Region, Rubizhne), Kyiv Medical University (Kyiv), Kyiv National University of Technology and Design (Kyiv), Lviv Medical Institute (Lviv), Danylo Halytsky Lviv National Medical University (Lviv), Lviv National University of Veterinary Medicine and Biotechnologies named by S. Gzhytskyi (Lviv), International Humanitarian University (Odessa), Pylyp Orlyk International Classical University (Mykolaiv), National Medical Academy of Postgraduate Education named after P. L. Shupik (Kyiv), Bogomolets National Medical University (Kyiv), Lviv Polytechnic National University (Lviv), National Pharmaceutical University (Kharkiv), Odessa National Medical University (Odessa), Odessa National Polytechnic University (Odessa), I. Horbachevsky Ternopil State Medical University (Ternopil), Uzhhorod National University (Uzhhorod), Ukrainian State Chemical Technology University (Dnipro) [5].

Proper quality level of skills and practical habits of future professionals of the pharmaceutical industry, educating of whom in the country is carried out in a relatively large number of higher education institutions should be provided through the introduction of aquality management system (QMS). However, not all higher education institutions received the relevant certificates and did not introduce the application of QMS in the learning process. So, professional studying of future industry professionals is an urgent scientific and pedagogical problem of higher education institutions.

The purpose of the study

Therefore, the aim of this study was to analyze and study features of training specialists for industrial pharmacy and segment of pharmaceutical wholesale and retail trade market of medicines realization, and also implementation, functioning and improvement of the QMS.

Presentation of the main material

Pharmaceutical education in Ukraine was formed in the 90's in the context of significant changes in the socio-economic and spiritual space of society, due to the significant spreading of new educational technologies and significant expansion of opportunities and needs for personal human development. The directions of pharmaceutical education in Ukraine were focused on updating and making significant adjustments to the goals, objectives and content of the educational process, as reflected in the Concept of Multidisciplinary Continuing Education approved by the Ministry of Health of Ukraine in February 1991. The concept has provided the allocation of personnel training for the industrial pharmacy, as well as specialists in economics and management, clinical pharmacy. It was laid the foundations for modern specialties of specialty "Pharmacy". It should be noted that until 1992 the direction "Pharmacy" was consisted of only one specialty. During the years of independence in Ukraine, the significant changes in pharmaceutical education were observed. Taking into account the real needs in the field of medical and pharmaceutical education and science, changes and additions to the List of directions and specialties of obtaining specialists, approved by the Resolution of the Cabinet of Ministers of Ukraine dated by May 24, 1997, No. 507 were implemented [16].

The Order of the Ministry of Education and Science of Ukraine No. 838 from 18.12.2007 approved the Concept of development of the pharmaceutical sector of the healthcare sector of Ukraine [11], which defines the priority directions and program tasks concerning formation of a system of training specialists, namely: the gradual introduction of step training of pharmaceutical personnel; implementation of the system of evaluation, monitoring and quality control of pharmaceutical education, which consists in the sequential acquisition of academic degrees of "bachelor" and "master" with the further obtaining scientific degrees; implementation of a credit-modular training in organization of education taking into account the

complexity of the students' educational work on the basis of the European Credit Transfer System (ECTS); expansion of academic mobility, which consists of a significant increase in the mobility of students, teaching staff and other personnel for the mutual enrichment by European experience; ensure the employment of graduates: facilitating the professional recognition of qualifications through the use of the Appendix to the diploma recommended by UNESCO; creation of a data bank of specialists in pharmacy; the introduction of a pan-European system of quality assurance of education through the creation of a modern system of pharmaceutical training with the use of a credit accumulation system; creation of conditions for the implementation of the thesis: "lifelong learning" and preserving the system of postgraduate education; expanding research on identifying the needs of specialists in certain specialties and opening new specialties to meet the needs of the pharmaceutical sector in the health sector; studying the efficiency and quality of specialists training (part-time study, postgraduate education); the gradual introduction of step-by-step training of pharmaceutical personnel, as well as systems for ensuring the quality of the educational process; creation of modern conditions of material and technical and informational provision of training of highly skilled specialists of pharmaceutical biotechnology for accelerating the formation of biotechnological trends in the pharmaceutical sector of the health care sector of Ukraine; improving the efficiency and quality of the practical training of a pharmacist and specialist for pharmacy manufacturing, industrial production and quality control of medicines both in the process of basic training and postgraduate specialization. It should be emphasized that the processes of modernization of higher education throughout the European space, encourage the creation of appropriate conditions for the qualitative training of specialists: professional competence, general education and culture, sociability, independence in decision-making and responsibility for their actions.

Due to the results of the investigations and requirements of World Health Organization (WHO), to the professional competencies of pharmacists and provisors it can be attributed to: the provision of pharmaceutical aid to any person who needs it; knowledge, skills and competences from a professional field; communicative skills and abilities, ability to chat, communicate with pharmacy visitors, etc. According to the requirements of the WHO, the emphasis is focused on the necessity of significant change of deep professional knowledge in pharmacy, to improve personal qualities, which together with the acquired skills and skills will allow a specialist to take a proper place among health care workers [16].

The implementation of the competence approach in professional education will contribute to the achievement of the main goal – the training of a qualified specialist who is fluent in profession capable of working effectively at the level of world and European standards, ready for constant professional growth, social and professional mobility [9].

Pharmaceutical education can not be separated from the strategic tasks of reforming the content of the educational process in Ukraine that relate to the development of state standards for the formation of systems and the amount of knowledge, skills, creative skills, other personality traits at various educational and qualification levels; providing alternative opportunities for education according to individual needs and abilities; an organic combination in the content of the education of its general and professional components in accordance with educational levels and peculiarities of the regions of Ukraine [17].

Pharmaceutical industry is one of the most dynamically developing in the difficult conditions of the present, and this is largely contributing to the development of pharmaceutical science and educational institutions where specialists are trained specially for this industry. The system of obtaining pharmaceutical personnel in combination with the system of their use should fulfill the functions of providing the population with effective and safe medicines, to

create and develop the production of domestic medicinal products, to control their quality, to provide organizational and methodological support to the pharmaceutical business, to develop a modern system of training specialists in the pharmaceutical industry in accordance with the necessity to provide high-quality medical care for the population [16].

Lviv Polytechnic National University is one of the first in the system of higher education of Ukraine, that started training the personnel according to the graduate system (bachelor, specialist, master), in accordance with the normative and legal framework provided by the Law "On Education" № 1060-XII, with changes from June 11, 2008. The following educational and qualification levels were established in Ukraine: a qualified worker; junior specialist; bachelor; specialist, master [4; 12].

In accordance with the Law of Ukraine "On Higher Education" dated by September 28, 2017, No. 1556–18, the training of specialists with higher education is carried out with appropriate educational or scientific programs at different levels of higher education:

- initial level (short cycle);
- the first (bachelor's) level;
- the second (master's) level;
- the third (educational / scientific / educational-creative) level;
- scientific level.

These levels are controlled by National Qualifications Framework (NQF) (systemic and structured by competences description of qualification levels) [7], which is intended for use by executive authorities, institutions and organizations implementing public policy in the field of education, employment and social and labor relations, educational institutions, employers, other legal and physical persons for the purpose of development, identification, correlation, recognition, planning and development of qualifications. The document on higher education (scientific degree) is issued to a person who successfully completed the relevant educational (scientific) program and passed the certification.

In accordance with part two of Article 5 of the Law of Ukraine "On Higher Education" in Ukraine [10] the following degrees of higher education are awarded:

- junior bachelor;
- bachelor;
- master;
- Doctor of Philosophy / Doctor of Arts;
- Doctor of Science.

Nowadays, department of the technology of biologically active compounds, pharmacy and biotechnology of Lviv Polytechnic National University as a graduate, provides courses for students of specialties 162 "Biotechnologies and bioengineering" and 226 "Pharmacy, industrial pharmacy" of full-time and part-time forms of studying. The dynamics of changes and development of the department during last decades were analyzed. Training of specialists in technology of medicinal products in Lviv Polytechnic was started in 1964 at the Department of Technology of Biologically Active Compounds, Intermediates and Dyes of the Faculty of Technology of Organic Substances, continuing the scientific traditions of the Department of Chemical Technology of the Chemical Technology Faculty of the Lviv Technical Academy, founded in 1923. During the existence of the department, the graduation of specialists for industrial pharmacy took place in the following specialties: Technology of medicinal products; Chemical technology of biologically active compounds; Industrial pharmacy; Chemical technology of pharmaceuticals; Technology of pharmaceuticals; Pharmacy; Pharmacy, industrial pharmacy.

Bachelor's degree in "Biotechnology" and "Pharmacy" in Lviv Polytechnic was started in 2001 at the Department of Technology of Biologically Active Compounds, Pharmacy and

Biotechnology, which in turn was created on the basis of the Department of Technology of Biologically Active Compounds, Intermediates and Dyes. During its existence the department has constantly expanded the scope of training of specialists in the field of organic synthesis of biologically active compounds, biochemistry, technology of medicinal compounds and biotechnology.

During the period of existence of the department, engineering personnel for the chemical, pharmaceutical and biotechnological industry were prepared: from 1945 to 2000–2017 engineers-technologists, among them 843 engineers in technology of dyes, 770 engineers in technology of biologically active compounds, 340 biotechnologists and 58 technologists of pharmaceuticals, as well as 34 masters of biotechnology and 33 masters of pharmacy. In the period from 2000 till 2011, the department has prepared and issued diplomas for 170 specialists and 69 masters in biotechnology and 345 specialists and 277 masters in pharmacy. The number of graduates for the educational-qualification level "Bachelor", "Master" and "Specialist" in different specialties for industrial pharmacy is given in *tables 1, 2*.

Graduates of the department are well-known in chemical, pharmaceutical and biotechnological enterprises, many of them are heads and chief engineers of enterprises, leading specialists of scientific research institutes of the National Academy of Sciences of Ukraine, and teachers of higher education institutions. 3 academicians, 18 doctors of science, 101 candidates of science are among graduates of the department, from which 3 doctor's and 48 candidate's theses have been defended at the department.

Table 1

The number of graduates for the educational-qualifying level "master" and "specialist" in different specialties for industrial pharmacy

No.	Years of training	Specialty	Education level	Total number	Full-time education	Part-time education
1.	2003–2011	8.110204 "Technology of Pharmaceuticals"	master	266	248	18
2.	2003–2011	7.110204 "Technology of Pharmaceuticals"	specialist	295	182	113
3.	2012–2016	8.12020103 "Technologies of Pharmaceuticals"	master	140	140	-
4.	2012–2016	7.12020103 "Technologies of Pharmaceuticals"	specialist	135	112	23
5.	2017	226 "Pharmacy"	master	46	34	12
6.	2018	226 "Pharmacy, industrial pharmacy"	master	34	24	10

Lviv Polytechnic is the only Ukrainian university which according to one of the most authoritative ratings of the Times Higher Education, entered the thousand best universities in the world, having trained in the field of "computer science" in the range of 401-500. And in the branches of engineering and technology and physical sciences Lviv Polytechnic is the only technical university in Ukraine that entered this rating. It is also important that the results of the certification audit of the quality management system according to ISO 9001:2015, Lviv Polytechnic has received a certificate of compliance in the field of "Providing services in the field of higher education, research and experimental development, architectural, engineering, technical testing and analysis services". The university is among the few certified universities (among 300 universities and academies) [1].

Table 2

The number of graduates for the educational qualification level "Bachelor"

No.	Graduation year	Specialty	Total number	Full-time education	Part-time education
1.	2006	6.1102 "Pharmacy"	66	46	20
2.	2007	6.1102 "Pharmacy"	22	22	-
3.	2008	6.1102 "Pharmacy"	83	65	18
4.	2009	6.1102 "Pharmacy"	63	57	6
5.	2010	6.1102 "Pharmacy"	91	54	37
6.	2011	6.1102 "Pharmacy"	87	54	33
7.	2012	6.1102 "Pharmacy"	50	50	-
8.	2013	6.120201 "Pharmacy"	67	51	16
9.	2014	6.120201 "Pharmacy"	48	48	-
10.	2015	6.120201 "Pharmacy"	50	35	15
11.	2016	6.120201 "Pharmacy"	63	50	13
12.	2017	6.120201 "Pharmacy"	40	39	1
13.	2018	6.120201 "Pharmacy"	53	40	13

Lviv Polytechnic National University is an institution of higher education of fourth level of accreditation, which provides educational services and the implementation of innovative research in accordance with the current needs of the economy and the requirements of stakeholders, spread of scientific knowledge, cultural and educational activities, conservation and enhancement of best traditions of university education. University activities are carried out within the existing national and international legal, regulatory term basis and internal statutory and regulatory documents. The University constantly monitors the changes in these documents related to its sphere of activity, and in accordance with these changes, the internal documents are corrected in a timely manner in accordance with the provisions of "Managing documented information". The University's leadership annually analyzes the functioning of the QMS using the SWOT analysis methodology that determines the external and internal factors related to its sphere of activity and strategic development and influences on achievement of the planned results of the functioning of the QMS, strengths and weaknesses, opportunities and threats. Analysis of the results are recorded in the form of "SWOT-analysis" of the corresponding protocol. The University has developed andimplemented an QMS [8], that covers the processes required for its functioning and their interaction, in accordance with the requirements of ISO 9001 and DSTU (National Standard of Ukraine) ISO 9001. The QMS is maintained in its current state and is constantly improving.

The University Management identified the processes required for the effective functioning of the QMS and their application within the University, as well as:

- defined the necessary inputs of these processes and outputs from them (in the relevant internal regulatory documents);
- determined the sequence and interaction of these processes;
- defined the criteria and methods (in particular, monitoring, measurements and corresponding indicators of efficiency) necessary to ensure the effectiveness of the functioning and control of these processes (in the relevant internal regulatory documents);
- determined the resources needed for these processes and ensured their availability;
- appointed persons with responsibility and authority regarding of these processes;

- considered risks and opportunities;
- provided assessment of these processes during internal audits and analysis of the QMS from the management side and the introduction of any changes needed to ensure that these processes achieved their intended results;
- ensured the improvement of the processes and the QMS in general.

In the University, for the effective management of processes, it is provided:

- the relevance of the documented information required for the functioning of the processes in accordance with the provisions on "Managing Documented Information".
- storage of documented information to ensure that the processes are executed as planned in accordance with the provisions of "Managing Documented Information".

Management of the University is responsible for the implementation, operation and ensure continual improvement of the QMS and efficient management of processes.

In framework of the implementation of the QMS at the Department, it was conducted a survey for fourth year student to monitor the quality of educational services through the student's eyes. The questionnaire of students of the fourth year of the specialty "Pharmacy, industrial pharmacy" was conducted with the purpose of determining the quality of education in a higher education institution. According to the formed questionnaire by lecturers of the Department, 30 students were interviewed, who gave answers to the following 6 questions *(Table 3)*.

As a result of the survey, the following results were obtained:

1. The interviewed group of students is homogeneous according to age and level of education.
2. 67% of respondents believe that the educational space of Lviv Polytechnic National University is equipped according to scientific and technological progress, 33% of respondents consider that educational space needs renovations.
3. 70% of respondents believe that the educational buildings of of Lviv Polytechnic National University as their service factors satisfy their needs.
4. 70% of respondents think that hostels as service factors do not meet their needs.
5. 73% of respondents are satisfied with the level of teaching disciplines by the lecturers of Department.
6. 47% of respondents are satisfied with the quality of education.
7. 30% of respondents consider expedient updating of the library of Lviv Polytechnic National University.

At the department, there are carried out classes of 87 subjects (including postgraduate). All disciplines, which are taught by the lecturers of the department, educational and industrial practices of students are 100% provided with working educational programs. The total number of students is 365 persons, including: full-time form of studying – 298 students, part-time form of studying – 67 students. At the Department of Technology of Biologically Active Compounds, Pharmacy and Biotechnology there are a postgraduate study in specialties 03.00.02 "Biotechnology", 15.00.01 "Technology of medicines, organization of pharmaceutical business and judicial pharmacy", 14.03.07 "Physiologically active compounds". Since 2016, at the Department it is conducted studying of graduates of higher education of PhD degrees in the specialty 226 "Pharmacy, Industrial Pharmacy" and 162 "Biotechnology and bioengineering".

In 2014–2015, 8 persons attended the post-graduate course at the department.

In 2015–2016, 11 persons studied in the post-graduate course at the department.

In 2016–2017, 5 persons were trained in the post-graduate course at the department.

In 2017–2018, 5 persons were studied in the post-graduate course at the department.

In 2018–2019, this year 9 persons is studied in the post-graduate course at the department.

Table 3

The questionnaire for students was created within the framework of the QMS

Question	Options for answers
1. Do you think that the learning spaces is equipped according to scientific and technological progress?	• Yes, quite • Partially • No
2. If "no" or "partially", what kind of learning space requires new equipment? (several answers are possible)	• Laboratories (chemical, physical, etc.) • Lecture halls • Sports complex • I believe that the learning space is fully equipped according to scientific and technological progress
3. What are the service factors in Lviv Polytechnic National University that satisfies you? (several answers are possible)	• Educational building • Hostel • Dining room • Library • Sports complex
4. What are the service factors in Lviv Polytechnic National University that you are not satisfied with? (several answers are possible)	• Educational building • Hostel • Dining room • Library • Sports complex
5. Is the level of teaching quality at the Department satisfied with you?	• Yes, completely • Moderately • No • Hard to say
6. What is needed to change at the Department on the first place, in order to improve the quality of education?	• Improve Knowledge Control • Update library • To increase the qualification of university lecturers

The department has developed and implemented a quality management system, set goals in the field of quality and developed a risk passport, which describes the procedure for detection, identifying, analyzing and assessing risks, taking measures to eliminate them and reasons for their occurrence in order to prevent further repeat, as well as documentary design their results.

The objectives in the field of quality are assumed a number of tasks, which are put forward by the scientific and pedagogical workers of the Department for the semester, namely: preparation of project applications (proposals) for participation in competitions: scientific research work for state orders for scientific and technical products, research grants financed from the state budget, scientific research projects on international cooperation; obtaining patents; advanced training courses "Seminar of psychological and pedagogical knowledge", at enterprises and in scientific institutions of the pharmaceutical industry; concluding inter-institutional agreements within ERASMUS + Program; publishing of scientific articles in journals within scientometric base of Scopus and Web of Science; creation of electronic educational-methodical complexes on educational disciplines and their allocation in the virtual learning environment of Lviv Polytechnic National University, etc.

Virtual Learning Environment in Lviv Polytechnic is a software system designed to support the distance learning process with an emphasis on learning, in contrast to a managed learning environment that has an emphasis on managing the learning process. The Virtual Learning Environment usually uses the Internet and provides tools for evaluating (in particular,

automatic assessment, from a task to choose), communication, downloading materials, returning students, evaluating colleagues, managing student groups, collecting and organizing student assessments, surveys, etc. This network service for daily use which contains all the necessary elements of theoretical and practical knowledge, control and self-assessment of learning activities, forms of organization of adaptation, motivation and creative orientation. According to ten years of experience since the introduction of the Virtual Learning Environment, students actively use it, which, undoubtedly, contributes to a better mastering of disciplines, assists them in preparing for control measures.

An important form of quality control of students' knowledge is the annual implementation of comprehensive control works *(Table 4)* at the general and educational levels of disciplines, which is determined by the scientific and methodical commission of the specialty.

Table 4

Results of complex control works for students of the first (Bachelor) level of education

No.	Subjects	Specialty, basic direction	Educational Year	Progress (standard 90–100%)	Quality (standard – not less than 50%)
11.	Pharmacokinetics	6.120201 "Pharmacy"	2014–15	94,6%	74,3%
22.			2015–16	100%	86%
33.			2016–17	100%	89,15%
44.	Normative provision of pharmaceutical production	12020103 "Pharmacy"	2014–15	100%	54%
55.			2015–16	100%	52%
66.			2016–17	100%	97%
77.	Industrial equipment of chemical and pharmaceutical enterprises	7.(8)12020103 "Technologies of Pharmaceuticals"	2015–16	100 %	87%
88.			2016–17	100 %	93%
99.			2017–18	92%	79%
110.	Industrial equipment and design of chemical and pharmaceutical enterprises in the GMP system	7.(8)12020103 "Technologies of Pharmaceuticals"	2015–2016	100 %	92,3%
111.	Modeling and designing of chemical and pharmaceutical enterprises in the GMP system	7. (8)12020103 "Technologies of Pharmaceuticals"	2017–2018	100%	67,9%

The analysis of the complex qualification work by disciplines of the Department for compliance with regulations demonstrates the quality training of students of the first (bachelor) and second (master's) level teaching specialty**.**

The department has the necessary set of educational and methodical documentation that reflects the organization, content and methodology of conducting the educational process. All disciplines, which are taught by the faculty of the department, are 100% provided with working educational programs. Work programs also cover all types of practices.

Essentiality of the new standards of higher education according to article 10 of the Law of Ukraine "On Higher Education", the standard of higher education is a set of requirements to the content and results of educational activities of higher educational establishments and scientific institutions at each level of higher education within each specialty [10; 14].

Higher education standards are developed for each level of higher education by the approved specialties in accordance with the list established by the Resolution of the Cabinet of Ministers of Ukraine of 29.04.2015 No. 266 [13] and the changes in 2017 in accordance with the National Framework Qualifications [7], which provides transition to a competency approach to the organization of educational process [6].

Standards of higher education are used to determine and assess the quality of the content and results of educational activities of higher educational establishments (scientific institutions) that have a license for educational activities in this specialty. The higher education standard defines the following requirements for the educational program: 1) the amount of ECTS credits required for a corresponding degree of higher education; 2) list of competencies of the graduate; 3) the normative content of the training of higher education graduates, formulated in terms of learning outcomes; 4) forms of appraisal of applicants for higher education; 5) requirements for the existence of an internal quality assurance system for higher education; 6) requirements of professional standards (if any).

Higher educational establishments, on the basis of an educational program for the relevant specialty, develop a curriculum, which defines the list and volume of academic disciplines in ECTS credits; sequence of teaching disciplines; forms of conducting training sessions and their volume according to the professional cycle and cycle of practical training, establishment of basic educational disciplines and variations of choice of higher education institutions and student; curriculum schedule; forms of current and final control [2; 15].

In accordance with the foregoing, the Department of technology of biologically active compounds, pharmacy and biotechnology of Lviv Polytechnic National University has developed the standards of higher education for students of specialties 226 "Pharmacy, Industrial Pharmacy" and 162 "Biotechnology and Bioengineering", namely: educational program of the first (bachelor) level of higher education, educational program for the second (master) level of higher education (qualification – master), educational scientific program of the second (master) level of higher education (qualification master – researcher) and educational scientific program of the third educational scientific level (qualification – doctor of physiology) correspond appropriate the requirements regarding the volume of ECTS, the list of graduate competencies, the normative content of the training of applicants for higher education, the form of certification of applicants for higher education, etc.

The educational program and educational scientific level data define basic academic disciplines and variational universities and students' choices and the sequence of their teaching, which is reflected in the corresponding structural and logical training schemes of specialists.

In addition, new extended applications for the bachelor's and master's diploma for specialties 162 "Biotechnologies and bioengineering" and 226 "Pharmacy, industrial pharmacy" (if necessary – for graduates of specialty 7.(8)12020103 "Technologies of pharmaceuticals" and 7(8).05140103 "Pharmaceutical Biotechnology"), which meet the modern requirements of European standards, were developed.

Special attention of the department is given to the publication of educational-methodical literature in the state language. The own library of the Department has 1 400 books (educational and scientific literature) and more than 2 000 scientific journals of domestic and foreign publications. Funds of methodical materials and manuals that are used for preparing students for laboratory and practical classes, coursework and diploma projects are located at the department and in virtual learning environment of Lviv Polytechnic National University.

The sets of tasks for complex tests for all normative disciplines were developed for students of specialty 226 "Pharmacy, Industrial Pharmacy" of first (bachelor) level of higher education.

The sets of tasks for complex tests on subjects: "Design of chemical and pharmaceutical industries in GMP system", "Technology and application of medical cosmetology", "Industrial equipment for pharmaceutical production" were developed For students of specialty 226 "Pharmacy, Industrial Pharmacy" of second (master) level of higher education.

A methodical seminar is held at the department, where the results of mutual visiting of classes, forms and methods of conducting independent classes, forms of control over the results of independent work of students are discussed, plans for editions of educational and methodical documentation are being prepared.

The scientific activity of the Department is based on the scientific direction – synthesis, research, technology and biotechnology of new pharmaceutical substances, organic compounds and functional materials, which have biological activity and a set of other practically valuable properties that includes:

- synthesis, properties and biological activity of new S-, N- and O-containing quinoid compounds;
- synthesis and biological activity of condensed and non-condensed heterocyclic derivatives on the basis of quinoid compounds;
- synthesis, chemical and biological properties of thiosulfonate derivatives of aliphatic, aromatic, heterocyclic and quinoid series;
- research of microbial associations of lactic acid cultures and the creation of functional beverages on their basis;
- selection and research of carriers for the modification of the lipase enzymes for the purpose of hydrolysis of vegetable oils and their re-etherification;
- development of the composition of the dental mix on the basis of natural composites, biologically active compounds with the addition of synthetic polymer materials;
- biologically active polymeric materials based on thiosulfonate and quinoid compounds;
- study of biosynthesis of glucose oxidase;
- research of chemical composition and study of pharmacological properties of plants of the Carpathian region;
- research of the modern market of insurance medical services and application of pharmacoeconomics methods for creation of the system of insurance medicine;
- mathematical modeling of biotechnological and pharmaceutical processes;
- polymeric carriers for the immobilization of bioactive ligands.

Within the framework of signed agreements, international scientific and technical cooperation with the organizations of the following countries: France, Germany, Russia, Poland, Lithuania, are carried out.

In 2015, the Department held the International Scientific Congress "Modern Directions in Chemistry, Biology, Pharmacy and Biotechnology" (September 29 – October 2, 2015) with the participation of Nobel Laureate, Professor of Cornell University Ronald Hoffman. In 2015–2018, agreements were signed on continuing cooperation with the Department of Organic Chemistry of the Kaunas University of Technology, the inter-institutional agreements on the program of academic mobility Erasmus + with the University of Du Men (Le Mans, France), the University of Toulouse III, Paul Sabatier (Toulouse, France), the University Opole (Opole, Poland), the University of Aix-Marseille (Marseille, France) and the University of Babes-Boyai (Cluj-Napoca, Romania), two projects of Ukraine-France international bilateral cooperation "Creation of sulfur-containing derivatives of carbocyclic and heterocyclic systems – potential

antithrombotic substances" (2017–2018) and Ukraine-Poland "Derivatives of 9,10-anthraquinone and related carbon and heterocyclic systems as prototypes of potential antitumor and antifungal substances" (2018–2019).

Cooperation with the research groups of Istanbul University, Opole University, Private institute of applied biotechnology daRostim is continuing. Private institute of applied biotechnology daRostim.

In the fourth scientific festivities of the Lviv Polytechnic National University, "Science Festivities 2018" (April 20, 2018, Lviv, Ukraine), as part of the team of the Institute of Chemistry and Chemical Technology, the teachers and students of the Department won 1st place for the demonstration of inventions of scientists, experiments, presentations, as well as master classes from "Polytechnic-Ecoland".

In the 2015–2018, students of the Department took part in the student's scientific and technical conference, All-Ukrainian Contest in the field of "Biotechnology" and "Pharmacy", received nominal scholarships, participated in the All-Ukrainian competition of student research papers in the field of "Biotechnology and Bioengineering" and co-authors of abstracts at conferences and co-authors of articles in Ukrainian and foreign journals.

On the basis of the Department of Technology of Biologically Active Compounds, Pharmacy and Biotechnology of the Lviv Polytechnic National University, first and second rounds of the All-Ukrainian Contest of Student Scientific Works on the specialty "Biotechnology and Bioengineering" were held.

Cooperation with local authorities, foundations, institutions of education and science is carried out on the basis of concluded agreements with the following organizations:

1. Institute of Organic Chemistry of the National Academy of Sciences of Ukraine (Kyiv) – updated since 2018.
2. Vinnytsia National Pirogov Medical University (Vinnytsia) Ministry of Health of Ukraine (Vinnytsya) – is in effect since 2004.
3. Zaporizhia State Medical University (Zaporizhia) – is in effect since 2007.
4. Danylo Halytsky Lviv National Medical University (Lviv) – is in effect since 2013.
5. Horbachevsky Ternopil State Medical University Ministry of Health of Ukraine (Ternopil) – is in effect since 2016.
6. National Pharmaceutical University (Kharkiv) – is in effect since 2010.
7. Lviv National University of Veterinary Medicine and Biotechnologies named by S. Gzhytskyi (Lviv) – is in effect since 2013.
8. Educational and Scientific Center "Institute of Biology and Medicine" of Taras Shevchenko National University of Kyiv – is in effect since 2013.
9. State high educational establishment "Ukrainian State University of Chemical Technology" (Dnipro) – is in effect since 2010.
10. National Technical University of Ukraine "KPI" (Department of eco-biotechnology) – is in effect since 2011.
11. Yuri Fedkovych Chernivtsi National University (Chernivtsi) – is in effect since 2013.
12. Odessa National Polytechnic University – is in effect since 2017.
13. Institute Of Blood Pathology And Transfusion Medicine Of The National Academy Of Medical Sciences Of Ukraine (Lviv) – is in effect since 2001.
14. Institute of Cell Biology National Academy of Sciences of Ukraine (Lviv) – is in effect since 2002.
15. State Scientific-Research Control Institute of Veterinary Medicinal Products and Feed Additives (Lviv) – is in effect since 2013.
16. Institute of Animal Biology, National Academy of Agrarian Sciences of Ukraine (Lviv) – updated since 2016.

17. Department of Physical Chemistry of Fossil Fuels of the Institute of Physical-Organic Chemistry and Coal Chemistry named after L. M. Lytvynenko of National Academy of Sciences of Ukraine (Lviv) – updated since 2016.
18. D. K. Zabolotny Institute of Microbiology and Virology of National Academy of Sciences of Ukraine (Kyiv) – is in effect since 2018.
19. JSC "Enzim" (Ladyzhin, Vinnitsa region) – is in effect since 2006.
20. PrJSC "Halychpharm" of "Arterium" Corporation (Lviv) – is in effect since 2008.
21. Andrey Sheptytsky National Museum (Lviv) – is in effect since 2009.
22. PrJSC "Enzim Company" (Lviv) – is in effect since 2018.
23. PrJSC "Mironivsky Hliboproduct" – is in effect since 2018.
24. Branch "Lviv Brewery" of PJSC "Karlsberg Ukraine".
25. National University of Food Technologies (Department of Microbiotechnological Synthesis).
26. National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (Department of Industrial Biotechnology).
27. Institute of Water Chemistry of the National Academy of Sciences of Ukraine.
28. Institute of Genetics and Biotechnology, National Academy of Sciences of Ukraine.
29. Institute of Biochemistry of the National Academy of Sciences of Ukraine.
30. Institute of Bioorganic and Petrochemistry of the National Academy of Sciences of Ukraine (Kyiv).
31. LTD "Pharma Life" (Lviv) – student practice.
32. JSC "Farmak" (Kiev) – student practice.
33. PrJSC "Darnitsa" (Kiev) – student practice.

Within the framework of the agreements on cooperation, a separate item describes the possibility for students to pass different types of practices. In particular, PrJSC "Halychpharm", PrJSC "Company Enzim" (Lviv), Branch "Lviv brewery" of PJSC "Karlsberg Ukraine" provides an opportunity for internship of students of the department: in 2015, 4 students were trained, in 2016 – 1 student, in 2017 – 1 student, currently 2 students pas the internship at PrJSC "Halychpharm" and 2 students (partially) work for PrJSC "Company Enzim" (Lviv).

The teaching staff of Department of Technology of Biologically Active Compounds, Pharmacy and Biotechnology is staffed with full-time employees with an average age of 48.56 years. The percentage of lecturers with a scientific degree is 91.17%, the academic rank – 70.58%. The department carries out training of highly skilled scientific and pedagogical personnel through studying in the magistracy, postgraduate studies and doctoral studies. According to the plan for improvement of qualification in the 2015–2018 academic year, 22 lecturers of the department were trained at scientific establishments and enterprises of the branch; in academic institutions (higher education institutions) of EU countries – 9 lecturers; at the Department of the Institute of Law and Psychology Lviv Polytechnic National University (seminar of psychological and pedagogical knowledge) – 25 lecturers.

Indicators of success and quality of knowledge indicate a rather high level of students' training. The subjects of bachelor qualification's and master's qualification works are relevant and correspond to the profile of training specialists. In 2015–2018, inter-institutional agreements were signed on the Erasmus+ Academic Mobility Program with the University of Du Men (Le Mans, France), the Toulouse III University, Paul Sabatier (Toulouse, France), the Opole University (Opole, Poland), the University of Aix-Marseille (Marseille, France) and the University of Babes-Boyai (Cluj-Napoca, Romania).

The department carries out work on methodological and organizational support of educational process in accordance with educational-professional, educational-scientific programs and training plans of specialists training. The set of educational and methodological

documentation, the number of textbooks, manuals, guidelines, comprehensive checklists, exam papers and tests for express surveys that cover the entire scope of the work syllabus of the appropriate disciplines are available. The department has its own library of scientific literature and periodicals.

In the department, all educational and auxiliary audiences renovated at the expense of funds of Lviv Polytechnic National University and sponsor funds.

The subject of the research work of the department is relevant, which is confirmed by a large number of contracts and corresponds to profiles of specialties. The theoretical and scientific-technical level of the research work of the department and the degree of engagement with the students of the scientific research works are high, as evidenced by a significant number of publications in domestic and foreign publications, in particular, for the reporting period 2015–2018 published – 497 publications, including articles – 206, of them – 93 in journals with impact factor; active participation in international and all-Ukrainian conferences and scientific contests, systematic defense of candidate's (doctor's) dissertations, participation of professors of the department in specialized councils for defense of candidate and doctoral dissertations. In 2015–2018, the volume of research work carried out by the staff of the Department with a positive dynamics significantly over the years of the reporting period has increased significantly.

Conclusions

The transition to a competency approach is an excellent quality of the new Law of Ukraine "On Higher Education". Providing a competent approach is a sign of innovation education, which can be carried out exclusively by highly skilled scientific and pedagogical workers. For the constant improvement of the professional level of the modern teacher of the higher education institution it is necessary to actively participate in research work, to publish the results in Scientific Metric Database journals, internships in domestic and foreign Establishments of Higher Education and research institutes, as well as in modern high-tech enterprises. All this will contribute to high-quality complex specialists training for the pharmaceutical industry of Ukraine.

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Chapter 17. TOPICAL QUESTIONS FOR PREPARING MEDICAL SPECIALISTS FOR THE PUBLIC HEALTH PROTECTION

L. VOVK, L. GDULEVICH, Yu. OSTROVERKHA
Higher educational Institution of the Lviv Regional Council
"Lviv Medical College of Postgraduate Education",
9, Mykolaychuka Str., 79000 Lviv, Ukraine
e-mail: ostrov.yu.a@gmail.com

Abstract. *The reform of healthcare system in Ukraine is accompanied by optimization and development of two subsystems: providing primary medical care and public health protection.*

At the first of them ends the reform of the primary medical care unit. In the second – the legal and regulatory framework is being developed for the development of public health system, the headquarters is created and the network of territorial public health centers is formed. Since the primary level is basic, it provides both a subsystem for medical care and public health care.

In the absence of specialists in public health care field, specialists in the field of general practice-family medicine are involved in the implementation of their tasks. Therefore, the training of qualified public health professionals is relevant. There is a program of training specialists in the new specialty "Public Health" in the system of post-graduate education at specialization courses for persons with basic training "nurse of general practice-family medicine" or "paramedic".

Keywords: *Reform of the national health care system in Ukraine; Primary medical care; Public health; Training of medical specialists in the field of public health.*

Formulation of the problem

In the process of reforming the health care system in Ukraine, there is an optimization and development of two subsystems: providing primary medical care and the protection of public health. Under new organizational approaches, medical care is subdivided into primary medical care(PMC), outpatient (specialized) and inpatient (highly specialized) medical care. At present, the stage of development of the primary level of primary medical care is almost completed. The main policy document regulating such activities is the order of the Ministry of Health of Ukraine dated March 19, 2008, No. 504 "On Approving the Procedure for Granting Primary Care". Its main goal is to provide the population with complex and integrated services for a comprehensive, continuous and patient-oriented PMC aimed at meeting the needs of the population in restoring and maintaining health, preventing the development of diseases, reducing the need for hospitalization and improving quality of life. In Ukraine, PMC is provided on the basis of general practice-family medicine (GPFM). It should be noted that Lviv was one of the first centers for the establishment of family medicine in Ukraine. In 1988, this kind of provision of PMC was started here. The main priorities of the GPFM are:

- recognition of primary medical care as a priority area of activity of society and state in the field of health care;
- focus on the patient, his family and society as a whole;
- equal opportunities for patients receiving PMC;
- guaranteed amount of free PMC;
- free choice of PMC subject;
- a conscious choice of methods of prevention, diagnosis and treatment of diseases;
- compliance with sectoral standards in the field of health care;
- the responsibility of the patient and his family members for their own health, accurate and timely information of the GPFM specialists about its changes.

The main medical specialists of the PMC are doctors and nurses GPFM who are working in the primary health care centers, outpatient clinics and obstetric clinics (in the countryside).

The development of the public health system in Ukraine is the fulfillment of the commitments made in the conclusion of the "Agreement on Association between Ukraine, on the one hand, and the European Union, the European Atomic Energy Community and their Member States, on the other hand" (ratified by the Law Ukraine No. 1678-VII dated September 16, 2014). In particular, Chapter 22, Public Health, reads as follows: "Article 426. The Parties shall develop cooperation in the field of health care with a view to raising its level of safety and protecting human health as a prerequisite for sustainable development and economic growth.

Article 427.1. Cooperation, in particular, covers the following areas:

1. Strengthening the health care system of Ukraine and its potential, in particular through implementation of reforms, further development of primary health care and training of staff;
2. Prevention and control of communicable diseases such as HIV / AIDS and tuberculosis, increased preparedness for the outbreak of highly pathogenic diseases and the implementation of the International Health Regulations;
3. Prevention and control of non-communicable diseases through the exchange of information and best practices, promotion of a healthy lifestyle, identification of key determinants of health and health problems, such as maternal and child health, mental health, alcohol, narcotic and tobacco dependence, in particular the implementation of the 2003 Framework Convention on Tobacco Control;
4. The quality and safety of substances of human origin, in particular blood, tissues and cells;
5. Health information and knowledge, guided by the approach "health care in all policies of the State".

For this purpose the Parties shall exchange information and best practices and carry out other joint activities, including through the "health policy in all policies" approach and the gradual integration of Ukraine into European health care networks".

It should be noted that certain predecessors of the public health system in Ukraine were social hygiene, social medicine and a network of treatment and preventive care establishments. Since the public health system is the basis of preventive medicine, which aims at preserving the health of the entire society and the individual health of each member.

In the world, the World Health Organization (WHO) and its European Regional Office play a major role in developing a strategy and action plan for strengthening capacity and improving public health services. In fact, they are the initiators and main developers of the Strategy "Health 2020: Fundamentals of European Policy in Support of the State and Society actions for Health and Well-being and the European Action Plan for Capacity-Building and Improving Public Health Services (ENP)", Adopted by the 62nd session of the WHO Regional Committee in September 2012.

WHO's definition of "public health is the art and science of disease prevention, life extension and health promotion through organized community efforts". Therefore, the system of public health protection includes the whole range of measures aimed at promoting health, preventive medicine and ensuring the positive impact of all factors affecting the health of the population (lifestyle, environment, biological factors, health system I).

Since the whole society should be involved in the implementation of these measures, such activities should be based on effective and efficient inter-sectoral interaction between authorities, business and the public.

WHO has developed ten main operational functions of public health:

1. Surveillance and assessment of the health and well-being of the population.

2. Monitoring and responding to health threats, as well as emergency public health events.
3. Health protection, taking into account the safety of the environment, labor, food, etc.
4. Strengthening health, taking into account the impact on social determinants and reducing inequalities in health indicators.
5. Prevention of illnesses, including early detection of a health condition.
6. Providing strategic guidance for health and well-being.
7. Provide public health with qualified staff in sufficient quantities.
8. Ensuring sustainable organizational structures and financing.
9. Informational and advocacy work (advocacy), communication and social mobilization, (ACSM-tools) for the sake of health.
10. Promoting research in public health to provide scientific justification for policies and practices.

Public policy and measures of organization of public health in Ukraine based on the orders of Cabinet of Ministers of Ukraine dated 30.11.2016, No. 1002-r "On approval of the concept of public health" and on 18.08.2017, No. 560-r "On Approval of the Action Plan for the Implementation of the Concept for the Development of the Public Health System".

In June 2018, draft Law of Ukraine "On the system of public health" was posted at the official website of the Ministry of Health of Ukraine for public comment, which defines the legal, organizational, economic and social principles of the public health system in Ukraine. In particular, it introduces the concept of "public health" at the legislative level, defines the subjects of relations in this system, establishes and delineates the powers of the Government, the Ministry of Health of Ukraine, other central and local executive bodies and local self-government bodies in this area. The draft law provides for the creation of a National Council for Public Health as a permanent advisory body to the Cabinet of Ministers of Ukraine. It also defines the main directions of the system's activity, the basic principles of the implementation of operational functions of epidemiological surveillance (in particular, the formation of a public health information information as a state information resource, which contains data on the state of health, well-being of the population and indicators of the environment of life), as well as monitoring , preparedness and response to hazards and emergencies in the field of public health (in particular, provisions for the implementation of International Health Regulations). It also reflects the basic principles of staffing, scientific and financial provision of the public health system. We hope that after extensive discussion by experts, additions and revisions based on their comments and proposals, adoption of the said Law will contribute to the development of the public health system in Ukraine.

The country is developing a network of public health facilities. Initially, the central institution of the system was created – by the order of the Ministry of Health of Ukraine dated September 18, 2015, No. 604 "On the establishment of a public institution" Center for Public Health of the Ministry of Health of Ukraine ". The document states that "The Center is a scien tific-practical institution of the medical profile of the Ministry of Health of Ukraine, which carries out functions for ensuring the preservation and strengthening of public health, conducting social-hygienic monitoring of diseases, epidemiological surveillance and biological safety, and the implementation of group and population prevention of disease, fight against epidemics, strategic management of public health".

In 2017, the establishment of regional public health centers is under way. In particular, for this purpose an order was issued by the Ministry of Health of Ukraine dated 02.11.2018, No. 2012 "On Approval of the Model Charter and Model structure of the Public Health Center (the regional, cities of Kyiv and Sevastopol)". In the Lviv region, the regional public health center was formally established in December 2017 on the basis of the Lviv Regional AIDS Center.

The decision of the XV regular session of the VII convocation of the Lviv Regional Council (LRC) dated March 20, 2018 "On the Reorganization of the Public Health Service in the Lviv Region" discontinued the functioning of the municipal facility (MF) LRC "Lviv Regional Health Center" and the (MF) LRC "Lviv Regional Medical Information and Analytical Center "by their joining to the (MF) LRC" Lviv Regional Center for Public Health". The issue of the subsequent joining to the state institution (SI) "Lviv Regional Laboratory Center of the Ministry of Health of Ukraine" is discussed.

The purpose of the study

The issue of the training of qualified medical specialists for practical work in the system of public health protection remains open. At present, only the first steps are taken in this area. Thus, on 01.02.2017, the Cabinet of Ministers of Ukraine No. 53 "On Amendments to the Resolution of the Cabinet of Ministers of Ukraine dated April 29, 2015, No. 266 "was adopted, which approved the specialty "Public Health". The Ministry of Education and Science of Ukraine issued an order dated 12.12.2018, No. 1383 "On Approval of the Standard of Higher Education in the specialty 229" Public Health "for the second (master's) level of higher education. "However, to date, there has not been established nor the need for qualifications and staffing levels for the public health system, nor the number of specialists who need to retrain or undergo a thematic improvement. Therefore, the state order for pre- and postgraduate training of personnel for the public health system has not been formed.

Primary medical care is the basic level for the comprehensive implementation of the programs of provision of medical care and public health (through a combination of providing a guaranteed amount of affordable, timely, quality and efficient primary care to a particular patient and improving public health, preserving, restoring and improving health I am the population). Therefore, at present, the implementation of these services involves medical specialists specializing in "general practice-family medicine". For the same reason, they received extensions of powers to provide services in this area (from prophylactic to palliative).

The list of priority tasks of PMC specialists in the implementation of public health programs includes:

- organization and vaccination in accordance with the schedule of preventive vaccinations;
- realization of programs for infectious and non-infectious diseases that are identified as priorities at the national and regional levels;
- work in the centers of infectious diseases (except especially dangerous ones) and implementation of measures for their localization and liquidation;
- ambulatory treatment of patients with tuberculosis;
- counseling on the prevention of diseases;
- participation in communication companies on health promotion and healthy lifestyle development;
- submission of emergency messages about an infectious disease or food poisoning, an unusual reaction to vaccination;
- entering data on the established diagnosis of the electronic health protection system.

In the conditions of the medically-demographic crisis in Ukraine, which, according to the State Statistics Committee, is getting worse year after year, there is a danger of chemical, biological, nuclear and radiation effects on health, real terrorist threats, the problem of creating a complete system of public health protection, its staffing and resource support becomes urgent. In addition, the processes of decentralization that take place in Ukraine in 2014 (transfer of powers and finances from state authorities to local self-government bodies) require qualified specialists in the field of public health of the united territorial communities (UTCs) that are created in the regions. This problem is especially acute in the countryside.

Presentation of the main material

We created a training program that allows to train qualified specialists in the new specialty "public health" in the system of postgraduate education at specialization courses for persons with basic training "nurse of general practice-family medicine" or "paramedics".

Duration of the cycle – 2 months (288 hours). 130 hours of them is theoretical courses, 142 hours – practice, 16 hours – seminars.

The program includes the following thematic sections:

- domestic health care system, preconditions, reasons, goals and objectives of its reform;
- formation of the public health system in Ukraine;
- primary health care on the basis of general practice of family medicine and organization of its provision in the united territorial community;
- participation of primary health care professionals in the implementation of public health programs;
- peculiarities of providing public health protection at the level of territorial communities;
- epidemiological surveillance and assessment of public health;
- health, medical valeology (sanology), healthy lifestyle;
- public health and non-communicable and infectious diseases;
- medical education, promotion of health and sanitary-hygienic education of the population;
- crisis communications and issues of biosafety, bio-protection and bioethics in the public health system.
- health, labour protection of the health workers
- topical aspects of creating an electronic health protection system in Ukraine;
- emergency medical care.

This training program can cover all areas of work of a nurse (instructor, manager) of public health.

During classes, active methods of teaching are used: methods of "round table" and "brainstorming", situational tasks, trainings, business games.

The training base for listeners of the cycle of specialization of nurses (instructors, managers) of public health is the centers of primary health care, the department of family doctors in polyclinics, family outpatients, obstetric clinics public health management bodies in the united territorial communities, institutions for the provision of medical and social services.

After completing the training, an exam is conducted in the form of test. The purpose of the cycle of specialization "Nurses (instructors, managers) of public health" is to gain new experience, mastering professional skills, necessary for the qualified provision of the community of health care and social care and planning and solving of public health protection problems. The main task is to teach the provision of public health protection of the territorial community, through the implementation of a set of measures to prevent and reduce morbidity, disability and mortality, early detection of diseases and monitoring of the health of the population, medical and social rehabilitation and palliative care, using this potential cross-sectoral cooperation.

We will describe in more detail some of the important aspects of the proposed program.

First. The curriculum is based on the ten operational functions of the WHO health system and the European model of competences for public health workers. This model was created by: Katarzyna Czabanowska, Olga Gershuni and Genc Burazeri (Maastricht University), Robert Otok (ASPHER); Natasha Azzopardi Muscat (Maltese University), (EUPHA); Darren Schickl (University of Leeds).

This document describes the general competencies that are expected from public health workers to perform public health functions in their organization / country. The teams of competencies are divided into ten sections:

Content and context

1. Science and practice.
2. Strengthening health.
3. Legislation, policies and ethical aspects.
4. One health and one safety.

Relationships and interaction

5. Leadership and systematic thinking.
6. Cooperation and partnership.
7. Communication, culture and advocacy.

Efficiency and achievement

8. Governance and resource management.
9. Professional development and observance of ethical norms.
10. Organizational literacy and flexibility.

Each section contains knowledge, skills and attitudes of public health workers. In turn, each competence is associated with ten major operational functions of public health.

Second. The main tasks of medical workers are:

- to preserve, strengthen and enhance health (in particular, by forming a healthy lifestyle, (HL);
- to prevent illnesses (using an arsenal of medical prophylaxis);
- to diagnose and treat illness in a timely manner;
- to facilitate suffering difficult and incurably ill (by providing palliative care)

However, as a rule, they are best guided in the provision of diagnostic and treatment process. They are somewhat better focused on medical prophylaxis. And not enough – about health management and medical and social care issues.

Therefore, the proposed program devotes great attention to the development of these issues. In particular, the principles of sanology (medical valeology) of prof. Apanasenko G. L. as the founder of science "Sanology (medical aspects of valeology)" is being taught in Ukraine, this subject studies the essence, mechanisms and manifestations of health, methods for its diagnosis and prognosis, as well as corrections based on the optimization of health mechanisms in order to increase it level, improvement of quality of life and social adaptation of the individual.

Attention is drawn to the fact that valeology is a modern comprehensive approach that puts the subject of its study into spiritual, mental and physical health of a person.

Three components of valeology are highlighted: valiosophy (philosophy of health, or wisdom of health), valeometry (measuring health) and valeopractic (body healing).

Healthy lifestyles are interpreted as a wise use of each person viability, also observance of scientifically substantiated recommendations of WHO and other medical organizations, in particular, regarding nutrition, necessary physical activity, hygiene, cold workouts, devastating habits and addictions, prevention of sexually transmitted diseases, the establishment of healthy, harmonious social relations.

In those people, who had listened the course, formed an understanding of the importance of a healthy lifestyle to preserve and strengthen public health, as well as mastering practical skills for its promotion.

Thus, in order to be healthy, a person needs to:

- realize their own health as a personal and social value;
- make efforts to acquire the necessary knowledge and skills of HL(healthy lifestyle) and to adhere to it in everyday life;

- share their knowledge and skills in the formation of health care;
- be responsible for negative actions that are harmful to their own health and health of others.

Tips for the formation of HLS in the family

1. They must love their children and instill HL skills systematically and consistently in them by personal examples.
2. To form trusting relationships and ensure a positive family atmosphere in the family; be responsible for inflicting harm to the child's health through mental pressure, physical punishment or other violent actions.

Tips for the formation of HL in the community

Develop accessible infrastructure for physical development for all age groups; to create a safe environment at the community level (prohibition of negative advertising, which promotes alcohol beverages, smoking, unhealthy food, etc.).

Third. Despite the significant prevalence of chronic non-communicable diseases in the statistics on morbidity, disability and mortality of infectious diseases, the last one are still in the focus of professional attention of primary care medical workers. Therefore, the topic "Public health and non-communicable diseases" is an important part of the curriculum.

Non-communicable diseases (NCDs) are painful conditions that are not transmitted from person to person, they continue to run and slowly progress, impair psycho-emotional and physical (somatic) health, and are caused by an unhealthy way of life.Among these diseases, the largest proportion has four groups: cardiovascular, cancer, diabetes and chronic respiratory diseases. Actually, they have gained global epidemic spread and cause the greatest devastating impact on public health. On the account of these four (NCDs) groups, two thirds of the world's deaths, up to 60 percent of the adult and almost 20 percent of the children's population suffer from this pathology. In Ukraine, this (NCDs) determines the level of total mortality of the entire population of our country – 82.8%, and determines the death rate of the working-age population at 62.4%.

Among the NCDs in the structure of morbidity, disability, disability and mortality, of the population is affected by diseases of the circulatory system and the most common among them is hypertension. Ukraine belongs to countries with a very high degree of hypertension. In Lviv region, as in Ukraine as a whole, about 30% of the population suffer from hypertension and only 60% of them know that they have high blood pressure, and only 15% are treated.

Fortunately, non-communicable diseases can be prevented. WHO experts have shown a close relationship between non-communicable diseases with conditions and lifestyle and generally recognized risk factors. According to expert estimates, 80% of all cases of heart diseases, strokes, type 2 diabetes and more than one third of all cancers can be prevented by changing the attitude of the population towards the use of tobacco products and alcohol , inadequate physical activity, unhealthy diet and excess body weight (obesity).

After all, 36% of the population of Ukraine smoke (of which more than 58% of men and 7% of women), 20% – excessive use of alcoholic beverages. Every third adult in Ukraine has overweight, 16% of Ukrainians are diagnosed with arterial hypertension, 1.2 million are suffering from diabetes, and about the same amount does not even suspect it to be present.

Obviously, negative social effects on the level of prevalence of NCDs include poor quality of life, lack of education, rapid urbanization and aging of the population, as well as socio-economic, gender, political, behavioral and environmental determinants of health.

The possibility of effective prevention of NCDs under the control of risk factors underscores the feasibility and the necessity of organizing an active, well-considered control of non-infectious diseases at the national, regional and global levels.

That is why, in September 2011, at the United Nations Assembly (UN), world leaders, announcing an epidemic of non-communicable diseases in the world, adopted a political statement (United Nations Political Declaration on Non-Communicable Diseases) on measures to reduce the global burden of these diseases. The concept of countering NCDs is based on the experience of the implementation of the Integrated Non-communicable Disease Prevention Program (CINDI) of the World Health Organization, as well as the international research on how to cope with major chronic illnesses throughout human life. This approach takes into account that a small number of risk factors and conditions are common to most chronic diseases. This similarity means that complex actions against certain risk factors carried out within the social context can lead to a decrease in most of the NCDs as well as to the improvement of the health situation. At the same time, in spite of various socio-economic and cultural conditions in the countries of the world several common points are allocated for the organization of prevention and control of non-communicable diseases:

- cross-sectoral struggle (participation of the education, occupational safety, industry and agriculture, ecology, physical education and sports, media spheres for leadership in health care;
- involvement of social organizations, private business, under the increased attention of the government;
- strengthening the preventive component of health care (prevention standards, health management standards, algorithm for work with healthy people);
- inclusion of the term “health” in the basic human values and creation of conditions for a healthy lifestyle.

The state policy of countering NCDs in Ukraine is regulated, in particular, by the Government order, dated July 26, 2018, No. 530-r "On Approval of the National Plan of Measures for Non-Communicable Diseases to Achieve Global Sustainable Development Goals".

Fourth. An important objective of the proposed curriculum is the awareness of the WHO principle of public accountability for public health and the concept of "strategic management / health protection management". They should learn how to implement such leadership in the interests of public health: through cooperation, citizen engagement, and a combination of regulation and conviction, as well as through adapted strategies, sustained structures and prediction, and on the principle of anticipation. During the study, the position "you are not alone in the territory of medical service! is formed. Partners in the field of public health work alongside you. Learn how to communicate with them and mobilize them for cooperation in the interests of the community". Such partners for medical professionals in the health sector are: the state (state structures, public sector), private investor (private partner, business structures, private sector), public organizations (civil nonprofit sector). Important partners at the level of the territorial communities, especially in rural areas, are educators, social workers, members of political and community organizations, priests and members of religious communities, associations of citizens with special needs and patient organizations. During the classes, practical approaches and experience of advocacy, communication and social mobilization (ACSM-tools) as an effective ways for implementation of public health protection

Fifth. In conditions where Ukraine is in a state of war, socio-economic instability and real threats to its existence, the essential components of the curriculum are, without a doubt, the mastery of students basic skills in planning and implementation of crisis communications, knowledge about the features and tasks of inter-sectoral cooperation in the context of the crisis, studying the experience of organization and activity of medical and social "hot" lines, helpdesks and "call centers" (support services), etc. at the national and regional levels. It is also evident that listeners learn the skills of providing emergency medical care, as well as the basics of tactical medicine.measures are learned.

Conclusions

Thus, the curriculum offered by the authors allows to train qualified specialists in the new specialty "public health" in the system of postgraduate education at specialization courses for persons with basic training "nurse of general practice-family medicine" or "paramedics". The program is timely and addresses the issue of urgent training of specialists for the grassroots level of the public health system at the level of the territorial communities.

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Chapter 18. SCIENCE OF UNITARY HUMAN BEINGS – APPLICATIONS IN A SMART SOCIETY

Yu. PAZYCHYN
Ivano-Frankivsk National Medical University,
2, Halytska Str.,
76000 Ivano-Frankivsk, Ukraine
e-mail: universitas.international@ukr.net

Abstract. *This article focus the application of the Science of Unitary Human Beings in a SMART Society, its creative impact in a fast-growing society of technology and social relations. (approach in a non-linear, rhythmic and virtual context). To that end, the main concepts and definitions of the Rogerian model will be addressed, and if it were operationalized. A bibliographical review of the main theoretical developments in the different components of the model (relationship with the patient, variables, environmental, technological and theoretical supporting framework) is made. In the same way, and whenever possible, in the light of the theoretical development carried out, an effort is made to ascertain its practical application in the various contexts of the Science of Unitary Human Beings. At the end of the paper, potential applications of the Rogger model are presented in the different components of healthcare (research, teaching, healthcare practice).*

Keywords: *Science of unitary human beings; Global heath; Digital society; Human energy field; Aging; Virtual reality; Environmental wave patterns; Imagery; Therapeutic touch; Smart society; NASA.*

Problem's Formation

This article, focus health in SMART Society from a science of unitary human beings point of view. In our days, with the internet and globalization of mobile technology, people can access information, innovative ideas and tools from anywhere, including in space. Martha E. Rogers, who was born in 1914, developed and taught a model. This framework was first presented by Rogers in 1970 as a "conceptual model of the life process in man" [75].

After several refinements it become the nursing conceptual system known as the Science of Unitary Human Beings [79].

She described a conceptual system "that was humanitarian, rather than mechanistic and she was a cynic of western medicine, healthcare, and the pharmaceutical industry". Rogers was also critical of technology as something that could replace face-to-face, health care interventions, invasive medical procedures, and medications [11].

The Science of Unitary Human Beings, pays particular attention to "unitary, irreducible human beings and their respective environments" [78].

Martha E. Rogers' conceptual system explains that "The irreducible nature of individuals is different from the sum of their parts". The objective is "to promote human betterment wherever people are, on planet earth or in outer space" [80].

The model provides a frame of reference for the study of unitary humankind.

This conceptual system is a synthesis of facts and ideas that form an indivisible whole.

A major value for the Science of Unitary Human Beings is simply the quick development of the science as researchers, address important research questions and systems.

For instance, speculations have been intently inspected for their conceivable connections with the framework [66].

In such a situation, ideas and standards of the science experience steady examination to guarantee theoretical consistency.

Particularly charming in chaos was the idea of unpredictability, an idea viewed as consistent with the rogerian guidelines, which also proposes an unpredictable change.

However Rogers [80] communicated worry over the appropriateness of such examinations.

The science of chaos depends on a three dimensional reality, which suggests that consistency is unimaginable in light of the fact that science can never precisely measure all factors [29].

This is not quite the same as the pandimensional world perspective on Rogers, which suggests that the unconventionality of progress is normal, for the idea of progress, instead of an estimation trouble [80].

In this quickly developing Rogerian theoretical framework, each exploration considered gives a trial of the framework as well as conceivably gives the premise to modifications in the applied framework.

Therefore, it isn't bizarre in looking at the writings to discover milestone considers, refering to a Rogerian applied base, and Science of Unitary Human Beings.

Investigation Purpose

The art of creative innovation is changing all parts of life on the planet and stretching out to the edges of the cosmic system. Moreover the implications of darkness, distance, time, and space have moved toward becoming progressively uncertain in this digital age, as computer generated realities progressively rival to nature, and recreated reality persistently increments in detail and complexity.

Online life is moving political power far from those that try to smother the sharing of news; anyway its potential remains hampered by the simplicity of circulation of negative and destructive information.

The use of genetic, genomic science and the electronic medical record innovation in human services, while still in beginning times of execution, is changing human services to make treatment progressively individualized.

Rogerian and other helpful persons calculated models in healthcare and different orders too, as interdisciplinary discoursed should be utilized to direct the utilization of these new devices of mass correspondence and data sharing, to build individuals decisions, and encourage general mankind improvement.

At the point when considered all inclusive, it is troublesome not to envision that Rogers would have considered the expansion of energy in Earth's air, water, and when all is said in done, as appearances of shorter and higher frequency patterns and an evolutional in formative procedure, which is neither great nor terrible however something that challenges we all to envision and plan for change.

So also the development of worldwide portable information can be viewed as an indication of this more prominent decent variety and intricacy of wave phenomenon.

It is progressively a test to create and utilize innovation in ways that upgrade human wellbecoming.

The investigation porpuse of this working paper, is to make a short review on Science of Unitary Human Beings (conscepts, definitions, and theories), and possible applications of that framework in a Smart Society.

Main material's presentation

a) Concepts and Definitions

Rogers' Science of Unitary Human Beings has some core concepts and definitions.

- Energy field

"Field ... is a unifying concept and energy signifies the dynamic nature of the field". "Energy fields are infinite and pandimensional; they are in continuous motion" [80].

The two dimensions of the concept are human energy field and environmental energy field.

- Human Energy Field

"Is defined as a unitary human being who is irreducible and indivisible into parts" [24].

"(…) identified by pattern and manifesting characteristics that are specific to the whole and which cannot be predicted from knowledge of the parts" [80].

They can be individual or colective.

- Environmental Energy Field

Defined as "an irreducible, [indivisible] ... energy field identified by pattern and integral with the human [energy] field" [80].

***-** Openness*

Characteristic of human energy fields and environmental energy fields, which "are open, not a little bit or sometimes, but continuously" [80].

- Pattern

Defined as a unique "abstraction, [the nature of which] changes continuously, and [that] gives identity to the [energy] field" [80].

"Energy field patterns are not directly observable, although manifestations of energy field patterning are observable as experiences, perceptions, expressions, situations, and events" [24].

- Pandimensionality

Is defined as "a nonlinear domain without spatial or temporal attributes" [80].

***-** Homeodynamics*

Are principles that characterize changes in human energy field and environmental energy field patterns [24].

The three dimensions of the concept are resonancy, helicy, and integrality.

***-** Resonancy*

Defined as the "continuous change from lower to higher frequency wave patterns in human and environmental [energy] fields" [78].

***-** Helicy*

Defined as the "continuous, innovative, unpredictable, increasing diversity of human and environmental [energy] field patterns" [78].

***-** Integrality*

Defined as the "continuous mutual human [energy] field and environmental [energy] field rocess [78].

***-** Well-being*

Is a value that expresses the life process; is defined by what is wellness and what is illness or disease means for each society [24].

- Health patterning Practice Method

It is defined as the nursing process.

The three dimensions of the concept are pattern manifestation knowing and appraisal-assessment, voluntary mutual patterning, and pattern manifestation knowing and appraisal-evaluation [10; 21; 22].

Pattern manifestation knowing and appraisal-assessment

It is defined as the continuous process of apprehending and identifying manifestations of human energy field and environmental energy field patterns that relate to current health events.

- Voluntary mutual patterning

It is defined as the continuous process whereby the nurse with the client patterns the environmental energy field to promote harmony related to health events.

Voluntary mutual patterning processes that are most consistent with Rogers' Science of Unitary Human Beings are non-invasive modalities.

- Pattern manifestation knowing and appraisal-evaluation

It is defined as evaluation of voluntary mutual patterning by means of pattern manifestation knowing and appraisal.

- *Relational Propositions*

Given Rogers [77] and [78] rejection of causality, causal terms such as effects are not used in relational propositions.

The statements of associations (relational propositions) between concepts of Rogers' Science of Unitary Human Beings are listed below [24].

Human energy fields and environmental energy fields are integral.

Manifestations of pattern are interrelated.

Well-Being values are interrelated.

Health patterning practice method is associated with changes in manifestions of pattern.

Health patterning practice method is associated with well-being.

b) Framework: Science of Unitary Human Beings

The Science of Unitary Human Beings starting point is a standard of thought in health and nursing. Rogers, displays her framework as the Science of nursing from which an assortment of hypotheses will rise. Characterizing unitary human beings as irreducible energy fields, she thinks the individual and the environment as integral and irreducible, and uses the term "energy field" to describe each in shared process.

Rogers presents four ideas as fundamental to her applied framework:

- energy fields;
- openness;
- pattern;
- pandimensionality.

She suggests that energ fields are the fundamental units of all living and non-living substance. These fields are vast and exist without boundaries. By the idea of opennes, Rogers presents that the universe is one of open frameworks. Pattern is proposed as a reflection alluding to the distinctive qualities of energy fields and is the methods by which vitality fields are distinguished. She hypothesizes pandimensionality to be a trademark of human and ecological fields as well as of all reality. She advances this conceptualization as a method for encountering individuals and their reality [77].

Consolidating these thoughts she describes unitary human and environmental fields as being "irreducible, pandimensional energy field(s) identified by pattern and manifesting characteristics different from those of the parts and which cannot be predicted from knowledge of the parts" [80]. Notwithstanding these essential ideas, Rogers proposed three standards which she calls the standards of homeodynamics.

1. Resonancy
2. Helicy
3. Integrality

As indicated by Rogers, the standards of homeodynamics give a "new science" method for seeing individuals and their environment in which changes the common procedure of the two.

c) Science of Unitary Human Beings - Long Range Theories

Long Range Theories, are those with a deeper impact on health care services.

Theory of Accelerating Evolution [76; 77; 80]

The hypothesis of accelarating evolution proposes that the main 'standard' is quickening change. Higher frequency field patterns, show developing variety, that open the way, to more extensive scopes of encounters and practices, raising questions about the general thought of 'standards', as human rule as rhytms in environmental field rhythm accelerating. Rogers speculated that hyperactive kids' give a genuine case of speeded up rhythms with respect to other youngsters.

Theory of Manifestations of Field Patterning in Unitary Human Beings [76; 77; 80; 18]

This hypothesis manages the signs of the entire unitary human as changes in human sleep walking patterns, human field motion, perception of time passing, and other rhythmic development. Rogers recognized non-obtrusive modalities as the premise of healt practice now and later on. She said that medical caretakers must utilize, nursing information in non-intrusive courses in an immediate exertion to advance prosperity. Rogers reliably recognized the requirement for people, network based wellbeing administrations in participating, non-obtrusive modalities.

Theory of Paranormal Phenomena [76; 77; 80; 18].

This hypothesis focus on the development of paranormal. It recommends that experiences ordinarily marked as 'paranormal' are real signs and advancement in field of pattern. They are para dimensional types of mindfulness.

Theory of Health as Expanding Consciousness

Newman proposed a new concept of health in a dialectical manner, that is, "disease fuses with its opposite, absence of disease, non-disease, and brings forth a new concept of health" she continues, "This synthesized view incorporates disease as a meaningful aspect of health" [56].

Theory of Humanbecoming [58–61].

According to Parse [61]:

"Humanbecoming is freely choosing personal (…), is cocreating rhythmical patterns of relating, in open process with the Universe (…), and cotranscending multidimensionally with emerging possibilities".

Life Perspective Rhythm Model [27].

"The process of human development is characterized by rhythms that occur within the context of continuous person-environment interaction" [28].

Nursing is an activity focuses on enhancing the developmental process toward health. A central concern of health science and the nursing profession is the meaning attributed to life as the basic understanding of human existence.

Middle Range Theories

Middle Range Theories, focus on a multidimensional and multidisciplinar approach of Science for Unitary Human Beings.

1) Power as Knowing Participation in Change [8; 20].

According to Malinski [48].

"A prime example of ongoing theory development is Barrett's [8] theory of power as knowing participation in change. Principles of homeodynamics describe the context, nature, and process of change. Like communication theory, which holds that people can never not communicate, people cannot not participate in change. However, the nature or quality of participation varies".

2) Health Empowerment Theory [83].

According to Shearer [83]:

"Health empowerment emphasizes facilitating one's awareness of the ability to participate knowingly in health and health care decisions. Is a theory-based intervention designed to promote the use of personal resources and social contextual resources with the goal of enhancing well-being in homebound older adults. Health empowerment theory is expressive of a human health pattern of well-being and is viewed as a relational process that emerges from the recognition of personal resources and social contextual resources. This process facilitates purposeful participation in the attainment of health goals and the promotion of individual well-being" [83].

3) Theory of Aging [2].

According to Malinski [2]:

"Alligood and McGuire [2] and Butcher [17] have explored the development of a Rogerian theory of aging in line with her theory of accelerating evolution / change.

They tested it with a group of seniors, ages 55 to 94, exploring perception of time, sleep patterns, and activity. They were not able to statistically support the hypothesized relationships deduced from the theory. Alligood and McGuire identified activity as having a stronger relationship to timeperception and sleep patterns than age of the participant. The more active persons tended to experience time as racing and reported more satisfying sleep patterns (...)".

4) Theory of Aging as Emerging Brilliance [17].

According to Malinski [48]:

"Butcher [17] reviewed emerging interdisciplinary perspectives on aging, identifying support for a view of unitary aging, pointing out once again that, rather than chronological ageper se, what is important is the unique, unfolding field pattern for each human being.

Such a theoretical perspective, he noted, has the potential to shift the experience of aging from one of potential dispiritedness to one replete with potentials for continuing growth and service, "a fulfilling life imbued with splendor, meaning, and accomplishment, active involvement, growth, adventure, wisdom,experience, compassion, glory, and brilliance" [17].

5) Theory of the Art of Professional Nursing [3], also referred to as the Theory of the Art of Nursing [5].

Alligood M. R. [3] "(...) A art of nursing is the ability to balance responsability for the welfare of others with respect for their human freedom and individual rights through empathic, knowing participation in the moral action we call nursing practice".

6) Theory of Creativity, Actualization and Empathy [1].

According to Malinski [48]:

"Alligood investigated the concepts of creativity, actualization and empathy. She hypothesized that there would be a positive correlation between creativity and empathy, and between actualization and empathy. Additionally, she hypothesized that the combined contribution of creativity and actualization to the variance in empathy would be greater than either one separately. She demonstrated significant support for all of her hypotheses. In a follow-up study with an older sample (age 61–92), Alligood again found a positive correlation between self-actualization and empathy. However, contrary to the results of her initial study, a negative correlation was found between creativity and empathy in this older sample".

7) Theory of Diversity of Human Field Pattern [32].

According to Hastings-Tolsma [32]:

"Time experience is a pivotal concept in Rogers' Science of Unitary Human Beings. As an energy field integral with the environmental field, the human field is recognized by pattern manifestation – a distinguishing characteristic of energy fields. Such pattern manifestation reveals the diversity of the human field. Time experience is one pattern which emerges from the mutual human-environmental energy field process but is likely the cornerstone for understanding the human field experience of change.

8) Theory of Enfolding Health-as-Wholeness-and-Harmony [9]

The basic of this theory is described by Carboni [19]:

"The theory of enfolding health-as-wholeness-and-harmony (…) recognizes the existence of subtle and gross manifestations of field pattern and the dynamic matrix of subtle configurations of patterning identified as health-as-wholeness-and-harmony. Evolutionary change is specified to be a dynamic, non-linear, and acausal process characterized by the movement of gross manifestations of patterning to new syntheses of subtle manifestations of patterning".

9) Theory of Enlightenment [35].

According to Malinski [48]:

"The theory is composed of four concepts-awareness, wakefulness, and human field motion, all representing human-environment field patterning; plus well-being, which they deduced from the principle of integrality and defined as the sense of harmony and satisfaction with life.

They defined enlightenment "as a positive, dynamic experience manifested as expanded awareness, increased wakefulness, higher levels of human field motion, and higher levels of well-being" [48]. Awareness and wakefulness flow within helicy, human field motion within resonancy, and well-being within integrality".

10) Theory of Healthiness [42].

According to Leddy and Fawcett [42]:

"Theory of Healthiness proposes that greater perceived ease and expansiveness of human-environment mutal process (perception) is associated with greater perceived energy, wich in turn, contibutes to higher healthiness".

11) Theory of Human Field Motion [25; 26].

According to Malinski [48]:

"Ference [24] developed the concept of Human field motion which she proposed as a manifestation of the wave frequency of unitary human beings.

She further proposed that time experience, creativity traits, and differentiation were manifestations of human synergistic development that would be correlates of human field motion.

Developing an instrument to measure human field motion, Ference demonstrated a positive relation-ship between human synergistic development and human field motion.

In response to measurement difficulties with the original word form of the Human Field Motion Scale, Ference (1988) began development on a picture scale to measure human field motion, thus introducing visual metaphors as a measurement modality. This new scale will further expand measurement options in research dealing with human field motion" [25].

12) Theory of Intentionality [88; 89].

According to Malinski [48]:

"Zahourek [90; 91] synthesized a theory of intentionality in healing which she sees as consistent with Rogerian nursing science, although, given the nature of grounded theory development, she did not explicitly use it to develop her theory.

Rogers was uncomfortable with the word intentionality, however, she tended to interpret it too narrowly, as in willing something to happen, which would be inconsistent with her science [13]. Zahourek [90; 91] did not cite Rogers' writings, but she did discuss intentionality in thetherapeutic touch literature and perspectives from other nurse scholars, such as Jean Watson, and a wide range of interdisciplinary literature (…).

Assumptions underlying her theory include the idea that intentionality is innate in human beings and is different from intent and intention. It forms the matrix for healing, a transformation which is both process and outcome (…).

Although clearly located within the unitary worldview, it is not clear that the theory resonates better with Rogers' science of unitary human beings than with Watson's or Newman's theories. Intentionality as "in part, linear as directed thoughts and images for healing" does not seem reflective of Rogerian nursing science, yet intentionality as "nonlinear and nonlocal" does".

13) Theory of Kaleidoscoping in Life's Turbulence [16].

According to Malinski [48]:

"Rogers used the kaleidoscope to illustrate what she meant by continuously shifting human environmental field patterns.

Turbulence, patterning, and flow are the concepts of this theory, with turbulence relating to the postulate of pandimensionality and the principle of helicy, patterning to the postulate of pattern and the principle of resonancy, and flow to the postulate of openness and the principle of integrality. Turbulence is a "dissonant commotion in the human-environmental field process characterized by chaotic and unpredictable change" [16].

Butcher [16] detailed a practice methodology for kaleidoscoping that fits within Barrett's, [10] health patterning process. Turbulent life events happen; often this is the focus for nurse and client. Such events have the potential to become transformative ones, where persons experience innovative growth and change.

This resonates with the clinical practice applications described by Reed [71; 72; 74] and Hills and Hanchett [35]".

14) Theory of Pattern [4; 5].

According to Alligood and Fawcett [4]:

"(...) The existence of organization and patterning in living systems is an obervable phenomenon (…), a dinamic process, (…) an obervable event in real world, and identifies – human beings and under goes continuous revision and innovation".

15) Theory of Perceived Dissonance [14].

According to Malinski [48]:

"Bultemeier [14] proposed a theory of perceived dissonance, where human-environmental field manifestations such as illness are perceived as nonharmonious, uncomfortable, discordant, or dissonant. She offered a theoretical perspective for pattern appraisal of such field manifestations,linking her theory with Barrett's (1990, 1998), and provided examples of possible patterning modalities to use in practice. Her research focus was women experiencing premenstrual syndrome".

16) Theory of Self-Transcendence [71; 73; 74].

According to Malinski [48]:

"Reed [71; 74] formulated a theory of selftranscendence in which she reinterpreted lifespan developmental theories from a Rogerian perspective, identifying what she saw as both congruencies and incongruencies. Reed [71] described the Rogerian formulation of self-transcendence as one of a multidimensional expansion of self boundaries, inwardly, outwardly, and temporally.

The first major assumption underwriting her theory rests within Rogerian science. Human and environment are integral. Reality is pandimensional.Awareness is not limited by time and space. Her second assumption, that self-transcendence is an innate human imperative and, therefore, participating in it is necessary for wellbeing, could be debated within Rogerian nursing science. This author, however, is comfortable with it, seeing transcendence as a quality of spirituality, which she has argued flows within integrality Malinski [47] [and reflects helicy and resonancy".

17) Theory of Sentience Evolution [57].

According to Malinski [46]:

"Experiencing integrality suggests multidimensional awareness which has implications for health and healing of the unitary human / environmentalfield process. (...) Interplay between spirituality and mysticism, with some closing suggestions for ways to actualize this awareness in everyday life".

18) Theory of Pandimensional Awareness Integral Presence [69].

Phillips work proposed and ideas like "energyspirit" and "homo pandimensionalis".

Energyspirit is the key for all life. "Homo Pandimensionalis" represents the creative and mutable in human-environment mutual process. This theory "opens perception – experience of visible – invisible phenomena of the Universe energyspirit for living and transcending".

"The idea is to help people participate in broadening their pandimensional awareness – integral presence for wellbecoming" [69].

e) Environmental Wave Patterns

Several notable studies have investigated the mutual process between human beings and environmental wave patterns present in the environment.

These studies have dealt primarily with light and sound wave patterns. However, the Rogerian conceptual system is by no means limited to these two manifestations of wave pattern.

1) Effects of Light in Human Field Motion [44].

According to Bramlett [13]: "Ludomirski-Kalmanson [44], reasoning that light could be perceived by the human field without vision, conducted her study involving exposure to red and blue light in a sample of totally blind adults.

She hypothesized that human field motion would be increased during exposure to blue light as opposed to red light, regard-less of visual sensory perception.

As predicted, she found no significant difference the human field motion scores of sighted and blind subjects. Also as predicted, she found that subjects exposed to blue light exhibited significantly higher human field motion scores than subjects under red lights [44]. This study provided impressive support for the principle of integrality".

2) Effects of Light and Chronic Pain [53].

According to Bramlett [13]:

"McDonald [53] conducted a study with persons having chronic pain to determine the nature of the relationship between the environmental presence of certain visible lightwaves and the human experience of pain. She hypothesized that persons exposed to higher frequency (blue) lightwaves would experience less pain than persons exposed to lower frequency (red) lightwaves. She also hypothesized that longer exposure to the blue lightwaves would more likely be accompanied by a reduction in the experience of pain than shorter exposure times. She found a trend toward greater pain relief with blue light exposure, and reported a statistically significant correlation between longer exposures to blue light and relief of pain".

3) Effects of Light in Hyperactivity [45].

According to Bramlett [13]:

"Malinski [45] explored the relationship between hyperactivity in children, perception of short wavelength light, and color preference. While no statistically significant results were reported, the hyperactive children in the study tended to be able to identify information illuminated with lower light filters than children in the control group".

4) Sounds Effects [86].

According to Bramlett [13]:

"Smith M.C. (1986) proposed that subjects in an environment of high-frequency sounds would demonstrate greater increases in vividness and creativity of imagery than would subjects in a low-frequency sound environment. Finding no support for her hypothesis, M.C. Smith cited the need for consideration of both theoretical and methodological issues. She further suggested that future research involving sound frequency should consider qualities of sound beyond frequency".

5) Harmonic Sounds Effects [87].

According to Bramlett [13]:

"Smith M. J. [85], testing the principle of integrality, investigated the relationship between a varied harmonic environment and restedness in individuals confined to bed. Smith hypothesized that the "perception of restfulness will be lower (subjects will be more rested) for confined subjects who experience varied harmonic auditory input than for those who experience quiet ambience" [85]. Providing either composed music or ambient room noise, M. J. Smith

[85] found that subjects who listened to the composed music perceived themselves as significantly more rested, supporting the principle of integrality".

f) Therapeutic Modalities

In this section the author shows some application of non-evasive therapeutic modalities.

1) Imagery

According to Bramlett [13]:

"Guided imagery has been conceptualized as a useful modality in field patterning.

Butcher & Parker [15] found that those subjects participating in pleasant guided imagery had a greater sense of timelessness. A similar relationship between imagery and human field motion was not demonstrated. However; results of this and other studies support the potential of imagery as a modality in health patterning".

2) Therapeutic Touch

According to Bramlett [13]:

Therapeutic touch has received growing attention as a therapeutic modality. First conceptualized and investigated within nursing by Krieger [38–40], numerous researchers have expanded on the theoretical and research base of therapeutic touch [34; 36; 54; 70].

3) Hemoglobin and Therapeutic Touch

According to Bramlett [13]:

"In Krieger's [38; 39] early research, subjects receiving therapeutic touch experienced significant increases in hemoglobin levels thus supporting the potential of therapeutic touch in patterning human fields".

4) Anxiety and Therapeutic Touch

According to Bramlett [13]:

"Heidt [34] and Quinn [70] both found that subjects experiencing therapeutic touch demonstrated significant decreases in anxiety. While Heidt utilized therapeutic touch with physical contact, Quinn used therapeutic touch without physical touch, thus supporting the theoretical proposal that this modality is based on mutuality of energy fields rather than relying on physical touch. However, Quinn [70] failed to demonstrate decreased anxiety in a later study of subjects awaiting open heart surgery who received therapeutic touch. Citing the confounding considerations of methodological issues and medical regimens, Quinn [70] demonstrated some of the subtle complexities of this modality".

5) Pain and Therapeutic Touch

According to Bramlett [13]:

"The utility of therapeutic touch in individuals experiencing pain has also been inconsistently demonstrated.

Meehan [54] was unable to demonstrate statistical significance when using therapeutic touch in adults with postoperative pain.

However, Keller [36] did find significant decreases in pain in adults with tension headaches who received therapeutic touch".

6) Relation With Patients and Therapeutic Touch

According to Bramlett [13]:

"Heidt [34] conducted a grounded theory analysis of nurses' and patients' experiences of therapeutic touch. Categories of experience reported included opening intent, opening sensitivity and opening communication. This qualitative study provided elaboration of the experience of therapeutic touch thus further illuminating the subtleties of this therapeutic touch".

g) Applications to SMART Society – Virtual Reality

Virtual Reality (VR) is a general term that alludes to a kind of innovation that incorporates mechanized showcases that delineate three dimensional conditions in which people can communicate [30].

Brief History of Virtual Reality in Health Care

Phillips [68] composed a publication in which he anticipated that VR would significantly impact individuals' lives and in that capacity, assume a noteworthy job in nursing research.

From that point forward, VR has been quickly grasped by numerous people and gatherings, for utilizations, for example, computer games, driving appraisal, and even to enlarge social insurance conveyance.

Numerous medicinal services experts utilize customary PC presentations to give VR conditions as instructional approachs [51].

Augmented reality programs have been utilized to prepare suppliers for laparoscopic medical procedure [82] and intravenous catheter addition [52].

What's more, VR programs are being utilized to an ever increasing extent as a treatment for disorders, for example, recovery after stroke [89], treatment for anxiety [63], and phobias [30].

In healthcare, VR is being explored as a technique for providing pain and symptom management interventions,, with positive discoveries of the utility of VR in decreasing side effects [89].

Types of Virtual Reality

A lot of VR innovation takes into account a cooperation between the client's development and a reenacted mechanized condition with the end goal that head, eye, or joystick movement causes an adjustment in the virtual world seen.

In particular, VR preferably gives a feeling of essence, which is a feeling of being inside the VR condition instead of watching it all things considered [43].

Computer generated reality can be shown utilizing an assortment of advances, including basic work area programs, head-mounted presentations, exceptional rooms with anticipated scenes, and different devises that take into account multisensory input, including movement, sound, and contact.

According to Davis [23], there are two types of VR: immersive VR displays, and less immersive VR displays.

Immersive VR Displays

Immersive VR situations are those that are more similar and have a high level of quality [64].

This enables people to outwardly investigate a virtual world, and to have command over the course in which they are looking.

According to expert estimates, 80% of all cases of heart diseases, strokes, type 2 diabetes and more than one third of all/

Objects seem exact and three dimensional [12].

Another famous vivid VR condition is shown in a cubic room in which a PC ventures pictures to the dividers what's more, roof.

The client can stroll through the condition inside the cutoff points of the room.

This sort of vivid VR takes into consideration development and association inside an exact recreated condition [84].

Less Immersive VR Displays

There are less vivid sorts of VR stages utilized, for example, those that are shown on personal computers or on film screens.

These VR programs normally enable the client to outwardly move about the virtual world utilizing a development gadget, for example, a joystick or mouse.

Instances of normal VR conditions that numerous individuals use from their very own PCs are PC diversions that delineate virtual universes.

The preferred standpoint to these sorts of less immersive VR is that they are moderate, effectively accessible, and increasingly available to numerous analysts.

Virtual Reality or Real World ?

There are significant advantages to utilizing VR in research.

Smith-Coggins et al. [85] inspected the effect of snoozing on the execution of doctors and medical attendants who worked the night move in the crisis office.

The investigation above additionally represents another advantage of VR examine, which is the capacity to gauge factors that would be hard to quantify, all things considered, because of security concerns.

For instance, Kurtz, Baker, Pearlson, and Astur [41] analyzed the execution of people with schizophrenia to controls in the organization of three recommended prescriptions.

Subjects had to read the prescription, note the time, and get the right dose out of a drug bureau in a VR loft.

Estimations incorporated the area of the person in the loft at indicated times; contrasts between the recommended dose and the dose of medicine taken; and blunders in the kind of drug taken.

Execution was estimated by the PC program itself and by direct perception of the execution of the subjects in the given task.

NASA approach to Science Unitary Human Beings

In Ursa Major, there is a star (RA 9h 33m 56s D 48° 9′) named Martha E.Rogers, by NASA, for her work.

Rogers published several working papers [78; 80], as well as other Roggerian schollars, on the application of Science for Unitary Human Beings in space environments, as well as the use of Virtual Reality as support technology.

The model has proven to be appropriate to promote interaction Man, Earth, Space, and promote health, comfort and well-being in space and aeronautical industries.

h) Science Unitary Human Being Theory and SMART Society

Innovation and different advancements can possibly incorporate all individuals on an increasingly equivalent playing field of proficient life span and a real existence lived with dignity and a reason. The correlations provide a useful matrix to consider some of the changes that are taking place in what John Phillips calls "wellbecoming".

Table 1

Correlations on Science Unitary Human Being Theory

	"PAST"	**SMART Society**	**"FUTURE (?)"**
1	Longer Waves	Shorter Waves	Seems Continuous
2	Lower Frequency	Higher Frequency	Seems Continuous
3	Longer Rythms	Shorter Rythms	Seems Continuous
4	Slower Motion	Faster Motion	Seems Continuous
5	Time Drags	Time Races	Seems Timeless
6	Shorter Life Spans	Longer Life Spans	Transcendence
7	Less Differentiated	More Differentiated	Transcendence
8	More Visible	More Invisible	Ethereal
9	Heaviness	Lightness	Weightless
10	Pragmatic	Imaginative	Visionary

Source: *Based on Baumann [11] including variable Frequency (2)*

1) Waves and Frequency

First two initial relations of the investigation of unitary improvement of mankind as taught by Rogers are the advancement of energy waves from longer to shorter, and the changing frequency of those waves from lower to higher, developing toward constant change.

Both of these perceptions are considered in Rogers' idea of resonancy

2) Rhytms and Motions

Rhythms and motions as instructed by Rogers, the previous is said to go from longer to shorter, while the later go from slower to quicker.

This association after some time that gives some level of certitude and consistency (pattern).

The blast of neuroscience, now appreciates how active and purposeful the brain is during sleep. According to Baker, Rorden, & Fridriksson, non-invasive low amperage current and magnetic energy brain stimulation can help brain damaged by brain injuries.

3) Time

Time is broken into little parts [31].

According to Balbi [7], "the division into past, present and future is observer-dependent, in our universe it is possible to define a universal cosmic time: this is a feature which is not at all obvious a priori, and descends from special symmetry properties of spacetime on large scales" [7]. Such a thought is holographic, is and will be as present and now, in Buddhist idea of mindfulness [81].

4) Life

The expanding human life expectancy or life span is presently a worldwide phenomenon of uncommon extent with numerous suggestions.The term transcendence quality has been utilized in a few hypotheses in nursing and different contexts [37; 62; 72], regarding the human capability to expand potential.

5) Differentiation

Malinski [49] suggested that increasing diversity calls for a healthcare system that is able to provide increasingly individualized treatment and care for each person while honoring informed choices.

6) (In)visible

Newman's [56] theory of health understands, as framework of expanding consciousness explication this correlate's evolutional direction and essence.

7) Lightness

Rogers model is an open system that is pandimensional in nature, heaviness, lightness and weightless should not be seen as referring to simply a physical matter. We can found this in Buddhism, while an ocidental view was described by Teilhard de Chardin [88].

8) Imaginative

According to Science of Unitary Human Being, pragmatism contributed to homeostasis, hemodynamics called for innovative and visionary thinking and acting.

Conclusions

The present work aims to evaluate the possibility of applying the Science of Unitary Human Beings model to a Smart Society. The analysis will be composed of four sections: research, education, management and health care application. At the level of research, from the data reproduced in the paper, Rogers' methodology, as a model of non-intrusive practices, proved to be an effective method for application in a Smart Society. In particular, it is worth highlighting the use of vitual reality technology, for testing environmental, social and psychic variables. As a result of the results obtained in the research component, the application of the Science for Unitary Human Beings methodology for educational purposes reveals to be an appropriate model for social models like Smart Society.

On management, Science for Unitary Human Beings, proves to be a good approach, in SMART Society, especially due to empowerment. Finally, the practical aspect in health care reveals a lot of application potential, in the context of Smart Society. However, there are several results that were not conclusive, both in the perspective of the user and the health professional, also in the control of environmental, technological and social variables. Further investigations should be conducted in these areas.

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Chapter 19. HEALTH-PROTECTING PSYCHOLOGICALLY SAFE DEVELOPMENTAL ENVIRONMENT OF A PRESCHOOL EDUCATIONAL INSTITUTION

Yu. KALICHAK
Drohobych Ivan Franko State Pedagogical University,
24, I. Franko Str., 82100 Drohobych, Ukraine
e-mail: yukalichak@gmail.com

Abstract. *The article is dedicated to child's personality problems of the development in the conditions of a psychologically safe developmental environment of a preschool education institution. The concept of a psychologically safe developmental environment of the institution have been revealed, the conditions and principles of psychological safety of a child of preschool age have been characterized. The carried analysis made it possible to determine the conditions for the successful organization of a psychologically safe developmental environment in the preschool education institution, namely: interaction and coordination of efforts of all kindergarten employees (administrative, pedagogical, medical and psychological staff), children, their parents in the sphere of protection and quenching of children's health; transformation of the psychological consciousness of the educator; theoretical psychological training of the educator on the problem of preserving, quenching and forming the health of preschoolers.*

The practical implementation of these technologies is that the educator selects the content of the training, takes into account the individual-psychological peculiarities of children as much as possible, which ensures the conditions for a free and independent choice of activity, the child's acquisition of personally meaningful knowledge.

Keywords: *Psychological safety; Developmental environment; Preschool age; Preschool education institution; Development technologies.*

Formulation of the problem

Readiness for healthcare work in the preschool education institution forms the basis of professional training for pedagogical activities and requires serious searches for the creation of a coherent effective system of this training. Considering the fact that the ultimate goal of professional training is the formation and development of the personality, the issue of mastering certain professional experience by future specialists, serves the purpose and means of study, which results in the development of the subjects of the educational process and their professional development not losing its relevance at the present stage.

Professional training in the system of higher education is based on the effective construction of the educational process, providing a gradual transformation of cognitive activity into professionally aimed one. The readiness of a future specialist for professional activity is assessed not only by the effectiveness of the professional development, but also by the efficiency of personal growth. The training of a future specialist in higher education is realized in the pedagogical process, which as an open, dynamic and self-developing system (integral education) includes the following components:

- the meaning of training in accordance with the goals, specific tasks and the specifics of this training professional qualifications(the meaning of training is considered as a goal and as a result of professional training in accordance with educational-qualification level);
- the teacher as a designer and organizer of the process of training, development and upbringing of a future specialist;

- pedagogical toolkit – methods, receptions, means of educational interaction, organizational forms of training;
- the subject of training as an active participant in learning activities, which result is the personal mastery of professional experience and the ability to apply it creatively in future activities.

Considering the active position of the participant in educational interaction, it is undeniable that the essence of the pedagogical process lies in its binary nature, since it combines the pedagogical activity of the teacher of higher education and the educational activity of the student. Consequently, the didactic process is based on the interaction of the teacher's activity and the student's educational activity, the teacher's management of the cognitive activity of the student (appropriate selection of methods, means of influence and organizational forms, optimal interaction) in accordance with the objectives of professional training and its contents.

Proceeding from the statement that a person reveals the properties and connections of elements of the real world only in the process of activity, it is logical that knowledge is given only to the role of resources in the process of mastering professional skills and skills. From a philosophical point of view, activity is defined as a way of human existence and of society as a whole, at the same time, the specifics of human existence is in its active attitude to the world, based on its purposeful changes and transformations.

The world community acknowledges the health to be of one of the greatest values of man. Ukraine belongs to the cohort of states, in which educational policy the problem of preserving, quenching and forming the health of children and youth occupies a prominent place and is solved by different methods.

At the same time, in modern education there is a contradiction between the various active activities in this aspect and the results of the work carried out. The problem of psychological health of a growing person, on the one hand, is under the special care of scientists and practitioners: the number of scientific researches on the technology of formation, quenching and preservation of health is increasing, various projects and programs are being implemented, the network of educational institutions for the promotion of healthcare is increasing, contests of creative work of teachers on the identified problem are held, manuals, methodological recommendations of the corresponding content are published. On the other hand, the results of medical and pedagogical practice show a significant deterioration in the health of children. In particular, a large number of children in preschool institutions is in a state of chronic fatigue, which is the basis of neuropsychiatric exhaustion.

The reasons for this situation are: insufficient level of teacher's competence in the issues of healthcare of pupils and, consequently, the lack of priority for many of them in the pursuit of health promotion, motivation for a healthy lifestyle; ignoring the priority hygienic and physiological requirements for the organization of educational process in the preschool educational institutions; inconsistency of technologies and methods of teaching with age and individual characteristics of children, authoritarian and reproductive learning style, leading to teacher dictatorship, formation of preschoolers as passive consumers of information, etc. In addition, educators are guided mainly on the intellectual achievements of preschool children, without paying attention to the development of communicative, emotional and other competences of preschool children

Incorrectly selected pedagogical technologies or pedagogical errors negatively affect the psyche of the child, manifesting in the form of neurotic disorders. This, in its turn, causes the low level of cognitive activity, high level of anxiety, instability of the emotional sphere and lack of communication skills in the majority of preschoolers.

The analysis of psychological literature and its own pedagogical experience convincingly indicates that positive results in the field of health preservation of a child of preschool age depend essentially on an integrated approach to solving this problem.

Firstly, the idea of the health priority should be understood by all participants of the educational process (teachers, administration, doctors, psychologists, other employees of preschool educational institutions parents of preschoolers).

Secondly, healthforming and healthcare technologies must fill the content of education, methods, forms, methods and methods of their implementation, but also the conditions under which education, upbringing and development of children of preschool age are carried out.

Thus, the formation of a safe developmental environment in the child's personality development involves the intensification of the educational process in the preschool educational institutions.

The analysis of recent publications

The problem of the use of healthcare technologies in pedagogical practice of preschool educational institutions has become the subject of scientific research by many authors (T. Boichenko, A. Bohinich, A. Bondarenko, A. Vashchenko, V. Koval, S. Kondratiuk, H. Kryvosheiev, V. Nesterenko, A. Omelchenko, etc.,). Problems of forming a priority attitude towards one's own health and mental health in preschool children were investigated by V. Ananiev, I. Bekh, L. Bozhovych, D. Elkonin, O. Zaporozhets, O. Kononko, V. Kotyrlo, V. Kuzmenko, etc.,. But the theoretical and practical aspects of creating a healthcaring environment in the preschool educational institutions have not yet received sufficient analysis and justification.

Nowadays, they understand a psychologically safe developmental environment as the environment favorable for life and human activity, as well as the surrounding social, material and spiritual conditions that have a positive effect on the health of the individual. This statement is based on the awareness of the importance of providing favorable conditions for human life as a medium of life, in which there is no harmful effect of its factors on human health and there are opportunities for providing normal functions of the body and restoration of violated the violated ones [1].

I. Under the psychological safety of the educational environment Baieva understands the healthcare directions of its formation. The author points out free of psychological violence, constructive interpersonal communication. It forms the psychologically healthy personality [2].

The psychologically safe developmental environment of the preschool educational institution is understood in the general sense of the observance of sanitary-hygienic norms, air and light regimes and other aspects in all spheres of the organization of life of the child in the preschool education institution. The analysis of works on the creation of a psychologically safe developmental environment demonstrates the interdisciplinary nature of this work; it embodies the ideas of such branches of scientific knowledge as physiology, pediatrics, psychology, pedagogy, hygiene, sociology, ecology, human ecology, etc. Due to this fact, different points of view have developed on the peculiarities of a psychologically safe developmental environment.
In the works of I. Zolotukhina, for example, the ergonomic, anthropometric and psycho physiological features of the functioning of a safe spatial object environment of the institution of preschool education have been identified [4]. A. Kirpichenkov considers the safe environment of preschool educational institution as a system that includes the educational process, social and substantive components [5]. Each of them has its own content, functions and features of realization of the tasks.

The social component, in the opinion of the author, is pedagogical staff, which embodies physical culture and healthcare technologies, medical personnel, which provides monitoring of the physical development of children and their health, as well as the observance of sanitary and

hygienic norms in the process of implementing educational work and organization of healthy eating; in addition to this the developing of the child social sphere outside the preschool education institution.

The subject component includes methodical provision of the educational process, as well as physical education facilities for the kindergarten for the organization of children's activities, which correspond to the pedagogical, aesthetic and hygienic requirements, as well as the anatomical and physiological characteristics of children of preschool age. Psychologically safe developmental environment should be considered as a single system, which has the conceptual framework for the implementation of healthforming and healthcaring activities in a pre-school institution, methodological support for this type of activity and pedagogical tools.

The basic components of psychologically safe healthcare environment can include the developmental nature of the childhood space, activity-age approach, providing comfort, functional reliability and safety, adherence to high aesthetic and hygienic indicators. The pedagogical staff of the kindergarten provides a comprehensive harmonious development of the child's personality and minimizes the negative impact of environmental factors by implementing these components of the health and preserving environment

Thus, under the psychologically safe healthcare developmental environment, we understand the following characteristics: implementation of innovative programs and technologies of healthcare areas, favorable psychological climate in course of their implementation, sanitary and hygienic state of the subject area of the preschool educational institution, rational organization of children's life, considering age and psychophysiological peculiarities.

The analysis of psychological literature [1–9] permits to determine the fundamental conditions for the successful organization of a psychologically safe environment in preschool educational institution, which is the interaction and coordination of efforts of all participants in the educational process.

The organization of a psychologically safe developmental environment involves compliance with the requirements regulated by sanitary norms and safety rules of life. Transformation of the psychological consciousness of the teacher is required. The attitude of the teacher towards the pupil must be changed (he must accept the child as he is, and on this basis develop his psychological needs, inclinations, abilities, identify the individual path of his development); the degree of his influence on children and the implementation of vocational and pedagogical activities from the standpoint of the formation of the psychological health of the preschool child's personality [10]. This involves the formation of healthcare competences (life skills) of preschoolers.

Theoretical and psychological training of the educator on the problem of formation, preservation and quenching of preschool children's health is needed [11]. As practice shows, training sessions on physical education within the pedagogical university can not provide the proper level of physical activity of student youth. One way of solving this problem is, in our opinion, the formation of a stable need for physical fitness for students, as well as skills and abilities of independent classes, the widespread use of physical culture and sports in the day schedule. Starting from the first year, students must get specific and individual tasks for independent classes. They may include morning hygienic gymnastics, physical training while - preparing for seminars, the implementation of specific home-based tasks for physical education.

A significant role in forming the motivation for the physical development of future teachers plays non-audition physical culture and mass-sport activities, which are a kind of continuation of educational work. The main directions of work during extracurricular time:

- methodical support;
- physical activity preparation;

- systematic planning of appropriate activities in the dormitories, at the faculties;
- students participation in the organization and realization of sports competitions, hiking trips etc. [3].

Due to the implementation of these areas, tangible results can be achieved, namely: enrichment of sports activities; creation of the self-government structure that will diversify the wide involvement of students in self-exercising in the dormitory, university, place of residence; assimilation of self-control methods of state of health and the physical condition of their own organism.

The process of forming students' internal motivation for physical education and sports is aimed at achieving the following goals:

a) development of a steady interest in physical exercises as a precondition for the physical self-improvement need;

b) implementation of regular control over the dynamics of physical preparation of each student;

c) formation of the habits for future teachers to engage themselves with physical exercises during the day [2].

Working on these areas will increase the level of functional indicators, physical preparedness and quenching of the body. At the same time, such classes develop skills and abilities of self-exercising and provide for the implementation of self-control over the dynamics of the psychophysical state in practice, assimilation of the methodology of conducting these classes and evaluating their effectiveness. The establishment of self-monitoring diaries in which the initial data of the level of indicators of motor activity would be recorded will facilitate this. A set of measures for self-control and co-control will contribute to raising the awareness and activity of young people [5].

One of the most important directions of physical culture, sports and mass activity of students within the higher educational institution is to study their methods of independent classes. It will help future teachers in practice work, in particular in promoting healthy lifestyles among schoolchildren. In order to do this, the methodological information and a list of recommendations of the general nature of health, as well as some typical programs, which include improving physical fitness, mastering the method of complex development of basic motor qualities should be submitted.

Due to the fact that physical education at the university involves the resolution of health, educational and upbringing tasks, we consider it expedient to organize an entire complex of pedagogical actions in relation to non-adjudicatory forms of student youth work. Particularly, it is about: systematic informing, the need for proper planning of the day's regime for the purpose of health promotion, observance of the basic rules of rational nutrition, requirements of personal hygiene, awareness of the need for regular classes in physical culture in the fresh air and quen ching, etc. Students learn about the results of modern scientific research on physiology, hygiene, particularly, regarding the nature of the actions and the health effects of harmful habits at the same time. Students will be able to experience the information they received, as the effectiveness of independent classes depends on these factors. Consequently, one can confidently assert that independent classes will eventually facilitate the transformation of abstract knowledge into sustainable inner convictions reinforced by personal experience of physical education and sports classes [5].

A number of external objective factors have a significant impact on the planning of student’s day regime: place of residence and distance to an educational institution; classes schedule and their amount; the period of examination sessions and vacations; conducting pedagogical practice at schools and health camps, etc. In view of the above mentioned information, we consider it obligatory to introduce the following components into the student's day regime: morning hygienic gymnastics, outdoor walks, exercise sessions during breaks

between classes and after them, independent classes on an individual schedule, attending sports sections, classes in health groups and general physical training, participation in tourist trips, observance of the optimal meal and sleep.

Quenching is an important prerequisite for health promotion, improving the organism's resistance to adverse environmental factors and developing immunity to various diseases. Among the basic rules that are put forward for quenching, we observe the following: graduality, systematic character, correct dosage, individualization of methods, application of various means of physical culture and sports. The beneficial influence of the earth, the sun, the air, and thq water is felt even with such, at first sight, simple procedures, such as walking barefoot on the ground or in the morning dew, having baths or saunas [1].

The complex of morning hygienic gymnastics involves the implementation of 10–12 general development exercises, aimed at the development of flexibility, strength, mobility in the joints. It is preferable to include exercises for the muscles of the neck, hands, shoulder girdle, trunk and legs. Walking and jogging, stretching exercises and breathing exercises could have done with. Independent physical classes are carried out on the whole according to the program of development of basic physical qualities on an individual schedule. It consists of compulsory participation of a specialist and may include, for example, two or three workouts per week, which involve the development of speed, strength, flexibility, endurance, agility, and others.

The above-mentioned peculiar extra classes in extra-curriculum time will allow a significant increase in motor regime transition from the usual four hours of compulsory tuition or elective physical education classes to 8–10 hours per week.

The set of exercises for students self-training in extra-curricular time is carried out by the teacher of physical education, taking into account their level of physical training and the dynamics of its growth. This is possible only with the monthly control over the implementation of an individual chart of basic physical qualities development, which allows you to analyze and assess achievements and disadvantages in work, as well as find ways to eliminate them. It should be considered that students specific activity is an educational one, and in the future, a their working acrivity that prompts the teacher to be in different static positions or conditions of limited movement in the workplace for a long time. Uncomfortable workplace requires from the pedagogical worker body not only strength but also strength endurance of static and dynamic nature. In order to develop these qualities you can use a long running or cross. These accessible and unassuming types of physical exercises are quite effective, since they involve large groups of muscles, as well as contribute to the harmonious development of all functions of the body, activation of the respiratory and cardiovascular systems, improvement of metabolism, flow of nervous processes, increase of psychophysical tone.

With the purpose of complex development of physical qualities, increase of working capacity and training an organism, it is possible to carry out exercises by the method of circular training, which allows to strengthen muscles, to improve the work of internal organs and contributes to the formation of perseverance and purposefulness. These complexes consist of 5–6 exercises for the main muscle groups. Do not less than ten repeats, and for exercises aimed at general endurance – more than thirty [5].

Physical education, sports and mass work in student dormitories have an important role. It is aimed at broad involvement of students in active motor activity and involves organizational advocacy work, material, technical and methodological support, and the implementation of specific mass events. To this end, we consider the most important means such as:

- development of calendar plans of sport events (the sports hall of dormitories, review-contests for the identification of the best athletes, etc.);
- carrying out of hiking trips, wanders, excursions;
- organization of the final sport meating;

- repair and arrangement of premises for exercising with fitness equipment, rhythmic gymnastics, etc.;
- preparation of typical programs of classes for various sports;
- dormitories cup lottery draw in team sports;
- arrangement of comradely meetings with the participation of students teams, as well as professors and teachers [13].

In the course of his pedagogical activity the teacher selects the content of the training, takes into account the individual psychological peculiarities of the pupils and the conditions for a free and independent choice of activity, as well as the assimilation by the child of personally meaningful knowledge [12]. These are educational technologies: games, physical and motor activity, exercises for the removal of muscular and psychological stress, art therapy, etc. [14].

Conclusions

Thus, the implementation of the principle of improving the environment of the preschool educational institution involves the creation of a psychologically safe developmental environment, that is, environment in which the child is safe and comfortable to stay, which, in turn, contributes to his harmonious development. Creating this kind of healthcare psychologically safe developmental environment is a process that requires a clear awareness in all participants of the educational process of the significance of all components and conditions during its implementation.

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Друк ПП «ПÓСВІТ»
Адреса: вул. І. Мазепи, 7, м. Дрогобич, 82100 Україна
тел. факс (03244) 2-23-35, тел.: 3-38-50, 2-23-76.
E-mail: ***posvitdruk@gmail.com***