Modern Science

Moderní věda

№ 2 - 2020

scientific journal

vědecký časopis

Prague Praha

MODERN SCIENCE - MODERNÍ VĚDA

№ 2 - 2020

Incorporated in
Czech Republic
MK ČR E 21453
published bimonthly
signed on the 29th of April 2020

Evidenční číslo
Česká republika
MK ČR E 21453
Vychází šestkrát do roka
podepsáno k tisku 29. dubna 2020

Founder
Nemoros
Main office: Rubna 716/24
110 00, Prague 1, Czech Republic

Zakladatel
Nemoros
Hlavní kancelář: Rybná 716/24
110 00, Praha 1, Česká republika

Publisher
Nemoros
Main office: Rubna 716/24
110 00, Prague 1, Czech Republic

The East European Center of Fundamental Researchers
Rubna 716/24
110 00, Prague 1, Czech Republic

Vydavatel
Nemoros
Hlavní kancelář: Rybná 716/24
110 00, Praha 1, Česká republika

Východoevropské centrum základního výzkumu
Rybná 716/24
110 00, Praha 1, Česká republika

Address of release
Modern Science
Rubna 716/24 , 110 00, Praha 1
Czech Republic

Adresa redakce
Moderní věda
Rybná 716/24, 110 00, Praha 1
Česká republika

©Modern Science — Moderní věda. — Praha. — Česká republika, Nemoros. — 2020. — № 2.
ISSN 2336-498X

CONTENTS

Economics

Ivona Izabela Baba. The essence and features of security activities of insurance companies 5

Maryna Kryvoberets. Methodical approach to the evaluation and analysis of the tour operator competitive potential.....15

Vitalii Kuzmenko. Trends and features of financial support of Ukrainian enterprises' investment activity.....25

Yevhen Beltiukov, Nataliia Matsko. Assessment of production potential of industrial enterprise in the context of sustainable development 35

Public administration

Ivan Shkurat. State integration policies of Ukraine in the conditions of globalization.....43

Philosophy and theology

Olga Avyerina. Implementation of the systematic approach to education 50

Viktoriia Babyuk. The types of relevance within informal logic.....58

Pedagogy and psychology

Oleksandr Tadlya. Student club as a means of forming corporate culture in higher educational institution.....65

Natalia Shapovalova, Larisa Panchenko, Olena Bashchuk. Hyperbolic geometry in the course of professional training of future mathematics and physics teachers 73

Medicine and phisiology

Natalia Voloshchuk, Serhiy Konjuch, Andriy Melnyk, Olha Denysiuk. The influence of genistein, resveratrol and quercetin on functional state of kidney in rats with experimental chronic kidney disease. Connection with hydrogen sulfide system 82

Tatyana Kvyatkovskaya, Yevgeniy Kvyatkovsky, Valentin Kosse. Role of uroflowmetry in a clinical study of patients with chronic prostatitis.....93

Olena Nefedova, Oleksander Galperin, Yuri Filippov. Experimental determination of the influence of cadmium salt on cardiogenesis of a rat.....101

Inna Shevchenko, Zoya Alekseyenko, Olena Kefeli-Ianovska. Rates weight change and steel affections by lead acetate intoxication.....111

Olena Nefodova, Igor Zadesenets, Olena Shevchenko. The effect of cadmium salts on the development of vessels and atrioventricular valves of rat heart under the conditions of zinc citrate correction.....116

Elena Sharapova, Elvira Topka, Vlada Gruzd. Effects of electromagnetic radiation on the structure and function of male reproductive organs and their correction with immunotropic drugs (literature review).....124

Vera Shatornaya, Irina Kolosova, Vera Garets. Change of indicators of rat embryotoxity under isolated injection of cadmium compounds and combined with cerium 131

Agricultural sciences

Bogdan Yegorov, Natalya Batievskaya. The energy audit of granulation technology the production compound feeds in the form blend crumbs.....139

History

Svitlana Kagamlyk. The reading interests of Ukrainian church elite of the XVIII century 146

ECONOMICS

THE ESSENCE AND FEATURES OF SECURITY ACTIVITIES OF INSURANCE COMPANIES

Ivona Izabela Baba,
postgraduate student,
PHEI "Lviv University of Business and Law"

Annotation. *The methodology of scientific research in the article includes a certain set of theoretical provisions. As a result features of an insurance company that will differentiate its security activity from other entities of the enterprise are determined and the essence of the concepts of "security of insurance companies" and "security activities of insurance companies" is grounded.*

Key words: *insurance company, safety, security activity of insurance companies, threats.*

The problem of safety of functioning of all financial intermediaries, including insurance companies, being powerful investors for the national economy, is becoming increasingly relevant in today's financial and economic challenges.

Analysis of research and publications. The issues of the essence of the safety of insurance companies have not been sufficiently studied by domestic scientists. Thus, L.V. Gnylytska researches the economic safety problems of an insurance company [1]; Yudina S.V. deals with the issues of the financial safety of the insurer [2]. Smolyak V.A. notes that the security of any system is conditioned by a set of certain actions and their results which differ in nature, methods of implementation, composition of participants, resources used [3]. According to Yermoshenko A.M. [4], when determining the essence of the financial security of an insurance organization, a special place is taken by the financial condition of the insurer, a prerequisite of which is the balance of the financial performance system, resistance to internal and external threats. The analysis of scientific explanations shows that more attention is paid to certain types of insurer safety by scientists. As a result, our mission is to clarify the nature and security components of insurance companies in Ukraine.

Main material. The first component of scientific knowledge is the justification of the features of an insurance company that will determine and distinguish its security activities from other entities. There are different interpretations of "insurance company" in the national science and there are no common approaches to its understanding. The Law of Ukraine "On Insurance" recognizes insurers as financial institutions established as joint-stock, full, limited partnerships or subsidiaries with additional liability, as well as those that have been licensed to carry out insurance activities in accordance with the established procedure [5].

We agree with the opinion that an insurance company is a specific business entity. The subject of an insurance company is the provision of insurance (reinsurance and intermediary

insurance) services and financial management of insurance reserves (creation, placement, investment), implemented by the founders in accordance with the requirements of the Law of Ukraine "On Insurance" to maximize their well-being [6, p. 11].

The analysis of scientific sources on the nature of the insurance company and its features allows us to determine the following generalized approaches:

1. Insurer is a financial intermediary whose purpose is to make a profit;

2. It is a financial institution that is registered in the relevant register in the manner prescribed by law and operates after obtaining a license;

3. The subject of direct activity of an insurance company is insurance, reinsurance, financial activities related to the formation, placement of insurance reserves and their management.

An exclusive type of activity of an insurance company is insurance activity, activity in the provision of insurance services, i.e. services for the protection of legal entities and individuals from the risks of unforeseen events. Such activity of insurance companies contributes to the formation of a safe environment in the market economy and the rational use of resources, to create a condition for enterprises in terms of business continuity, and to compensate for unexpected losses. Therefore, the insurance activity of insurance companies must be safe and therefore depends on properly formed insurance reserves, fair actions of competitors and insurers' compliance with the law.

Investment activities (activities related to the formation, placement of insurance reserves) and reinsurance are inextricably linked to the provision of insurance services and determine the uniqueness and importance of insurance companies in the national economy.

Investment activity is conditioned by the nature and specifics of insurance services. Insurance companies, offering insurance protection, receive insurance premiums which they can use until the payment of insurance compensation. Therefore, the investment activity of insurance companies is the investment of own and borrowed funds of insurance companies in order to generate income in the future. Investment resources of insurance companies are equity and the funds of insurance reserves being at their disposal.

Security of investment activity of insurance companies depends on:

- the structure of the insurance portfolio formed and the term of the insurance contract;

- on the structure of investment resources and the amount of accumulated cash. Insurance companies' own funds are free from liabilities to insurers and are therefore invested in less liquid and long-term assets. Insurance reserves may be required at any time for insurance claims.

In addition to providing insurance services and carrying out investing activity, insurance companies can deal with reinsurance. According to the legislation of Ukraine, the insurer (reinsurer) has the right to take risks in reinsurance only in those types of compulsory and voluntary insurance, which he has been licensed for [5]. Any insurance company can carry out reinsurance of the risks which it is licensed for.

Reinsurance is the activity of insurance companies in the redistribution of risk in order to gain profit and, as a result, achieve social effects. This activity guarantees the

economic security of the insurance companies by forming a balanced insurance portfolio, fulfilling its obligations to the insurers; maintaining the stable functioning of the entire insurance market.

4. Depending on the types of insurance offered, one can distinguish: life insurance companies; insurance companies that offer risky types of insurance. Therefore, it is necessary to speak separately about the safety of life insurance companies and the safety of risk insurance companies. The specific activity of these companies affects their safety. For instance, a life insurance company is a company that offers insurance services where insurance indemnity is provided in the event of the death of the insured person; in the case of the insured person's survival until the expiry of the insurance contract and / or the insured person's reaching the age determined by the contract. These services are cumulative. Therefore, the safety of life insurance companies is created by:

- a higher minimum amount of authorized capital for a life insurance company than for risk insurance companies. According to the current legislation in Ukraine the minimum authorized capital for a life insurance company should be EUR 1.5 million.

- the proper formation and placement of insurance reserves, which are specific insurance reserves, which is due to the peculiarities of life insurance itself. The correct determination of their size is necessary, on the one hand, to guarantee the insurance companies future possible payments under insurance contracts, and, on the other hand, to determine the real results of their activities.

- the exclusive implementation of cumulative insurance only, providing of other types of insurance is prohibited by law.

- an activity that guarantees the safety and profitability of investments, which enables them to retain their real value over the term of the investment and, if necessary, to convert insurance investments into liquid assets in order to fulfill obligations to policyholders.

Risk insurance companies are those financial institutions that are created according to appropriate organizational and legal forms, meet the requirements of the law, are ready to risk and offer services to individuals and legal entities for insurance protection of property and personal interests. The security of risk insurance companies is formed by:

- availability of insurance reserves to the extent sufficient for future payments;

- balanced insurance portfolio under the following conditions: the ratio of terminated insurance contracts and newly concluded equals to one; receipt of insurance premiums for one type of insurance should not exceed 30% of the total amount of insurance premiums received;

- the proper level of actual solvency margin (net assets);

- the relevant norms of domestic legislation and internal regulations.

Thus, the insurance company offers to protect the interests of insurers or insured persons for profit. On the other hand, it is a business entity that immediately needs protection (security) to function effectively. It turns out, on the one hand, that the insurer offers protection against unwanted, harmful influences and their consequences, and, on the other, it must function safely itself. Such an ambivalent nature of the essence of an insurance company certainly influences the understanding of "security" and "security activity".

The second component of scientific knowledge is the substantiation of the essence of "security of insurance companies".

The meaning of the term "security" has expanded significantly over the last decades, from the traditional feature as a particular state of security for any subject to the science to be studied and developed; art to be grasped; culture that needs nurturing.

Systematic studies of the basic rules of the theory of security science reveal the content of the main concept of "security". At the same time, the complexity and diversity of the functional spheres in which security parameters develop, as well as the existence of a system of interconnections between them, necessitate a thorough scientific research in this direction. We will try to analyze and systematize the studied concepts from the position of analysis of "security of insurance companies".

It is worth mentioning that in the theory of security studies there is no single definite definition of this concept, a thorough explanation and interpretation. However, the concept of "economic security of the enterprise" is studied much more deeply. For instance, O.M. Lyashenko outlines the following approaches [7, p. 56]:

- resource-functional (state of use of corporate resources by functional areas);
- competitive (the company has competitive advantages);
- harmonization (harmonization of interests of the enterprise with interests of subjects of the external environment);
- approaches within the concept of development;
- protective (prevention and protection of the enterprise from the negative impact of threats);
- sustainable (the ability of an enterprise to maintain properties such as equilibrium and stability) approaches from the standpoint of the protective concept.

Similarly, such notions as "economic security of insurance companies", "economic security of the insurance market", "financial security" are found more often in the national scientific literature than "security of insurance companies". We think, these are the types of security of insurance companies. Thus, O.I. Baranovsky deals with the problem of "financial security" through the prism of providing insurance companies with financial resources, which will allow them, if necessary, to compensate for losses caused by the contracts of insurance and to ensure the effective functioning of the company [8, p. 559]. The explanation of the problem of financial security through security, in our opinion, indicates the action taken by insurance companies thus revealing the essence of security.

In his later works a well-known scientist already understands the financial security of the insurance market in general and a specific insurance organization as [9, p.37-38]:

- a set of conditions under which potentially dangerous for the financial state of insurance companies actions or circumstances are prevented and reduced to such a level that they are not capable of damaging the established order of operation of the insurer, its property and infrastructure and preventing the insurer from achieving its statutory goals;
- the state of protection of the financial interests of the insurance company, its financial stability and independence as well as the environment in which it operates.

According to V.I. Franchuk, the economic security of an insurance organization is

its state within the limits and the ability to counter threats and ensure the realization of economic interests. To ensure economic security, it is necessary to counteract business threats to insurance business structures, since otherwise there can be economic risk which will be much more difficult to overcome [10, p. 62].

T.V. Yavorska introduces the concept of "economically safe subject of insurance business" into scientific circulation, by which she understands the subject, which carefully carries out its activity, responds promptly to any market failures, external and internal threats in order to minimize or avoid them. The researcher emphasizes that the formation of economic security of the subject of insurance business should be carried out at its foundation, formation of the management system and all its functional spheres [11, p. 288–291]. This definition focuses only on countering external and internal threats without revealing the essence of security per se.

L.O. Matviychuk points to the frequent identification of the terms "financial security" and "financial sustainability" in his research. The scientist disagrees with the statement that without proper safe state of an insurance company one cannot speak about its financially stable and solvent state [12, p.30-32]

In our opinion, such an interpretation of financial security (as a process of achievement) by the author partially reveals the essence of security activity itself, because the process of achievement means actions. And we consider that the state is the conditions under which the insurance company is at a certain point of time and on the basis of which it is possible to determine the level of security.

Papka O.S. sees the financial security of the insurer as the state (conditions) of functioning, under which there is access to financial resources and markets providing itself and the insurer with a certain level of protection against internal and external financial threats and the proper efficiency of financial indicators. It has the ability to capitalize and develop in the future, so that it can fully fulfill its obligations to insurers, the state and other individuals to pay insurance claims, make the necessary payments to the budget, allocate insurance reserves and other financial transactions, characterized by the amount of capital losses, solvency, liquidity, profitability, income loss and profits in the future. Ensuring the security of the insurance market is characterized by the level of insurance companies financial resources that would allow them, if necessary, to compensate for the losses stipulated in the insurance contracts of their clients and provide effective functioning» [13, p.293-296]. In this author's explanation, the tax and investment components of security are differentiated. At the same time the author points out the characteristic features of financial security of insurance companies: the availability of own financial resources and insurance reserves; resistance to internal and external negative influences; competitiveness of the insurer; sufficient level of profitability of insurance and investment operations.

The interpretations presented in domestic science deal with the essential features of the types of security more than with the security of insurance companies in general. We can say that security is:

- security status;

- level of availability of resources;
- a specific characteristic.

We agree with the explanation that security is a state of protection of the interests of the business entity. It is advisable to use the level of resource availability in order to assess security, but not to explain its essence.

We interpret the security of insurance companies as a state of protection against internal and external threats, where the main interests and priority goals of insurance companies are realized. The main purpose of security of insurance companies is to eliminate the possibilities of inflicting losses or loss of benefits on insurance companies, to ensure their effective activity and quality realization of insurance services, reinsurance and investment activities.

In our view, the security types of insurance companies are interrelated in such a way that one type of security complements the other one. While emphasizing such interaction, it should be borne in mind that economic security plays a decisive role in this classification.

We believe that the effectiveness of insurance companies, especially under unstable conditions, depends to a large extent on the effectiveness of the mechanism for ensuring their economic security. At the same time the level of economic security of insurance companies depends on how well their management and specialists will be able to avoid possible threats and eliminate the harmful effects of certain negative components of the external and internal environment.

Thus, the economic security of an insurance company is a state of efficient use of resources and existing market opportunities of the insurer, which allow to prevent internal and external threats and to ensure its sustainable development.

The financial security of an insurance company is a state of protection of an insurance company against possible financial losses. This kind of security is crucial. The weakening of the insurer's financial security is evidenced by the decrease in liquidity, the weakening of its solvency and its financial stability.

Information security of insurance companies is a state of protection of confidential information, prevention of its leakage, protection of software products of an insurance company from accidental or deliberate alteration, disclosure or destruction. At the same time we support the opinion of O. Zhabinets, who believes that information security involves the protection of any confidential information regardless of its storage location, transmission or type of media [14, p. 38-35].

Political and legal security of an insurance company is a state of protection of insurance companies against unstable legislation, changes in the political situation and inefficient work of the legal department of insurance companies.

Market safety of an insurance company is a state of protection against ineffectively chosen model of behavior on the market, mistakes in the direct activity of the insurer and the implementation of non-competitive insurance service. This is the compliance of the insurance company with market demands and specific consumer needs.

Personnel security of an insurance company is a state of protection of insurance

companies against actions and negative influence of under-qualified employees, inefficient management staff. We agree with the view that personnel security is crucial in the system of financial and economic security of insurers. In accordance with international practice, much attention is paid to personnel security issues. The international information security standard ISO / IEC 27002: 2013 clearly traces the link between personnel safety and information security. Starting with hiring an employee and ending with contract termination [15, p. 270].

The third component of scientific research is the disclosure of the security activities of insurance companies.

The concept of "safe activity" is explained by some scientists. For the first time this concept was used in scientific research by V.I. Franchuk, who interpreted it as a form of active attitude of security subjects to security reality, the content of which was to carry out appropriate changes in it on the basis of assimilation and development of security culture. That is, activities aimed at counteracting threats, restoring activities to protect corporate interests, preserving the integrity of processes or systems based on the assimilation and development of security culture [16, p.155].

Continuing with the research of Franchuk V.I. Fostyak V.I. characterizes the security activity with the following key parameters [17]:

- continuous process from the moment of establishment of the enterprise until its liquidation;
- takes place in all aspects of the operation of the enterprise, which may be characterized by the possibility of occurrence of risks and threats as the primary causes of reduced security;
- such activity must be resourced, i.e. financial, material, labour and information resources;
- the result of such activity is the formation of safe conditions for enterprise development.

Taking into account these parameters, Fostyak V. considers that the security activity of the enterprise is the activity of the enterprise in cooperation with external subjects of security for ensuring its own dynamic stability of functioning and formation of safe conditions of development through protection from external and internal threats and minimizing risks [17].

The key features in determining the safety performance of insurance companies will be the following:

1) independent activity based on the use of various opportunities to create protection of material, financial, human, information resources;

2) activities not with the purpose of profit but with the purpose of development and further functioning of the insurance company;

3) systematic activity organized directly by the insurance company within the limits of both current regulations and laws or own initiative and approaches;

4) continuous activity carried out at its own risk and under its own responsibility.

Security activities of insurance companies is independent, systematic, carried out

at their own risk activities of insurance companies to identify (study), prevent, mitigate and eliminate (avert) threats.

We will divide the security activity of insurance companies into two types:

- active security activity is an activity based on anticipation of actions that pose a threat and aimed at protection against possible material, human and financial losses. It will be possible to evaluate its effectiveness when the available or possible losses are less than the set figures.

- passive safety activities are activities that are carried out by insurance companies after the occurrence of a dangerous event and aimed at the survival of the insurer, not at development.

Taking into consideration the specifics of insurance companies, we consider it advisable to speak separately about:

- security activity of risk insurance companies;
- security activities of life insurance companies.

The difference between such activities will be:

- the life insurance business of the insurance companies is aimed at guaranteeing the safety and profitability of insurance premiums, which makes it possible to keep their real value for the duration of the investment, and if necessary to convert insurance investments into liquid assets for the fulfillment of obligations to the insurers. Such orientation of activity is conditioned by the nature of functioning of the life insurance company, since the task of the insurers is not only to pay insurance indemnity in case of insured events but also to properly accumulate insurance premiums.

- security activities of risk insurance companies is aimed at guaranteeing the payment of insurance indemnity in the event of insured events related to the property and capacity of insurers and insured persons.

The main tasks of the security activities of insurance companies should be:

- ensuring the stability of economic development of insurance companies;
- neutralizing the impact of external crisis situations and deliberate actions of competitors;
- enhancing the image of insurance companies and maximizing their market value;
- counteracting the development of insurance fraud;
- reducing the dependence of insurance companies on external reinsurance;
- increase in the amount of investment, the profitability of which can often cover the negative financial result from the insurance business, increase the volume of insurers' own capital, which in crisis situations can be used to fulfill their obligations.

Thus, insurance companies when operating under unstable conditions need protection. However, the security of insurance companies is impossible without the creation, regulation and support of the state favourable conditions for this. Selected scientific research tool revealed the peculiarities of insurance companies, security of insurance companies and security activities of insurance companies.

References:

1. Ghnylycjka L.V., Saveljjeva A.V. (2015) Suchasnyj dosvid formuvannja systemy zabezpechennja ekonomichnoji bezpeky v strakhovykh kompanijakh [Modern experience in the formation of the system of ensuring economic security in insurance companies]. Finansy, oblik i audyt. Vol. 1, pp.186-195

2. Judina S. V., Ghryghor'jeva N. M. Chupryna O. Gh. (2018) Mekhanizm zabezpechennja finansovoji bezpeky strakhovoji kompaniji [The mechanism of ensuring the financial security of an insurance company]. Ekonomika i suspiljstvo. No. 17. pp. 627-633.

3. Smoljak V.A. (2016) Vyznachennja faktoriv vplyvu na rivenj finansovoji bezpeky strakhovoji kompaniji [Determination of the factors influencing the level of financial security of an insurance company]. Efektyvna ekonomika. [An efficient economy] (electronic journal), no. 5. Available at: http://www.economy.nayka.com.ua/?op=1 (accessed 20.02.2020)

4. Jermoshenko A.M. (2004) Vyznachennja ponjattja finansovoji bezpeky strakhovyka ta jiji kateghorij [Definition of the concept of financial security of the insurer and its categories]. Aktualjni problemy ekonomiky, no 4, pp. 46-51.

5. Verkhovna Rada Ukrajiny (1996) Zakon Ukrajiny "Pro strakhuvannja" [About insurance]. Available at: http://zakon2.rada.gov.ua/laws/show (accessed 20.02.2020)

6. Piratovsjkyj Gh. L. (2006) Strakhovyj biznes: upravlinnja rozvytkom [Insurance business: development management]. Kyjiv: Kyjiv. nac. torgh.-ekon. un-t. (in Ukrainian).

7. Ljashenko O.M. (2015) Konceptualizacija upravlinnja ekonomichnoju bezpekoju pidpryjemstva [Conceptualization of enterprise economic security management] Kyjiv., 2015. (in Ukrainian).

8. Baranovsjkyj O.I. (2004) Finansova bezpeka v Ukrajini (metodologhija ocinky ta mekhanizmy zabezpechennja) [Financial security in Ukraine (valuation methodology and ensuring mechnisms)]. Kyjiv. (in Ukrainian).

9. Baranovsjkyj O. (2014) Pytannja bezpeky u stanovlenni rynku strakhovykh poslugh [Security issues in the emerging market for insurance services]. Strakhova sprava, no. 2, pp.34-38.

10. Trynjko R.I. (2008) Strakhuvannja v systemi ekonomichnoji bezpeky [Insurance in the system of economic security]. Ljviv. (in Ukrainian).

11. Javorsjka T.V. (2012) Derzhavne reghuljuvannja strakhovogho pidpryjemnyctva v Ukrajini [he State Regulation of the Insurance Business in Ukraine.]. Ljviv. (in Ukrainian).

12. Matvijchuk L. O. (2013) Konceptualjni aspekty finansovoji bezpeky strakhovykh kompanij [Conceptual aspects of financial security of insurance companies]. Visnyk ONU im.. I. I. Mechnykova, vol. 2/1, pp.30-32.

13. . Papka O. S. (2012) Mekhanizm funkcionuvannja systemy finansovoji bezpeky strakhovykh kompanij [The functioning mechanism of the financial security system of insurance companies] . Naukovyj visnyk NLTU Ukrajiny, vol. 22.8, pp. 292-297.

14. Zhabynecj O. (2014) Zakhyst informaciji ta informacijna bezpeka strakhovykh kompanij [Information protection and information security of insurance companies]. Ekonomichnyj chasopys XXI, no 7-8, pp. 38-35

15. Zhabynecj O. J. (2015) Kadrova bezpeka v systemi finansovo-ekonomichnoji bezpeky strakhovykh kompanij [Personnel security in the system of financial and economic security of insurance companies]. Biznes Inform, no.5, pp. 269-274.

16. Franchuk V. I. (2017) Bezpekova dijaljnistj: systemnyj pidkhid [Security activity: a systematic approach]. Naukovyj visnyk LDUVS, no.1, pp.154-163.

17.Fostjak V. I. (2019) Formuvannja mekhanizmu upravlinnja bezpekovoju dijaljnistju promyslovykh pidpryjemstv [Formation of the mechanism of management of safety activity of industrial enterprises]. Efektyvna ekonomika. [[An efficient economy] (electronic journal), no. 1. Available at: http://www.economy.nayka.com.ua/index.php?op=1 HYPERLINK 6856 (accessed 10.02.2020)

METHODICAL APPROACH TO THE EVALUATION AND ANALYSIS OF THE TOUR OPERATOR COMPETITIVE POTENTIAL

Maryna Kryvoberets,
postgraduate student,
Interregional Academy of Personnel Management

Annotation. *The article substantiates that the process of assessing a tour operator competitiveness potential is carried out on the basis of the evaluation of its components and the identification of their impact on the process of market share formation. Methodical approaches to human potential assessment are analyzed and it is stated that the integral method is the most relevant to the specifics of tour operator activity. The indicators of assessment the tour operator financial potential were selected. The methodology of estimating organizational potential as a component of tour operator competitiveness potential has been improved. It is stated that strategic analysis is advisable to determine the optimal measures to improve the process of formation and realization the tour operator competitiveness. It is determined that SPACE-analysis is the most relevant for the tourism industry enterprises.*

Key words: *competitiveness potential, tour operator, potential evaluation, strategic analysis, human potential, financial potential, organizational potential, SPACE-analysis.*

Formulation of the problem. The tour operator's activity in today's global environment involves competition not only in the local market but also in the international tourism market. Active struggle for market positioning requires dynamic management of formation and realization the tour operator competitiveness potential. The effectiveness of this process entails a comprehensive assessment of the current potential and a thorough analysis of possible prospects. That is why it becomes necessary to select the methods of assessment and analysis that are most fully relevant to the specific of tour operator's activities.

Analysis of recent research and publications. Ukrainian scientists I. Babii [1], A. Hrynov [2], R. Skrynkovskyi, and A. Chubenko [3] propose to evaluate competitiveness potential based on indicators of their components.

M. Porter [4], J. Lambin [5], T. Peters and R. Waterman [6] are the pioneers in analyzing the company's competitive potential. A. Gupta [7] and J. Ho [8] propose to perform PEST-based analysis, I. Ansoff [9] – GAP-based analysis, W. Rudnicki and I. Vagner [10] – LOTS-based analysis, Malik Management Company [11] – PIMS-based analysis, K. Morozova [12] – SWOT-based analysis, and T. Dimitrova [13] – SPACE-based analysis.

The purpose of the article is to substantiate theoretical provisions on the evaluation and analysis of the tour operator competitiveness potential.

Outline of the main material. It is not possible to manage the tour operator competitiveness potential without a comprehensive assessment and analysis of its components. In the scientific literature, the main approach to the diagnostics process

of enterprise competitive potential is based on the evaluation of its components and identification of their influence on the process of market share formation [2; 3]. Considering the fact that the tour operator's competitiveness potential consists of human, financial and organizational potential, it is advisable to analyze methodological approaches to their evaluation.

V. Dyblenko, O. Shevchenko and S. Rakova distinguish cost, effective, integral and comparative methods of estimation the human potential of the enterprise [14]. The main disadvantage of using the cost method for assessing the tour operator human potential is the static result. Monetary interpretation of human potential does not carry information about its impact on competitiveness formation, in addition, cost of upgrading the skills of employees as a basis of evaluation does not fully characterize nature of the potential. The resultive approach to valuation is also quite narrow, since it involves the calculations of labor profitability, labor intensity, which are difficult to evaluate in service enterprises. The work of the tour operator's staff is creative and therefore difficult to evaluate. A similar problem applies to comparative methods, as each individual tour projecting and planning has not only cyclical processes that can be measured to a certain extent, but new ones that depend on changing requirements for the characteristics of the future product.

The most accurate and often used are the integrated methods of enterprise's human potential assessment, because they allow to cover a whole set of factors that affect the result of a given goal. Education, age, experience, specific skills, etc. are used as indicators to assess human potential [15].

Taking into account the specificity of the tour operator activity, we propose to calculate human potential as a geometric mean of the staff computerization indicator, the staff sustainability indicator and the staff qualification indicator (Formula 1).

$$LP = \sqrt[3]{I_C \cdot I_{QI} \cdot I_{CP}};$$

I_C – the staff computerization indicator; I_{QI} – the staff qualification indicator; I_{CP} – the staff sustainability indicator.

The staff computerization indicator reflects the impact of the information technology of the tour operator on the formation of its competitiveness potential through the development of human resources. It is calculated according to formula 2.

$$I_C = \frac{Q_C}{Q_E};$$

Q_C – quantity of computers on the balance of the tour operator; Q_E – quantity of employees.

The assessment of the tour operator's staff qualification indicator is based on the calculation of the proportion of employees with the appropriate level of knowledge, skills and abilities. The indicator is calculated by the formula 3.

$$I_{QI} = \frac{HE_T}{Q};$$

HE_T – quantity of employees with higher education in tourism or experience in the tourism business more than three years; Q – quantity of employees.

The staff sustainability indicator reveals a trend of employee satisfaction with working conditions and employers' satisfaction with the quality of human resources. The indicator of staff sustainability as it grows indicates the stable condition of the tour operator, and at the decrease – the need to change the systems of human resources development. The indicator is calculated by the formula 4.

$$I_{CP} = 1 - \frac{Q_r}{Q_c};$$

Q_r – the number of redundancies per year; Q_c – average annual number of employees.

The tour operator financial potential as an integral part of the competitiveness potential denotes the ability to manage cash flows effectively, and therefore its assessment should take into account the indicators of financial support from different sources. Thus, V. Turchak and S. Chyzhynska use a number of ratios to evaluate financial potential, of which it is advisable to use the acid-test ratio, the financial autonomy ratio, the return on assets and the return on equity [16].

N. Nawrocki uses a list of financial potential indicators, of which the equity maneuverability ratio and the financial sustainability ratio are appropriate for the needs of the tourist operator [17]. Another noteworthy indicator is The leverage ratio, which is included in the list of financial potential indicators according to L. Kostirko [18].

The above indicators are calculated on the basis of the formulas given in Table1.

We propose to calculate the financial potential (FP) of a tour operator as the geometric mean of the acid-test ratio (k_{TL}), the financial autonomy ratio (k_A), the return on assets (k_{PA}), the return on equity (k_{PC}), the equity maneuverability ratio (k_{FS}), the financial sustainability ratio (k_{MOF}), and the leverage ratio (k_{LE}) (Formula 5).

$$FP = \sqrt[7]{k_{TL} \cdot k_A \cdot k_{PA} \cdot k_{PC} \cdot k_{FS} \cdot k_{MOF} \cdot k_{LE}};$$

The organizational potential of the tour operator consists of external communications, internal communications, corporate culture and information technologies. With regard to the evaluation of internal and external communications of enterprises, most scientists propose to use the evaluation of marketing communications based on a result approach [19; 20; 21].

Table 1

Calculation formulas for indicators of tour operator financial potential

Indicator	Formula
The acid-test ratio	$k_{TL} = \frac{CA}{CL}$; CA – Current Assets; CL – Current Liabilities.
The financial autonomy ratio	$k_A = \frac{Eq}{TA}$; Eq – equity of the enterprise; TA – the amount of assets.
The return on assets	$k_{PA} = \frac{NP}{TA}$; NP – Net Profit.
The return on equity	$k_{PC} = \frac{NP}{Eq}$;
The equity maneuverability ratio	$k_{MOF} = \frac{NCA}{Eq}$; NCA – Net Current Assets.
The financial sustainability ratio	$k_{FS} = \frac{Eq}{CL+DI}$; DI – Deferred Income.
The leverage ratio	$k_{LE} = (1 - TR) \cdot \frac{GR \cdot DC}{Eq}$; TR – the income tax rate; GR – The return on assets ratio; DC – Loanable Funds.

More specific is the approach of A. Chumachenko [22], according to which, estimation the level of external communications of a tour operator with consumers and partners involves Delphi method (Formula 6).

$$I_{ECom} = \frac{EE_p + EE_c}{m};$$

I_{ECom} – the external communications level; EE_p – score level of communication with partners; EE_c – score level of communication with consumers; m – maximum total score of external communications.

Determining the level of internal communications involves the Delphi method for evaluating communications by communication channels, communication form, and organizational attribute. Received score divided by the maximum total score forms an

indicator of the internal communications of the tour operator (formula 7).

$$I_{ICom} = \frac{EEK_c + EEK_f + EEK_o}{m};$$

I_{ICom} – the internal communications level; EEK_c – score of the internal communications by communication channels; EEK_f – score of the internal communications by communication form; EEK_o – score of the internal communications by organizational attribute; m – maximum total score of internal communications.

According to A. Chumachenko, the evaluation of tour operator information technologies involves determining the availability of Internet, Intranet and website, and the absence of at least one component reduces the level of the indicator to zero. The effectiveness of the website is evaluated on the basis of the following components: catalogs and price-lists, online payments, booking, announcement of vacancies, information content, provision of services according to customer requirements [22]. Given the fact that the "License Terms of Tour Operations in Ukraine" requires existence of a website and access to the Internet, it is advisable to calculate the indicator according to Formula 8.

$$I_{IT} = \frac{i}{n};$$

I_{IT} – the IT level of a tour operator; i – number of opportunities provided by the web site of the tour operator; n – number of explored features.

The Delphi method for corporative culture evaluation includes: formal corporative culture, informal corporative culture, leadership position in the team, leadership style, culture of communication between the leader and subordinates (Formula 9).

$$I_{CorpC} = \frac{\sum_{i=1}^{n} EECC_i}{n \cdot m};$$

I_{CorpC} – the corporative culture level; $EECC_i$ – expert score of the i-th component of the tour operator corporative culture; n – number of investigated components of corporative culture; m – maximum score of the i-th component of corporative culture.

Therefore, the organizational potential of a tour operator is a geometric mean of the external communications level, the internal communications level, the IT level, and the corporative culture level (formula 10).

$$FP = \sqrt[4]{I_{ECom} \cdot I_{ICom} \cdot I_{IT} \cdot I_{CorpC}};$$

The next step in assessing the tour operator competitiveness potential is to identify its most influential elements. For this purpose, it is planned to build a regression model, which compares the formation dynamics of competitiveness potential's components with the market share of the tour operator. Market share is chosen to reflect the result of realizing the potential of competitiveness, because it indicates the efficiency of human, financial and organizational potential (Formula 11).

$$MS = f(HP; FP; OP);$$

MS – market share of the tour operator; HP – human potential; FP – financial potential; OP – organizational potential.

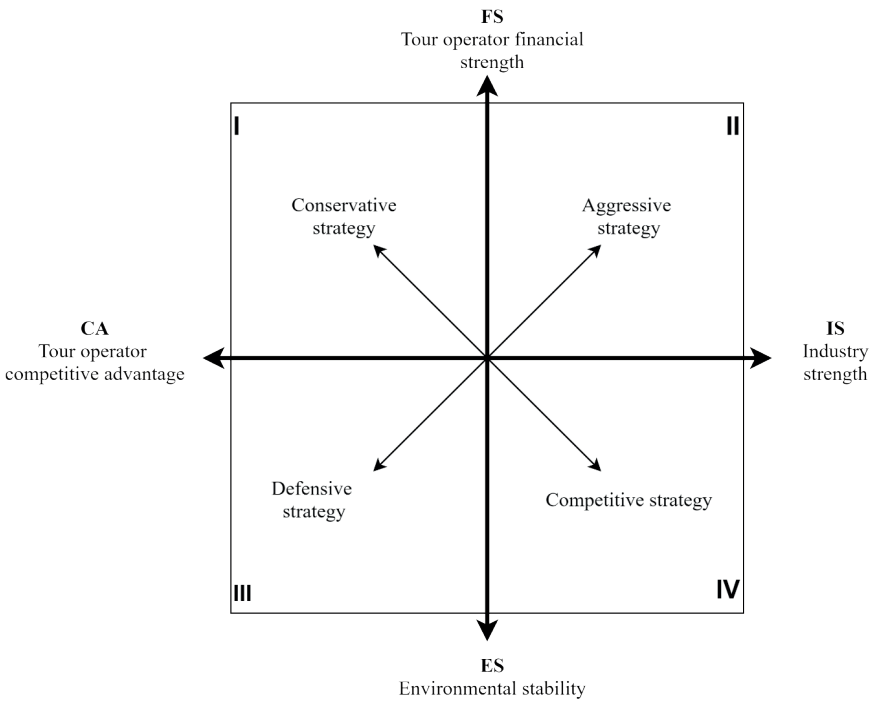


Fig. 1. Graphical interpretation of SPACE analysis [13]

Strategic analysis is a next step in competitiveness potential management. The analysis of competitiveness potential is carried out by different methods, which are selected depending on the goal. Thus, the methods of analysis are classified according to the formation direction of the information base, the method of displaying the final

results, the method of evaluation, and the possibility of making management decisions. SPACE-analysis is gaining popularity lately, because it has a clear logic, provides a legible visualization of the achieved results, has a high level of accuracy and allows to determine the best ways to improve the current state [13].

Similar to the SWOT model, SPACE analysis applies to the internal and external environment of a tour operator, but it does not identify its strengths, weaknesses, opportunities or threats. In addition, the scope of the factors considered in the SPACE analysis is narrower than in the SWOT method. This type of analysis involves obtaining four indicators (competitiveness of the tour operator, financial strength of the tour operator, strength of the industry, stability of the environment), on the basis of which an appropriate strategy is chosen (Figure 1).

We propose to evaluate the financial strength on the basis of a comparative assessment of the financial potential of the tour operator and its competitors (Formula 12).

$$FS = \frac{FP_i}{FP_{max}};$$

FP_i – financial potential of the tour operator; FP_{max} – the maximum level of financial potential among rivals.

Similarly, it is advisable to assess the competitiveness advantage of a tour operator by comparing market share with its rivals (Formula 13).

$$CA = \frac{MS_i}{MS_{max}};$$

MS_i – market share of the tour operator; MS_{max} – maximum level of market share among competitors.

The industry stability (IS) is assessed by two main criteria: the increase in the share of tour operators in the volume of goods and services sold in Ukraine, the increase in the number of tour operators. These dynamics are compared with other types of economic activity to determine the place of touring in the national economy.

The environmental stability (ES) covers the following indicators: dynamics of growth of tour operators' profits in Ukraine, level of development of tour operators' innovative activity, marketing and advertising opportunities of the industry. If the first indicator involves the processing of data of the State Statistics Service of Ukraine, then for the last two involve experts to carry out estimates.

The difference between the indicator of the industry strength and the competitiveness of the tour operator determines the coordinates on the CA–IS axis, and the difference between the indicator of the financial strength of the tour operator and the environmental

stability determines the coordinates on the FS–ES axis. Therefore, the placement of a tour operator in Square I implies the advisability of pursuing a conservative strategy, namely: winning new market segments; reducing the cost of creating a product; market development through the sale of available products in new, more promising markets.

Square II is typical for attractive industries with low environmental uncertainty, and the tour operator has a competitive advantage that it is able to retain and consolidate due to its financial strength. This position implies an aggressive strategy: price wars; expansion of tours production; capturing new market sectors. In addition, an aggressive strategy can be complemented by the following measures: maintaining the level of innovation and further developing competitive advantage; vertical integration; diversification; development of unique tours through high-tech production.

Positioning in Square III is typical of unattractive industries where organizations lack sufficient funds and competitive products. The behavior of the tour operator involves conducting a defensive strategy: active counteraction to possible internal and external threats; "Harvesting" of the most profitable tour packages; asserting market share (by flank defense, counterattack); abandoning low-income, low-growth tours.

Square IV is typical for tour operators, which have significant competitive advantages, but their financial strength is not sufficient to compensate for environmental instability. The key strategic imperative is to gain the financial strength to ensure the process of further expansion. Tour operators located in this quadrant should increase their profitability, differentiate (in terms of the products they offer) and increase overall marketing effectiveness. The following competitive strategy measures can be recommended: “focusing”, that is, developing highly differentiated product lines; use of various integration forms of sales of tours; search for new sources of funding; increasing its market share by selling an existing product in new demographic or geographic markets; cooperation through involvement in strategic alliances.

Conclusions. A comprehensive analysis of the formation and realization process of the tour operator competitiveness potential should start with an assessment of its components (financial potential, human potential, organizational potential) and the market share, then it is necessary to identify the influence of its components on the potential realization process, and finally conduct a SPACE-analysis to choose a strategy that will promote long-term development.

References:

1. Babii I. V. (2011) Otsinka konkurentnoho potentsialu v mekhanizmi antykryzovoho upravlinnia mashynobudivnymy pidpryiemstvamy [Assessment of competitive potential in the mechanism of crisis management of machine-building enterprises]. Visnyk Khmelnytskoho natsionalnoho universytetu, no. 5, vol. 2, pp. 143–146.

2. Hrynov A. V. (2013) Kontseptualni zasady systemnoho upravlinnia konkurentnym potentsialom mashynobudivnoho pidpryiemstva [Conceptual principles of system management of machine-building enterprise competitive potential]. E`nergosberezhenie.

E`nergetika. E`nergoaudit, no. 6 (112), pp. 54–57.

3. Skrynkovskyi R., Chubenko A. (2016) Diahnostyka konkurentnoho potentsialu pidpryiemstva ta vidpovidalnist za porushennia zakonodavstva pro zakhyst ekonomichnoi konkurentsii [Diagnosis of competitive potential of the enterprise and responsibility for violation of the legislation on protection of economic competition]. Pidpryiemnytstvo, hospodarstvo i pravo, no. 7, pp. 49–54.

4. Porter M. E. (1980) Competitive Strategy: Techniques for Analyzing Industries and Competitors. New York: The Free Press. (in English)

5. Lambin J. J. (1969) Measuring the profitability of advertising: An empirical study. The Journal of Industrial Economics, pp. 86–103.

6. Peters T. J., Waterman R. H. (1979) Beyond the matrix organization. Business Horizons, vol. 22, no. 10, pp. 15–27.

7. Gupta A. (2013) Environment & PEST analysis: an approach to the external business environment. International Journal of Modern Social Sciences, vol. 2, no. 1, pp. 34–43.

8. Ho J. K. K. (2014) Formulation of a systemic PEST analysis for strategic analysis. European academic research, vol. 2, no. 5, pp. 6478–6492.

9. Ansoff I. (1979) Strategic management. New York: Wiley. (in English)

10. Rudnicki W., Vagner I. (2014) Methods of strategic analysis and proposal method of measuring productivity of a company. Zeszyty Naukowe Małopolskiej Wyższej Szkoły Ekonomicznej w Tarnowie, no. 2(25), pp. 175–184.

11. Malik Management Company. Available at: https://www.malikpims.com/ (accessed 11 March 2020)

12. Morozova K. V. (2016) Sravnitel`ny`j analiz metodov izucheniya vneshnej sredy` predpriyatij [Comparative analysis of methods for studying the external environment of enterprises]. Innovaczionnaya nauka, no. 5, pp. 141–143.

13. Dimitrova T. (2017) Evaluating the strategic position of an organisation through SPACE analysis. Narodnostopansky arkhyv, no. 3, pp. 19–32.

14. Dyblenko V. I., Shevchenko O. O., Rakova S. O. (2012) Suchasni pidkhody shchodo otsiniuvannia trudovoho potentsialu pidpryiemstva [Modern approaches to assessing the labor potential of the enterprise]. Visnyk Kyivskoho natsionalnoho universytetu tekhnolohii ta dyzainu, no. 6, pp. 277–281.

15. Duda S. T., Popivniak S. V. (2013) Trudovyi potentsial pidpryiemstva: otsiniuvannia ta zasoby pidvyshchennia efektyvnosti vykorystannia [Labor potential of the enterprise: evaluation and means of increasing the efficiency of use]. Naukovyi visnyk NLTU Ukrainy, vol. 23, no. 3, pp. 370–375.

16. Turchak V. V., Chyzhynska S. D. (2014) Metodyka otsinky finansovoho potentsialu pidpryiemstva v suchasnykh umovakh hospodariuvannia [Methods of estimation of enterprise financial potential in conditions of modern management]. Molodyi vchenyi, no. 8(2), pp. 49–52.

17. Navrotskyi N. O. (2017) Otsinka efektyvnosti vykorystannia resursnoho potentsialu pidpryiemstva [Assessment of the using efficiency of the enterprise resource

potential]. Mizhnarodnyi naukovyi zhurnal Internauka, no. 1(2), pp. 97–101.

18. Kostyrko L. A. (2015) Analiz potentsialu finansovoi stiikosti v systemi upravlinnia vartistiu pidpryiemstv [Analysis of the financial sustainability potential in the enterprise value management system]. Visnyk Skhidnoukrainskoho natsionalnoho universytetu imeni Volodymyra Dalia, no. 4, pp. 122–128.

19. Lytovchenko I. L., Shkurupska I. O. (2015) Otsinka synerhetychnoho efektu vid zastosuvannia intehrovanykh marketynhovykh komunikatsii [Assessment of the synergistic effect of integrated marketing communications]. Ekonomika Ukrainy, no. 5, pp. 29–39.

20. Shtefanych D., Diachun O. (2014) Otsinka efektyvnosti komunikatsiinoi polityky pidpryiemstva [Evaluation of the effectiveness of the enterprise communication policy]. Visnyk Ternopilskoho natsionalnoho ekonomichnoho universytetu, no. 1, pp. 111–121.

21. Romanenko L. F. (2016) Marketynhovi komunikatsii ta otsinka yikh efektyvnosti [Marketing communications and evaluation of their effectiveness]. Naukovyi visnyk Khersonskoho derzhavnoho universytetu, no. 21(2), pp. 96–98.

22. Chumachenko A. S. (2015) Rozvytok spozhyvchoho kapitalu na turystychnykh pidpryiemstvakh Khersonskoi oblasti [Consumer capital development at tourist enterprises of Kherson region]. Kherson: Ailant. (in Ukrainian)

TRENDS AND FEATURES OF FINANCIAL SUPPORT OF UKRAINIAN ENTERPRISES' INVESTMENT ACTIVITY

Vitalii Kuzmenko,
Ph.D. student of Corporate Finance and Controlling Department,
Kyiv National Economic University named after Vadym Hetman

Annotation. *The article focuses on the process of structural simplification and weakening of the national economic development potential due to its rapid de-industrialization and agrarianization. The volume of innovative products sales, the share of enterprises engaged in innovation activities and the share of expenditures on R&D in GDP are analyzed. The main trends in the area of investment activity financing within the timeframe of 2002-2018 are outlined. It is emphasized that the "fourth industrial revolution" requires mastering of innovative technologies. Therefore, the attention is paid to the increase of financial support for innovative technologies' realization and increasing the share of the total amount of R&D expenditures in the GDP of Ukraine to the level of more than 2,0%.*

Key words: *investments, innovations, scientific and technical activity, investment activity, capital investments.*

Research relevance. Nowadays, permanent economic cataclysms require a revision of economic development principles and an awareness of the global changes in the era of singularity. In this context, the attention is paid not only to the next geopolitical challenges or financial crises, but also fundamentally innovative circumstances of coexistence due to the Sixth techno-economic paradigm or the "Fourth Industrial Revolution". In accordance with technological background, this is based on the synthesis of information and physical, biotechnology and nanotechnology and means a transition from the domination of nature and the senseless consumption of its resources to the co-evolution of society and nature based on the philosophy of sustainable development and the introduction of innovation.

The instance of the new techno-economic paradigm represents a dilemma for all countries globally, namely: to master innovative technologies and join the mainstream of economic development to avoid finding themselves on the sidelines of the global economy. Thus, the restructuring of the Ukrainian economy requires significant amounts of investment financing, including investment in modernization within the high-tech and competitive goods production, as well as introduction of innovative technologies.

The major publications review. The study of financial support for the investment activity of enterprises in Ukraine has attracted the attention of many scientists. The scientific works of A. Peresada (2002), which cover problems of methodology of forms and directions of investment processes development in Ukraine and substantiate investment decisions aimed at economic development of the state, are considered as such of theoretical and practical value [1]. The particular attention should be paid to T. Vasilyeva (2010) research, which is devoted to the methodological provision of a mechanism for taking into account the innovative component in the structure of

macroeconomic indicators of economic development [2]. The co-authors' team led by S. Onyshko (2013) paid considerable attention to the interconnection of modernization and innovation structural transformations, to the formation of the financial mechanism for structural modernization of the economy [3].

A. Duka (2015) provided the theoretical principles and practical recommendations on improving the regulation of innovative and industrial development of the Ukrainian economy for the purposes of economic security [4]. T. Mayorova and S. Urvantseva (2016) investigated theoretical and practical aspects of financial potential formation for investment and innovative development of enterprises [5]. V. Zimovets, A. Danylenko and O. Tereshchenko (2019) distinguished the specifics and key disparities in business financing, investment activity and bank lending at the level of non-financial corporations sector as a whole and in terms of economic activities [6].

However, the need to revise the theoretical and practical provisions regarding the investment activity of enterprises and its activation at the expense of adequate financial support became urgent due to the situation in which the Ukrainian economy was in 2014-2019 (the need for a potential recovery of the East of Ukraine occurred in addition to the already existing economic problems).

The aim of the article is to study the level of innovation activity of enterprises, sources of costs financing for the implementation of basic and applied scientific research, as well as to study the patterns of investment activity of enterprises financing in Ukraine.

The main part of research. Our country has been able to fit into the global trend of post-industrialization within the timeframe of 28 years. In particular, the share of services in the country's GDP increased 1.7 times - from 30% to 51% during this timeframe. Ukraine is associated with a group of developing countries (world value - 69%) due to the current level of above-mentioned indicator.

At the same time, Ukraine has shown an impressive process of relative contraction in the industrial sector, entering the period of state independence with the hypertrophied large industrial sector, which makes almost 45% of GDP (for instance, the indicator it reached 50% in compartment with 30 -31% in the EU in 1992). The national economy has undergone a rapid process of reducing the role of industry. The process of Ukrainian post-industrialization is concerned as the result of the rapid de-industrialization under the influence of the loss of competitiveness in an open economy rather than the result of the rapid development of the services sector.

At the primary stage of market transformations, the share of agriculture in Ukrainian GDP was significantly overstated (25.6% in 1990). Although the initially trend was rather declining and decreased to 7.5% in 2007, the following period was connected with rapid agrarian sector widespread. In particular, the agricultural sector's share in GDP has increased to 10.1% of GDP in 2018 (this makes 12.0% in the structure of gross value added). This indicates the movement of the national economy towards the least developed countries of the world (on average 26% of GDP) [7].

Such structural evolution can hardly be explained by the manifestation of the existing advantages of the Ukrainian economy, because our country is not included

into the top 10 exporting countries within global markets of agricultural products and foodstuffs by the volume of supplies (according to the WTO statistics [8, c. 31, 112-113]), where the EU holds 1.5% with its agricultural output in GDP. Thereby, the Ukrainian economy shows a type of "structural reverse", namely the movement from the production of machinery to the food production. Even if this evolution has some positive socio-economic consequences, it is generally associated with the process of structural simplification, decreasing potential for economic growth and development. Thus, this potential cannot be increased without an adequate amount of investment.

The background of these processes was represented by indistinct dynamics of innovative products (goods, services) sales within the total volume of industrial enterprises sales. Thus, this indicator decreased by 11.75 times, namely: it was 9.4% in 2000 and only 0.8% in 2018. The average share of enterprises engaged in innovation activities was 12.7% during 2010-2018 (maximum made 16.6% in 2016, minimum made 8.2% in 2005). In accordance with the latest published statistics, only 777 enterprises were engaged in industrial innovation in 2018 (15.6% of target group). In accordance with the regional criteria, Kharkiv, Dnipropetrovsk, Kyiv and Lviv regions and Kyiv city have higher than Ukrainian average share of innovative enterprises.

About 22.4% of the internal R&D expenditures were spent on fundamental scientific researches, including 91.9% of researches funded from the budget, in 2018. The share of expenditures for the applied research implementation was 21.3%, namely: 58.1% expenditures were financed from the budget and 23.6% at the expense of business organizations. Almost 56.3% of the total expenditures were provided to support scientific and technical development, namely: 36.1% of expenditures were financed by foreign firms, 32.1% by organizations of the business sector and by 12.5% at the expense of business organizations. The general distribution of costs by funding sources for the implementation of fundamental and applied research together with scientific and technical development is shown on Figure 1.

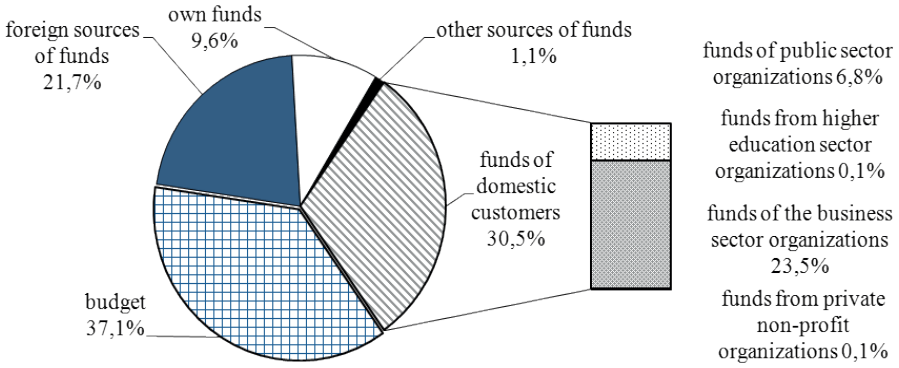


Fig. 1. The distribution of general costs for the implementation of scientific research and development by funding sources in 2018, %

Source: compared by author on the basis of [9].

Almost half of the expenditures on fundamental scientific research were in the field of natural sciences: 24.8% - technical, 8.7% - agricultural. About 37.8% of applied science expenditures were made in the field of technical sciences, 23.2% - natural sciences, 12.9% - medical and agricultural science. The main part of expenditures for the scientific and technical (experimental) development (88.9%) concerns the field of technical sciences [9; 10].

In 2018, the share of total R&D expenditures in GDP was 0.47%, including 0.17% at the state budget expense. At the same time, the share of similar expenditure in GDP of EU countries was about 2.06% in accordance with 2017 data. In particular, the share of R&D expenditure within the national economies was higher than average in Sweden (3.4%), Austria (3.16%), Denmark (3.05%), Germany (3.02%), Finland (2.76%), Belgium (2,58%), France (2,19%). The share of R&D expenditure was lower than European average in Romania, Latvia, Malta, Cyprus and Bulgaria (from 0.5% to 0.75%) [8; 10].

Thus, the experience of economic transformations in Ukraine shows the lack of possibilities to increase the volume of innovations implementation and to ensure the sustainable development of the country without the support of national and foreign investments.

A huge investment downturn occurred during the period of Ukrainian nation formation (1991-1997), namely the rate of decline in fixed capital investment was far ahead of the rate of GDP decline. The total capital investment volume was about 20% compared to 1990 within the national economy till 1997. At the same time, the share of investments relative to GDP was decreased by 5.3%. This reduction in investment has become particularly noticeable in the area of industrial production (from 72% in 1990 to 66% in 1997).

As a result, the level of fixed assets depreciation has grown rapidly. For instance, the indicator is 36.5% in 1990, 38% in 1997, 48.2% in 2005, the indicator increased to 83.5% in 2014 (Figure 2).

The reversal of the upward trend in the level of fixed assets depreciation became noticeable in 2015. These changes were caused by the write-off of capital assets within transport and communications sector. The measure of their depreciation decreased from 97.9% in 2014 to 51.7% in 2015. The total disposal amount was 9 779 bln UAH, including: 4 366.9 bln. UAH dropped out of the area of land and pipeline transport; 5 410.7 bln. UAH dropped out of the area of warehousing and auxiliary activities in the field of transport. At the same time, only 170.9 bln. UAH dropped out of this area yearly during the timeframe from 2010 to 2014.

This circumstance influenced the level of fixed assets depreciation within the national economy. For instance, it decreased from 83.5% in 2014 to 60.1% in 2015. At the same time, the share of fixed assets of the transport and communications sector within the total fixed assets volume decreased from 70.4% in 2014 to 18.6% in 2015. The industrial sector was the area with the largest volume of fixed assets (about 50.3% of fixed assets of the economy).

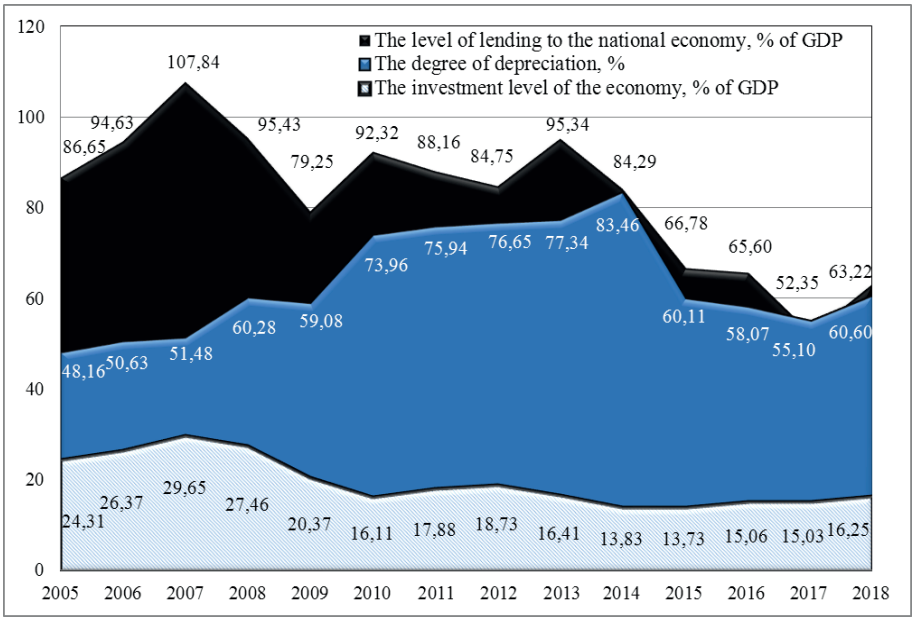


Fig. 2. The macroeconomic indicators of Ukrainian economy in 2005 – 2018 years
Source: compared by author on the basis of [9]

The change in the value of fixed assets in Ukraine in 2015 was the reason for the average level of deterioration within the national economy to get closer to the indicators of EU countries (in Poland, the level of fixed assets deterioration was 46.9% at the beginning of 2018) [11; 12].

However, the fixed assets renewal ratio, which characterizes the share of new fixed assets introduced to their total value at the end of the year, remained at the previous level, namely about 2% yearly (the same indicator is about 8% in Poland). In conclusion, the further decrease in the degree of fixed assets deterioration within the economy and the increase in the share of fixed assets within the industry are caused by liquidation process, avoiding investment and reproduction processes.

The state of fixed assets depends to a large extent on the structure and amount of financial resources that aimed at their updating. The private funds of enterprises are still the main source of fixed capital investment financing in Ukraine, namely: retained earnings and depreciation (about 63% of investments were financed from own funds from 2002 to 2018). It is important to pay attention to the fact that the long-term predominance of enterprises' own funds in the structure of sources of investments in fixed capital financing caused the dependence of the business investment activity on the indicators of their financial condition, particularly profitability.

At the same time, the negative effects of the global financial and economic crisis of 2008, which led to the bankruptcy of both banks and business entities with a high share of credit in the assets structure globally [13; 14], didn’t have a significant impact on the

structure of financing of fixed capital investments in Ukraine during 2009-2013 due to the predominant reliance of domestic entities on their own investment resources.

In accordance with the monograph co-authors [5, p.120] points of views, the expansion of investment activity at the expense of own funds is possible due to the tax burden reduction; enabling economic entities to use both straight and accelerated depreciation due to the objectives of their activity; establishment of a recovery fund for enterprises within their accounting policy for the purpose of using depreciation deductions for investment needs.

The role of debt capital increase within the national economy is one of the incentives for intensifying the business innovation and investment activity. Moreover, the debt capital is one of the most dynamic and understandable financial instrument for business entities and society that can significantly accelerate the reproduction processes, improving their quality. However, only 11% of investments in Ukraine were financed through bank and other kinds of loans from 2002 to 2018. At the same time, the majority of resources were from Ukrainian banks (84.5%), which is especially dangerous due to the reduction of their number (according to the Deposit Guarantee Fund statistics, 81 banks are in the process of liquidation as of mid-2019 [15]).

The total liquidation of banks caused two times reduction of the total volume of foreign direct investment (FDI) to Ukrainian financial sector in 2013 and another five times reduction in 2014 [16, p. 225].

The share of fixed capital investments financed by bank and other kinds of loans started to decline sharply from 2014. An average decline is 16% yearly in 2014-2017. In accordance with expert point of views, this was caused by a large-scale recapitalization of the financial sector within the national economy, as well as a slowdown in the growth rate of hybrid capital of non-banking financial institutions, which weakened the functional capacity of this sector to transform savings into investments. The consequences of the recapitalization of financial institutions were a loss of confidence in the financial sector and a decrease in the level of monetization of the national economy from 53.2 to 50.3% of GDP [17, p. 20].

If we pay attention to foreign investment (FDI), it is possible to define that foreign investors invested resources mainly to industry and wholesale and retail trade in 2015-2020. At the same time, new goods are emerging, the range is changing, costs and low commercial risks are quickly being paid off in these areas. In addition, the industries without long-term investment and new technology are popular, including the financial and real estate sectors.

The distribution of FDI, which were invested into Ukrainian economy, by type of activity is shown at Figure 3.

Although these investments are attracted by profitable industries, they do not strengthen enough Ukrainian economy competitive position on global markets. On the one hand, the excessive FDI into the financial sector provide circulating funds into the financial system. This contributes the stable liquidity of the national financial system. On the other hand, this creates the background for extensive development of the national

economy. The above-mentioned FDI structure does not allow Ukrainian economy to fully integrate into the global value chains and causes the low percentage of Ukrainian high-tech global export volumes, namely only 7.2% of the industrial export. The FDI do not meet requirements of national economy modernization and development of export of high-tech products that causes the consolidation of raw material specialization of the Ukrainian economy within the global market.

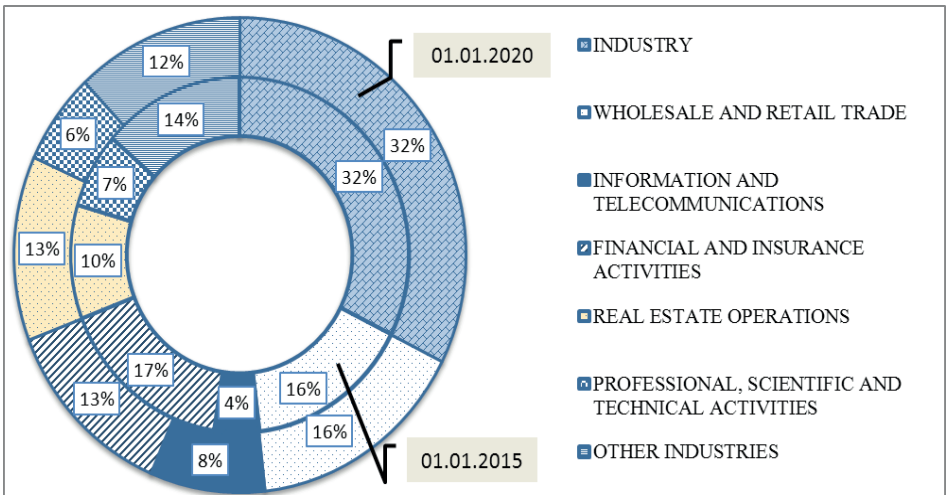


Fig. 3. The structure of FDI into the Ukrainian economy by type of economic activity
Source: compared by author on basis of [9]

Despite the fact that FDI were invested to the Ukrainian economy from about 130 countries in 2018, the main part of revenues is from a rather limited number of countries already within a long timeframe, namely Cyprus - 22.1%, the Netherlands - 19.1% and Germany - 15, 4%.

This fact indicates a rather limited geographical diversification of FDI exporting countries to Ukraine and suggests that two groups of capital create FDI flow into Ukrainian economy: directly owned by foreign residents and controlled by foreign companies of Ukrainian residents (Ukrainian capital previously taken out of the country into the offshore jurisdiction).

In particular, the total amount of FDI accumulated from such territories reached 13 045.7 mln. USD as of the beginning of 2018. This makes more than 33% of total FDI volume. The offshore investment displaces in this way the capital of developed countries from the Ukrainian economy and provides only quantitative indicators of FDI inflows to Ukraine, avoiding the qualitative ones. Thus, the return of offshore national capital takes place in the form of “foreign investment”.

The need to overcome the investment crisis and create the background for accelerating economic growth in Ukraine require direct government intervention in economic processes. At the same time, the attempt to carry out the national economic

policy on the basis of price liberalization, sale of state property at a price much lower than its real value, repressive monetary and financial policy, which caused the fall of investments, tended to failure.

For instance, there was a rapid decline in fixed capital investments at the expense of the state budget during 1991-1997. They have declined 15.5 times and their share in total investment has decreased from 27% in 1990 to 8.4% in 1997. The slow investment increase is noticeable since 1998. The top of the trend was in 2004, when the share of capital investments at the expense of the state budget was 11% of the total volume of investments and 2.3% of GDP. The above-mentioned indicator decreased by half already in 2005 and reached 5.5% of the total volume of investments and 1.2% of GDP accordingly.

The state of public financing of investments was also affected by the global financial and economic crisis of 2008-2009. In particular, at this time tax and non-tax revenues decreased, financing of the budget deficit was complicated. However, the balance became possible due to unplanned revenues to the state budget in 2008, namely: revenues were 231.7 bln UAH that makes 65.7 bln. UAH (39.6%) more than in the previous year. Thereby, the volume of investments from the state and local budgets continued to grow in 2008. The effects of the public investment crisis were noticeable only in 2009, when investment from the state and local budgets decreased by 42.23% and 58.05% respectively. There was an increase in public investment in 2009-2012. Their amount has doubled from 10 848 mln. UAH to 21 710 mln. UAH during three years. The increase in public investment was related to the EURO 2012 conduction and the implementation of infrastructure projects at the expense of budgetary allocations.

Together with adoption of the Concept of reform of the territorial power management, laws "On cooperation of territorial communities", "On voluntary association of territorial communities" and amendments to the Budget and Tax Codes on financial decentralization, the changes have also occurred in the structure of financing capital investments for the benefit of local budgets. Thus, the share of local budget funds in the structure of capital investment financing increased from 2.47% in 2013 to 9.27% in 2017. These changes create the possibility to form a thesis on the initial establishment in accordance with the European charter of local self-government in Ukraine, an effective and reliable local self-government institute.

Conclusions. It is summarized that the current geopolitical and economic crises, significant inflation expectations and financial instability have a negative impact on the investment climate of the country and complicate the attraction of national and foreign investments. These processes have a negative impact on the structural simplification and weakening of the potential of economic development of the country. Therefore, Ukrainian economy needs significant investment in order to master new technologies. The lack of decisive action in this direction may lead to the loss of competitive positions within the market and transformation into a raw material appendage to developed countries.

In such circumstances, the state and local budgets tend to become one of the most important sources of the enterprises' investment activity financing. The public

investment policy may be the driver of structural restructuring of the Ukrainian economy. The practical experience shows that this is the right direction for high and sustainable growth. Thus, the rapid entry of "Asian tigers" into the global economy was carried out with the participation of the state, which was actively involved in investment activities. Chinese phenomenal success in recent years is connected with both the regulatory role of the state and public investment into the economy [18].

At the same time, it is important to focus public finances, first and foremost, on supporting enterprises engaged in innovation and increasing the share of total R&D expenditures into Ukrainian GDP from 0.47% to at least 2.0%.

References:

1. Peresada, A.A. (2002) Investment process management. Kiev: Libra (in Ukr.).

2. Vasilyeva, T.A (2010) An innovative component in the structure of macroeconomic indicators of economic development. Sums: SHEI «UAB NBU». (in Ukr.).

3. Onishko, S.V, & Uninets-Khodakivska V.P. (2013) Financial mechanism of structural modernization of the Ukrainian economy. Irpin: Publisher of National University STS of Ukraine. (in Ukr.).

4. Duka, A.P. (2015) Investment support for innovative and industrial development of the national economy. Dissertation for Doctor of Economics. Kyiv. (in Ukr.).

5. Ilchuk, V.P. (2016) Innovation and investment principles of sustainable development of the core branches within the national economy. Chernihiv. Chernihiv National University of Technology. (in Ukr.).

6. Zimovets, V.V., Danylenko, A.I., & Tereshchenko, O.O. (2019) Companies' finance within the corporate sector of Ukrainian economy. NAS of Ukraine, State Institution «Institute of Economics and Forecasting of NAS of Ukraine». URL: http://ief.org.ua/docs/mg/311.pdf (in Ukr.).

7. World Bank's Databank. World Development Indicators. URL: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators

8. WTO. World Trade Statistical Review 2017. URL: https://www.wto.org/english/res_e/statis_e/wts2017_e/wts17_toc_e.htm

9. State Statistics Service of Ukraine (2019). Official web-site. URL: www.ukrstat.gov.ua (in Ukr.).

10. Scientific and innovative activity of Ukraine. Statistical collection. URL: http://www.ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/09/zb_nauka_2018.pdf (in Ukr.).

11. Fixed assets in National Economy in 2015. Statistical Information and Elaborations / Centralstatistical Office of Poland. Warszawa, 2016. URL: http://stat.gov.pl/en/topics/industry-construction-fixedassets/fixed-assets/

12. Bulletin of Public Information. Poland. URL: https://stat.gov.pl/obszary-tematyczne/przemysl-budownictwo-srodki-trwale/srodki-trwale/naklady-inwestycyjne-oraz-srodki-trwale-w-gospodarce-narodowej-w-2017-r-,2,1.html (in Pol.)

13. Jacobson T., Linde J. and Roszbach K. Firm Defaultand Aggregate Fluctuations.

Journal of the European Economic Association. — 2012.1-22 (in Pol.)

14. Ferrando A. and Mulier K. Firms' Financing Constraints: Do Perceptions Match the Actual Situation? ECB Working Paper Series. 2013. No. 1577. URL: http://www.ecb.europa.eu/pub/pdf/scpwps/ ecbwp1577.pdf

15. Individual Deposit Guarantee Fund. Official web-site. URL: http://www.fg.gov.ua/not-paying/liquidation (in Ukr.).

16. World Investment Report 2017. Unated Nations. Geneva, 2017. URL: http://unctad.org/en/Pages/DIAE/World%20Investment%20Report/World_Investment_Report.aspx

17. Danilenko, A.I., Zimovets, V.V., & Sheludko, N.M. (2015) Decapitalization of the financial sector of the Ukrainian economy: causes and consequences. Economics and Forecasting, 4, 7-28. (in Ukr.).

18. Zevin, L.Z. (2006) It is necessary to reasonably combine private and public investments. State investments in a market economy: limits and opportunities: round table materials. Moscow. 38–41. (in Russ.).

ASSESSMENT OF PRODUCTION POTENTIAL OF INDUSTRIAL ENTERPRISE IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

Yevhen Beltiukov,
Doctor of Economics, Professor,
Nataliia Matsko,
postgraduate student,
Odessa National Polytechnic University

Annotation. *The features and methods of production potential of an industrial enterprise estimation are investigated in the article. It is also proposed to take into account the environmental aspect of the enterprise's performance and to include the environmental component in the elements of the assessment of production potential. This will allow the formation and use of production potential within the framework of sustainable development.*

Key words: *production potential, assessment of production potential, assessment methods, sustainability.*

Formulation of the problem. The driving force behind the development of the country's economy is the development of the industrial sector. The efficient functioning of industrial enterprises provides for: the formation of GDP in a high-level country through the ability to generate corresponding added value; strengthening of competitive positions in the international market by improving the quality of products and reducing the costs for their production and sale; growth of investment attractiveness, which, in turn, improves the production capacity and provides the enterprise with the opportunity to develop in an innovative way.

Production potential plays a leading role in the development of both an individual industrial enterprise and the economy as a whole. The existing state of production potential directly influences the possibility of its reproduction and growth on an innovative basis. The higher the level of development of the components of the potential, the greater the opportunities for implementation of scientific and technological progress. Effective utilization of production capacity to the fullest extent and ensuring its development require competent management. In order to respond quickly to changes in the external and internal environment of the enterprise and timely management decisions, it becomes necessary to assess the level of production potential and obtain reliable information on the state of the components of the potential. Intensive industrial activity is marked by excessive environmental impact on the environment, which requires a transition to a sustainable development path.

Analysis of recent research and publications. The issues of formation, development and efficiency of utilization of production potential, as well as its competitiveness, have attracted the attention of many scientists, among them are works: S. Ishchuk [2], P. Pererva, N. Poberezhna [7], Y. Petrovych [8], L. Sachynska [9]. Methods and features

of the estimation of production potential were investigated in the works of scientists: V. Cherevko, O. Nakisko, S. Rudenko [1], I. Kryvoviaziuk [3], Ye. Mishenin, O. Dutchenko, T. Semenko [6], R. Tolpezhnikov [10], O. Khryniuk, T. Boiko [11]. Despite the large number of scientific works on the formation and features of the assessment of production potential, these issues remain relevant and require research and clarification due to the accelerated pace of scientific and technological development due to globalization. However, globalization necessitates the transition of industrial enterprises to the path of sustainable development, which also needs the attention of scientists.

Statement of basic materials. Assessment of production potential is the basis of managerial decision-making regarding adherence to the strategy of enterprise development and change of influence factors of functioning environment. Different approaches to defining the concept of production potential and its components led to the emergence of a variety of approaches and methods of its assessment. It is worth noting that there is no single method for assessing the level of production potential due to the lack of a single definition of its concept.

R. Tolpezhnikov [10, p. 104] systematized according the calculation method the basic methods of production potential estimation: equivalent, functional, correlation, cost and combined methods.

The estimation of production potential by the equivalent method is carried out by the value of any of its elements, in which other elements of it are translated by means of special coefficients. It is based on the interchangeability of elements. According to the functional method, the value of production potential is equal to the volume of production, and the values of its individual elements are determined by the specific gravity of the production, in the production of which these elements are crucial. The disadvantages of this method include: the magnitude of the individual elements of the potential have a relatively permanent nature, in contrast to the volume of production; the difficulty in accurately determining the participation of each of the elements in production; the method does not meet the definition of the essence of production potential, as a complex of production resources, not manufactured products. Correlation method - involves the use of different correlation-regression models to take into account factors of influence in determining the magnitude of production potential. The limitation in the application is the inability to take into account the sectoral features of management. By cost method, the cost of production capacity is the sum of the costs of its each element. The combined method involves the combination of different methods of assessing production potential. The disadvantages of this method are the complexity of the assessment process of production potential and limited practical value. However, a positive characteristic is the consideration of the sectoral features of the enterprises functioning.

Assessment of production potential within the cost method is carried out by evaluating its following components [11, p. 523]:

- production component - assessment of the status and use of fixed assets. The coefficients are calculated: upgrades, disposals, depreciation, receipts, share of machines and equipment in the total value of fixed assets, indicators of stockpile, assets and capital;

- material component - estimation of working capital and material resources. The following are calculated: material consumption of products, coefficient of turnover of material resources, specific weight of material costs in the cost of production;

- intangible component - valuation of intangible assets. The following are calculated: The coefficient of production returns of intangible assets, the factor of production capacity of intangible assets, the return on investment in intangible assets;

- personnel component - evaluation of industrial production personnel. The following are calculated: labor productivity, turnover factor, turnover from admission, turnover from disposal of technological personnel;

- information component - research of available knowledge and information technologies. Calculated: the proportion of the costs associated with the production or acquisition of scientific and technical information and its maintenance in relation to the total cost of the enterprise.

Determining the value of production potential through the estimation of enterprise value is based on the following approaches [10, 12, 2, 6]:

• effective (profitable) approach;
• comparative (market) approach;
• cost approach.

Note that these approaches are classified by the time of the estimate: the cost approach is formulated on the basis of past time, the comparative (market) takes into account the present time, the effective (income) approach assumes the future time.

Methods of effective (income) approach are: method of capitalization of income, method of discounting of cash flows, method of residual income. They allow you to forecast revenue from the use of the asset in the short and long term, followed by an increase in the current value of the asset by the amount of revenue.

The content of the benchmarking approach is to compare the characteristics of the property with that of a sale or lease transaction. The use of the method of paired sales, quantitative and qualitative analysis of sales, the method of expert comparison, the method of multipliers of comparison are envisaged. In this case, the level of production potential is crucial when making management decisions.

Cost approach methods, provided the necessary information base most accurately reflect the level of production potential of an industrial enterprise: comparative unit method, elemental calculation method, cost calculation method, index method, infrastructure cost accounting method, replacement method. The cost of an enterprise in this approach is determined by the cost of creating (restoring or replacing) a similar entity.

In turn, I. Kryvoviaziuk [3] outlines the following methods and indicators of estimation of production capacity [3, p. 208]:

• group method - potential is considered as a set of production resources of the intended purpose, and its value is equal to the sum of the physical values of the constituent elements.

• by Kozachenko's approach - a complex characteristic of the level of production potential.

• estimation of the production potential of the enterprise on the basis of the analysis of the level of effective use of structural workplaces (CPM).

• measurement of the size of the production potential of the enterprise on the basis of elemental approach: the potential of fixed assets, the potential of industrial-production personnel, the cost of energy resources, the cost of technology, the cost of information. The sum of the costs of the elements of production potential is its total value.

• assessing the efficiency using the basic elements of the enterprise's production potential.

The scientists P. Pererva and N. Poberezhna [7] propose to evaluate the production potential from the point of view of production resource efficiency (financial, material, human and information) in the internal and external environments of functioning according to the indicators characterizing the enterprise's achievements and its capabilities.

A characteristic feature of production potential is that it has a dynamic character and its magnitude depends on the influence of a set of different factors. The set of such factors can be represented by two integral groups: technical, technological and organizational-economic direction [8, p. 195]. Factors of technological orientation are at the heart of the formation of the level of production potential competitiveness, since their influence forms the technical and technological base of the enterprise. They stipulate measures for updating and modernization of the technical and technological component of production potential and materialize in a qualitatively new technical and technological base of the enterprise. Organizational and economic factors play an equally important role in the formation of competitive production potential. Competent management is capable of generating the potential of a high-level enterprise. The management of the company is tasked with providing investment opportunities for projects of development of technical and technological base, improving the level of qualification of personnel, conducting market research in order to achieve the goals of the strategic plan. The combination of a strong technical base and a competent management organization provides the company with a synergistic effect and high competitive position in the market.

Along with the implementation of scientific and technological progress in production, the level of economic development is also influenced by the external environment, so it is advisable to evaluate and search for reserves of capacity building in the context of its competitiveness.

Capacity building should be based on analysis of market conditions, analysis of competitors' actions and availability of solvent demand. The methods of estimating the level of its competitiveness are the instruments of substantiation of the necessary capacity building. With these methods it is possible to estimate the existing competitive status of the enterprise, i.e its position in the market. The weaknesses of the enterprise identified in the course of the assessment are opportunities for progressive capacity building along with the development of competitive advantages. The results of the competitiveness assessment of the enterprise are the basis for determining the priority areas of activity for the development of its potential.

Qualitative assessment methods generally have a low level of mathematical

formalization, they are characterized by the complexity of implementation and the discretion of assessment. They do not allow the use of competitiveness assessment in the process of analysis and identification of priority areas for strengthening competitive positions in the market. Quantitative methods make it possible to assess the real chances of an entity in competition for attractive strategic areas of management and to make sound, tactically and strategically, managerial decisions [9, p. 145].

Talking about the assessment of production potential can not ignore the environmental aspect of its formation and development. We propose to include in the elements of the assessment of production potential (the potential of fixed assets, the potential of industrial production personnel, the cost of energy resources, the cost of technology, the cost of information) environmental component within the elemental method of assessment, because the results of production activities are marked by excessive negative environmental impact.

Assessment of the environmental component requires the allocation of relevant indicators characterizing the environmental aspect of the enterprise results.

According to the Methodology for assessing the effectiveness of implementation of regional environmental protection and state (national) targeted environmental programs of Ukraine, indicators of the implementation of environmental objectives are divided into the following types [5]:

• type 1 - indicators of the success of the process (regulatory, organizational, scientific) of ensuring the implementation of the environmental program;

• type 2 - environmental load indicators: volume of emission reductions; the share of emission reductions from the total; reducing the density of atmospheric emissions with respect to a specific area; reducing the ratio of industrial emissions to atmospheric air to GDP, etc.;

• type 3 - environmental performance: reducing the number of days in which atmospheric air pollution exceeded the limit value; reducing the content of pollutants in soil due to man-made soil pollution (by indicative indicators), etc.

In [4, p. 857] proposed a generalized system of the assessment indicators of the environmental component, which consists of two evaluation areas: cost and natural.

Valuation of environmental component is carried out in the following groups:

• indicators that characterize capital investment;

• metrics that reflect current costs;

• indicators characterizing environmental payments;

• indicators that characterize additional revenues and expenditures;

• Indicators reflecting other costs caused by the mismatch of environmental characteristics to administrative and market requirements.

Groups of estimation of natural (resulted) indicators:

• a group of indicators that characterize the environmental-destructive impact on recipients;

• a group of indicators characterizing the peculiarities of the functioning of production, technical and environmental systems.

The results of the assessment should be investigated in dynamics and in comparison with the leading international industrial enterprises in order to objectify the evaluation. Each enterprise includes its specific indicators in the environmental management program depending on the specific activity.

The implementation of environmental management has a positive impact on both the environment and the results of the enterprise. The rational consumption of production resources and the possibility of recycling will significantly reduce the production costs of the enterprise. Also, the implementation of measures to reduce harmful emissions allows to save money on state sanctions and penalties. Searching for possibilities of optimization of consumption of production resources leads to introduction of innovative technological processes and updating of technical base of production. All this ensures the company to increase its competitive position in both national and international markets. Sustainable development enterprise has the opportunity to reach markets more widely, in particular by meeting international environmental requirements.

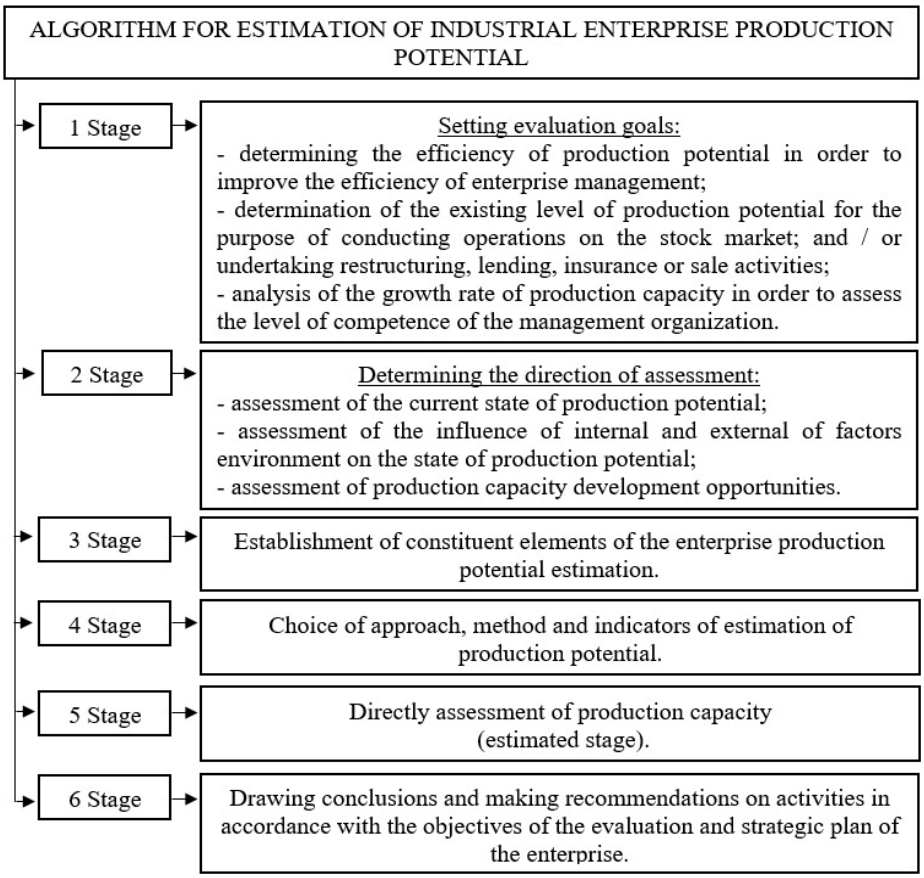


Fig. 1 - The algorithm of industrial enterprise production potential estimation
Source: by the author

Therefore, after identifying the approaches, methods and indicators of production potential estimation, it is necessary to determine the algorithm for estimating the production capacity of an industrial enterprise, which is presented in Fig. 1.

The first step in assessing production capacity is to identify the reasons for the need for such an assessment. According to the objective, it is necessary to determine the level of capacity utilization, the available capacity level and / or the dynamics of the capacity level. The objectives of the assessment determine its direction: the assessment of the existing state, the assessment of the factors of the influence of the operating environment on the state of the potential and / or the determination of competitiveness and capacity development potential. Once the components of the production potential have been identified, the methods and indicators of their evaluation have been selected, the evaluation process takes place directly. Based on the findings of the study of the state of production potential, recommendations are given that meet the purpose of the assessment and strategy of the enterprise. Performance indicators require periodic monitoring in order to make effective management decisions on changes in the qualitative and quantitative structure of the potential.

Conclusions. Consequently, the study of methods of assessing production potential indicates a large number of them. Assessment methods and indicators vary depending on the resource concept or the concept of competitiveness. The most versatile measure of production capacity is cost. Cost allows you to bring the elements of potential into a single content and explore the dynamics of their condition.

However, existing assessment approaches do not take into account the environmental aspect of the enterprise's performance, which is a disadvantage in the context of sustainable economic development. Considering the environmental component is necessary because of the excessive environmental impact of production activity. The development and implementation of an environmental management program enables industrial enterprises to improve their performance by reducing production costs and increasing production intensity. At the same time, compliance with national and international environmental standards opens up new markets and increases the competitiveness of the enterprise.

References:

1. Cherevko V. D., Nakisko O. V., Rudenko S. V. (2017) Typolohiia ta implementatsiia metodychnykh pidkhodiv do otsinky vyrobnychoho potentsialu ahrarnykh pidpryiemstv [Typology and implementation of methodological approaches to the assessment of agricultural enterprises production potential]. Actual problems of innovative economy, no. 1, pp. 28-33.

2. Ishchuk S. O. (2008) Kontseptualni zasady formuvannia ta rozvytku vyrobnychoho potentsialu promyslovykh pidpryiemstva [Conceptual principles of formation and development of industrial enterprises production potential]. Regional economy, no. 3, pp. 48-56.

3. Kryvoviaziuk I. V. (2017) Ekonomichna diahnostyka. 2-he vyd.: navch. posib.

[Economic diagnostics. 2nd edition: study tool]. Kyiv: Center for educational literature. (in Ukrainian)

4. Maliuk O. S. (2017) Formuvannia systemy pokaznykiv otsinky ekolohichnoho potentsialu vyrobnychoho pidpryiemstva [Formation of indicators of the system of estimation of ecological potential of a production enterprise]. Economy and society, no. 9, pp. 853-858.

5. Ministerstvo ekolohii ta pryrodnykh resursiv Ukrainy (2012) «Pro zatverdzhennia Metodyky otsinky efektyvnosti realizatsii rehionalnykh pryrodookhoronnykh ta derzhavnykh (zahalnoderzhavnykh) tsilovykh ekolohichnykh prohram» № 2146/22458 ["On Approval of the Methodology for Assessing the Effectiveness of Implementation of Regional Environmental Conservation and State (National) Targeted Environmental Programs" № 2146/22458]. Ministerstvo ekolohii ta pryrodnykh resursiv Ukrainy.

6. Mishenin Ye. V., Dutchenko O. M., Semenenko T. O. (2017) Otsinka potentsialu pidpryiemstva: konspekt lektsii [Assessing the potential of the enterprise: lecture notes]. Sumy: Sumy State University. (in Ukrainian)

7. Pererva P. H., Poberezhna N. M. (2012) Vyznachennia efektyvnosti vykorystannia vyrobnychoho potentsialu mashynobudivnoho pidpryiemstva [Determination of efficiency utilization of machine-building enterprise production potential]. Marketing and innovation management, no. 2, pp. 191-198.

8. Petrovych Y. M. (2015) Osnovni chynnyky pidvyshchennia konkurentospromozhnosti vyrobnychoho potentsialu promyslovykh pidpryiemstv [The main factors for increasing the competitiveness of the industrial capacity of industrial enterprises]. Lviv Polytechnic National University, pp. 193-197.

9. Sachynska L.V., Bedin O.V. (2012) Formuvannia konkurentospromozhnosti potentsialu pidpryiemstva ta yoho otsinka [Formation of competitiveness of enterprise potential and its assessment]. Ekonomichni nauky. Seriia: Oblik i finansy. Zbirnyk naukovykh prats [Economic sciences. Series: Accounting and Finance. Collection of scientific works] (electronic journal). Available at: http://archive.nbuv.gov.ua/portal/soc_gum/en_oif/2012_9_3/33.pdf (accessed 12 February 2020).

10. Tolpezhnikov R. O. (2012) Metodyka otsiniuvannia vyrobnychoho potentsialu pidpryiemstva [Methods of assessing of the enterprise production potential]. Economy and region, no. 6, pp. 102-106.

11. Khryniuk O. S., Boiko T. O. (2015) Vyrobnychyi potentsial pidpryiemstva: pidkhody ta metody yoho otsinky [Production potential of the enterprise: approaches and methods of its evaluation]. Global and national problems of economy, no. 7, pp. 521-526.

PUBLIC ADMINISTRATION

STATE INTEGRATION POLICIES OF UKRAINE IN THE CONDITIONS OF GLOBALIZATION

Ivan Shkurat,
Ph.D. of Sciences in Public Administration,
Associate Professor of Department of Political Sciences,
Pereyaslav-Khmelnytsky State Pedagogical University
named by Gregory Skovoroda

Annotation. *The article deals with the concept of "globalization", analyzes and summarizes its advantages and disadvantages for Ukraine. It has been researched that Ukraine has the potential to become not just a European but a global state, and if it adopts and develops global values, it will be able to become even "above" Europe. It is substantiated that globalization in general and world economic relations, in particular, is an objective process that expresses the totality of conditions for the development of the modern world community and, above all, scientific, technical and economic progress. This is an inevitable stage of the ascension of humanity to new horizons, which ultimately has positive beginnings, but at the same time is not devoid of serious and large-scale contradictions, and therefore does not exclude negative influences.*

Key words: *globalization, European Union, integration, Single economic space, innovative development, politics.*

Articulation of issue. Globalization in general and world economic relations, in particular, is an objective process that expresses the totality of conditions for the development of the modern world community and, above all, scientific, technical and economic progress. This is an inevitable stage of the ascension of humanity to new horizons, which ultimately has positive beginnings, but at the same time is not devoid of serious and large-scale contradictions, and therefore does not exclude negative influences. Today, Ukraine is an active participant in many global events. Therefore, before planning, doing, building long-term strategies, we need to find out where we are today, in which coordinate system, we are the object or subject of a particular process.

If you look at Ukraine from a global perspective, it is part of the Euroregion, where in recent years there have been quite active, sometimes dramatic processes of disintegration and unification of large social systems characterized by internal modernization and involvement of large populations. Undoubtedly, these events cannot be ignored by politicians and scientists. Participation in a process that is not clear makes such a participant the object of the process, and real knowledge makes it possible to influence and benefit from the course of events. We believe that the essence of the process of globalization is that no phenomenon (economic, social, legal, political, military, etc.), any process in society, in our lives, however large or, by contrast, small, can not be considered as themselves. The interconnection and interdependence of individual actions, phenomena

and processes is intensifying, requiring the consideration and evaluation of the opposite effect, of all consequences, both close and distant, in the immediate and remote areas.

Analysis of recent research and publications. This topic has been investigated by many domestic and foreign scholars and practitioners, in particular V. Andrushchenko, V. Volynka, V. Liakh, V. Pazenko, M. Mikhalchenko, R. Voitovich [1], E. Zagrava [2], O. Molnar [3], Y. Pavlenko [4], A. Pechnik [5], Y. Prisyajnyuk [5], V. Sidenko [7], S. Sokolenko [8], T. Ratuwohery [6], O. Toffler, R. Robertson, M. Castells, F. Fukuyama, S. Huntington, and others. Scientists have thoroughly explored the main problems and prospects of integration policy in Ukraine in the time of globalization.

The purpose of the article is to explore the concept of "globalization", its main directions, advantages and disadvantages in the context of Ukraine's integration policy.

Presenting the research findings. Globalization is a relatively new and highest stage in the development of the process of internationalization of numerous aspects of social life [3]. Globalization as a universal form of historical dynamics leads to qualitative and quantitative changes in the functioning of transitional societies [1].

E. Zagrava in his book, "Globalization and Nations" argues that only a strong state is capable of pursuing an active and effective state policy. And he sees the source of this power as an alternative to the national sector [2, p. 52].

According to V. Sidenko it is possible to speak about the high probability that at the first stages of implementation of the concept of integration development within the Common Economic Space (hereinafter – the CES) there will be a discrepancy in certain economic parameters with the standards of the European Union (hereinafter – the EU) [7]. For example, there is a problem of harmonization widespreading of Ukraine's economic mechanisms with the CES member states. At the same time, we have similar commitments to the European Union. So in alignment with which economies do we focus? Perhaps it should be made clear that we will coordinate economic parameters within the CES solely on the basis of the provisions of European Union law. However, today the CES agreement does not.

Another issue is the creation of a customs union for the CES member states. However, in the documents fixing its European choice, Ukraine sets itself the task of joining the customs union with the EU. And the agreement on the Single Economic Space also aims at creating a customs union and does not spell out the answers to the question how to combine the two tasks. Instead, one can hear the argument that first we will achieve competitiveness through integration into the CES and then integrate into the European Union. So, to deepen integration with the CES countries only to leave it? This is logical.

It is necessary to develop a unified strategy for European integration, in which both the processes of our accession to the European Union and the development of opportunities in the post-Soviet space are clearly coordinated – with the focus on the formation of a wide European economic space [7].

According to political scientist Tantelli H. Ratuwohery, what Europe is now proposing is not globalization. After all, there will be enough restrictions for genuine liberalization, genuine political and economic freedom. Now Europe has created a wall,

protecting itself from all, and in particular from Ukraine. In order to enter the EU, Ukraine must already have the preconditions for itself to rise and be at the level of the European state [6]. The country has the potential to become not just a European country, but a global state, and if it adopts and develops global values, it can become even higher than Europe. Europe is now living rather than global but European values, and globalization is only an element of bargaining for it. As soon as Ukraine is able to overcome Europe's limitations on its own, Europe itself will be interested in Ukraine becoming a part of it. Therefore, the question is whether Ukraine will be able to use the world's resources not only to survive but also to influence others. And its purpose must be to organize itself and to absorb global values beyond the narrow borders of Europe.

It is also illustrative of how Japan operates, which, in the absence of large energy resources, was able to carry out its policies so as to obtain and receive them in the future. Ukraine should behave in a similar way, not adjusting to anyone, but building its own policy on a global scale. After all, until the Ukrainians learn to use other people's resources effectively, Ukraine will not become a global state [6].

Developing this opinion S. Sokolenko, a well-known Ukrainian economist, president of the International Market Promotion Foundation, emphasizes that the innovative development of society is possible under the condition of the state policy of promoting entrepreneurship through its various forms, as well as encouragement at the level of enterprises of the development of entrepreneurial talent in their own employees. [8, p. 35]. That is, summing up what the scientist said, it is possible to state that innovative development of society is possible under the condition of a widespread, universal and universal initiative.

Based on the scientific achievements of these and other researchers, we will try to find out Ukraine's place in the international coordinate system and the most probable vector of development, which is derived from the sum of external and internal vectors that affect our country. The framework, in this case, is the process of globalization against which all processes unfold. If they coincide with the dominant directions of global development of society, then their strength is much greater, and if on the contrary - contradictory, it leads to their damping.

In order to enter the EU, Ukraine must already have the prerequisites for itself to rise and be at the level of a European state. The country has the potential to become not just a European country, but a global state, and if it adopts and develops global values, it can become even higher than Europe. Europe is now living rather than global but European values, and globalization is only an element of bargaining for it. As soon as Ukraine is able to overcome Europe's limitations on its own, Europe itself will be interested in Ukraine becoming a part of it [5].

As we can see, the experts' opinions regarding the depth of Ukraine's involvement in globalization processes are somewhat different, but everyone is unanimous in the fact that there are large reserves to use them to their advantage. The vast majority of researchers believe that Ukraine has little openness to the world and is not actively promoting its ideas, products and services to the outside world and is poorly attracting foreign investment.

Let's note what prevents this. First, the image of Ukraine in the world as a corrupt state. Secondly, the functioning of the Ukrainian economy does not comply with international legal standards in terms of taxation system, regulatory system, transparency of financial transactions, etc., which is the cause of unfavorable investment climate. Third, despite the high level of declarations made about the need to attract foreign investment, there is in fact no sound effective public policy strategy to create a favorable investment climate. Ways to create such a climate: low tax rates, stable political and legal system, identified priority areas for attracting investment, creating special zones and more. Fourth, it is necessary to regulate the work of foreign transnational campaigns (hereinafter – TNCs). They have to create modern production in our country, and the Ukrainian state, for its part, has to create favorable conditions for them to want to invest in Ukraine, but in such a way that it does not harm their own business.

According to some experts, Ukraine is too open to the world, but somewhat one-sided. The structure of Ukrainian exports is dominated by products of chemistry and metallurgy, that is, almost raw materials [5]. With regard to political integration, we agree with experts who advise not to be attached to one particular center of political gravity, but to interact with all powerful states in the areas most relevant to Ukrainian interests.

Ukraine's increasing role in globalization will increase with its economy, internal consensus on key foreign and foreign economic orientations, strengthening of the political system and having its own strategic plan for including the country in globalization processes. Ukraine is very little involved in globalization processes. This is due to the fact that Ukraine is a fairly closed country that is not integrated into international economic and very specifically integrated into international political relations. Of course, one cannot be free from globalization as globalization progresses. Therefore, of course, the manifestations of globalization affect us as well. However, if we consider the positive and negative aspects of globalization, Ukraine mostly does not use the positives, while being affected by the negatives of globalization.

If we consider the most widespread negatives of globalization, we can speak of the dominance of some wealthier country in the economic and even cultural sphere. They also include the commercialization of cultural values, the subordination of the world to the interests of powerful transnational corporations, and more.

Speaking about globalization, it is necessary to distinguish two aspects of it - objective and subjective. The first reflects the trends of world historical development, the sources of which can be traced to the late primitive, and especially from the era of the Great geographical discoveries. In this regard, globalization is an objective and natural aspect of human development. However, in recent decades, due to the emergence of transnational corporations, the service of the leading Western and Japanese powers to their interests, as well as world informatization – the objective tendencies of globalization are increasingly artificially and purposefully directed towards securing the interests of the world capital. This goes, as a rule, to the detriment of most underdeveloped and underdeveloped countries, which are increasingly experiencing poverty. Unambiguously answered, economic or political spheres dominate globalization processes are hardly

possible. Globalization in its current form is subordinated to the interests of the world capital (transnational corporations) operating, using the military-political power of the leading Western powers, especially the United States. However, these states themselves, especially the United States, are leading the global globalization process in the pursuit of their own geopolitical interests, largely autonomous to those of leading multinationals.

In modern Ukraine, ambiguous and insensitive position in terms of geopolitical self-identification. The point here is, first of all, in the contradiction between the economic and political interests of our establishment. In economic relations, we have nothing to expect from the West. Western investment is insignificant and does not relate to the development of advanced technologies, and Western markets remain and will remain virtually closed to us. However, the Ukrainian authorities are seeking the wing and custody of the West. The latter defines her declarative statements (little confirmed by real actions) about aspirations for Euro-Atlantic structures. On the other hand, the real markets for Ukraine are the Caucasian and Central Asian states, as well as the countries of Asia and Africa, where our goods can be successfully sold [4].

Ukraine must integrate into international economic relations and find its real place and opportunities to maximize the benefits of globalization and minimize the negatives. Given the current state of the national economy, given the various ratings, it is difficult to say that Ukraine will soon become a leading country. Therefore, one must realistically consider his role and place in the world. It should be guided by European values and position itself as a European country. However, it is not fundamental whether Ukraine is a member of the EU or not. Examples can be given of Switzerland or Norway, which are not EU member states but are European states.

Integration into the CES can really lead to improvement of the quality of work of Ukrainian enterprises, to increase of budget revenues, to improvement of financing of social sphere, and well-being of the population. Therefore, if the EU is a strategy, a common course, then the CES is a tactical current case that would allow to a certain extent to revive the national economy, which would again raise the standard of living of citizens.

Ukraine's economic interests (energy production, export opportunities for its goods, etc.) orient Ukraine to the East and South - Central Asia, China, Iran, and others. However, because of fears of strengthening Russia's political dominance, the Ukrainian establishment and much of society, especially in the western regions, are seeking a full rapprochement with the West and joining the Euro-Atlantic structures. The event is really interested in minimizing Russian influence in Ukraine, but it is not going to open its markets for our goods, invest in our economy any significant funds and share with us the latest technologies. The contradictions between the economic and political interests of Ukraine determine the duality and inconsistency of its foreign policy.

Ukraine is not sufficiently involved in globalization processes. However, the global development of globalization involves Ukraine and our political elite. As soon as our nationally conscious political elite begin to save money in Ukraine, there is a prospect that Ukraine will have a special national factor to consider. However, if you look at world processes, there are several features worth noting. Ukraine as a territorial space is

interesting enough for world political players.

The territory of Ukraine can become a field of positional, intellectual and technological wars for the right to influence the world space. Ukraine is not interesting because it has some achievements. However, it has technological and other resources, it is interesting as a geostrategic space, as a transit territory. Ukraine is interesting as an experiment of passing a large territory from one political and economic system to another. Our state is the optimal form where, avoiding civil conflict, one can create structures that either integrate into the world community (meaning transatlantic community) or be integrated into the East (not necessarily negatively colored by this concept) and accepted traditions of the East [3].

For objective reasons, Ukraine cannot, in principle, play a prominent role in the global globalization process. This is due to its low position in the world economy, lack of national consensus on key issues of foreign economic and foreign policy orientation, weakness and contradiction of the political course, and many others. Ukraine could only increase its role in the global globalization process in the conditions of rapid economic development on an innovative basis, reaching a public consensus on the most important issues of internal and external strategy development and, therefore, a decisive, independent foreign policy course without constant review of the instructions whatever they came out of).

As for the other aspect of globalization – integration, Ukraine's desire to integrate both into the EU and the CES raises some questions. Thus, the European Union not only prevents but also seeks to stimulate the development of regional economic cooperation among the countries with which it has partnerships. In particular, the concept of the European Commission "Wider Europe", which offers new opportunities for accession to the European economic structures of neighboring countries (including Ukraine), provides for the promotion of cooperation and development of free trade between these countries [1]. However, the problem is that it is impossible to combine the two integration processes if the principles of their construction are incompatible. In this respect, there are significant problems in the Single Economic Space Agreement, signed in September 2003, in terms of its compliance with Ukraine's European integration course. Unfortunately, the agreement has no guarantees of basing this process on EU principles and there is no clear guarantee of using this mechanism as a mechanism for joint entry into the European Economic Area.

Therefore, it is possible to speak about the high probability that already in the first stages of implementation of the concept of development of integration within the Common Economic Space there will be a mismatch on certain economic parameters with the standards of the European Union. For example, there is a problem of widespread harmonization of Ukraine's economic mechanisms with the EEA member states. At the same time, we have similar commitments to the European Union. So in alignment with which economies do we focus? We may need to make it clear that we will coordinate economic parameters within the EEA solely on the basis of European Union law. However, today the CES agreement does not.

Conclusions. It is impossible to avoid the impact of globalization processes. Ukraine is still poorly involved in these processes. The reasons for Ukraine's low level of involvement in global global processes are the unwillingness and unwillingness of the political elite to participate in them, primarily due to the lack of a global outlook and lack of knowledge of foreign languages; lack of consensus in society regarding the direction of development of the country; the absence of powerful domestic transnational corporations. The exit is seen in the rotation of the elites, the creation of their own TNCs, the conduct of their own independent policies, subject to widespread public support, adopting a national course on globalization.

There is no consensus among experts as to the prospects of Ukraine's integration with the EU and the CES, but Ukraine must be as close as possible to all possible unions, etc. which provide it with security and markets. To do this, one must strive to be the subject of integration initiatives under any circumstances.

Ukraine needs to come up with a unified strategy for the globalization of the country, in which the processes of our accession to the European Union and the Common Economic Space and to other existing ones will be clearly coordinated and that will bring about unions, organizations and unions. The national interests of Ukraine are the measure of evaluation of any arrangements. Active entry into the global world requires adequate staffing, creation of its own TNCs, harmonization of all systems of the country to the international standards of its own flexible policies, subject to widespread public support, adopting a national course for globalization.

References:

1. Voitovich R. (2012). Globalization as a universal form of the historical dynamics of transitional societies. Bulletin of the National Academy of Public Administration under the President of Ukraine. Vol. 1, pp. 21-32.

2. Zagrava E. (2002). Globalization and nations. Kyiv, Phoenix, 64 p.

3. Molnar O. S., Popovich I. O., Tokar M. M. (2018). Globalization is an important factor in contemporary international economic relations. Formation of market relations in Ukraine. Vol. 11, pp. 20-24.

4. Pavlenko Yu.V. (2000). Globalization and its contradictions. Science and science. Vol. 3, pp. 11–23.

5. Pekhnik A. V. Prisyajnyuk Yu. I. (2018). Transnational corporations in the realities of modern international business. Collection of scientific works of Cherkasy State Technological University. Series: Economic Sciences. Vol. 51, pp. 82-90.

6. Ratuwuheri T. H. (1993). Conceptual problems of Third World Development Policy. Candidate's thesis. Kiev.

7. Sidenko V. (2012). Modification of the world economy under the influence of the newest factors of the global transformation crisis. Ukraine economy. Vol. 5, pp. 18-31.

8. Sokolenko S. I. (2002). Production systems of globalization: Networks. Alliances. Partnerships. Clusters: Ukr. context. Kiev, Logos, 645 p.

PHILOSOPHY AND THEOLOGY

IMPLEMENTATION OF THE SYSTEMATIC APPROACH TO EDUCATION

Olga Avyerina,
Candidate of Philological Sciences, Associate Professor,
Associate Professor of the Department of Management,
Information-Analytical Activity and European Integration,
National Pedagogical Drahomanov University

Annotation. *the study is the author's attempt to present and substantiate the feasibility of a single system-forming idea that would be a basis for philosophical understanding of modern education.*

Key words: *education, systematic approach, idea, concept.*

Throughout the history of mankind, each generation has certainly faced the issue of optimization of the educational process. Each historical stage is characterized by its system of knowledge transfer. There is a national, regional specificity of understanding the phenomenon of education and organization of training. There are, after all, a lot of personal aspects in the educational process that every teacher (educator, coach, mentor) brings in.

Traditionally, education is investigated as a process of a person's multifaceted development which contributes to his/her self-improvement and mastery of the socially significant experience of humanity embodied in knowledge, skills, creative activity and emotionally value-based attitude to the world. In the course of education, there is a transfer of expertise, knowledge and skills from generation to generation in all spheres of culture which is a necessary condition for the society activity in the reproduction of material and spiritual spheres [3; 6].

Education, in its advanced forms, is implemented by a set of educational institutions that make up the educational system of society. Therefore, it is conventional to consider the modern educational systems as supercomplex systems, with their principles, levels and components.

The systematic approach implies a certain position of the researcher who captures the study subject as high quality, holistic and variable. Within the systematic approach to the problems of education, there are two types of specific research. In the first case, the systematic approach allows describing the complex object in its synchrony revealing the composition and structure. It focuses on structural and functional relationships between elements. That is, it separates components, hierarchies and dependencies as if in a static version. In the second case, the systematic approach concentrates on education as a result of the development of the primary element of the system, that is, diachrony. For example, educational levels and their logical sequence over time [4, 5].

These two approaches accurately describe the complex educational system of society but the complexity prevents from perceiving and understanding the subject as a whole and lacks insight into the mission of education. Knowledge about the subject (education) should be such that its individual parts are combined into a single picture satisfying the systematic approach.

In our view, to implement the systematic approach means to understand the essence of the phenomenon through an integral Idea which clearly reflects the phenomenon mission, content, goals and structure.

An example of this systematic understanding of the phenomenon of man is the Ancient Vedic Doctrine based on the idea of the Chakra system. The existence of a human being is understood as the interaction of 7 major centers responsible for a person's organs, systems of the body, emotional and spiritual state. Thus, the mission of Ayurveda as a medical philosophy is to restore balance and harmony of a person's physical, spiritual and intellectual life. Understanding the human psyche is based on the Idea of the structure of consciousness proposed by K. Jung which is successfully used by psychologists, neurologists, physiologists, epistemologists as it is accessible, effective and working. A system of legal regulation based on the integral Idea - hypothesis-disposition-sanction - also works effectively at most.

Education is a significant and interesting component of any person's existence. The issue of systematic education is of fundamental importance to all professionals and organizations involved in this field globally. Therefore, the integral Idea as a basis for understanding this phenomenon is so much required.

From our point of view, the simplest and most elegant Idea was formulated yet by Socrates. The ancient Greek philosopher discovered the universal formula of human being: To be - To do - To have. Even today, there is no need to deny this simple truth because it sounds like the secret of a successful individual life in modern language. Socrates explained the conditionality of the three main components. At first a person must know him/herself, understand what he/she is worth, then learn how to make certain products and benefits that will be interesting to others, and only after that expect to be paid and have dividends. The formula proposed by the great thinker at once gives meaning and synergy to human existence.

As noted above, education aims to transmit socially meaningful experience to new generations, to reproduce the fullness of the cultural context and human existence. We consider it appropriate to use this universal formula as an integral idea for analyzing the educational system. Thus, in our opinion, the following algorithm should be at the heart of the educational system of society

TO BE – TO DO – TO HAVE

To substantiate this thought, let us turn to the chronological concepts of a person's development. Pythagoras, Socrates' compatriot (VI century BC), compared the stages of life with seasons: from birth to 20 years of age - the period of formation ("spring"); from 20 to 40 years of age - youth ("summer"); from 40 to 60 years of age - the flowering of forces ("autumn"); from 60 to 80 years of age - old age and fading ("winter").

Hippocrates (V-IV centuries BC) divided human life into 10 periods - 7 years each, and Aristotle divided childhood and adolescence into three stages: from birth to 7 years of age; from 7 to 14 years of age; from 14 to 21 years of age. The ancient Romans separated 5 phases of life with duration of 13 to 15 years each [1; 9–10].

Ancient thinkers had an intuitive sense of the age difference in everyone's life. The theories presented by famous psychologists, physiologists and geneticists - J.Piaget, L. Vygodskiy, B. Ananyev, D. Elkonin, O. Leontyev, S. Rubenstein, V.Stern, etc. were scientifically grounded. Each of these researchers studied a specific aspect of human psycho-emotional and intellectual development in the context of the epistemological paradigm. D.Bromley, J.Piaget, G.Craig presented their theories of periodization of a human life analyzing age-related differences in feelings, behavior and thinking.

All the specified concepts are united by the modern Age psychology where most researchers agree that the educational process for a person is permanent, it concretizes self-development of personality. The algorithm To Be – To Do – To Have acquires existential content and is realized throughout life. The systematic approach has a temporal dimension (diachrony) here embodied in a three-component system:

SCHOOL – HIGH SCHOOL – ADULT EDUCATION

In our view such a Model implements the systematic approach to education and embodies the integral idea To Be – To Do – To Have. The specified three-component system is a result of the analysis of cognitive theory of personality development. That is, we have linked the education system to the stages of cognitive, intellectual development.

So the first component of the Model is called the School and we include the whole complex of pre-school, extracurricular and secondary school education in this concept. The period from 0 to 19 years of age is extremely important for the formation of each personality. Based on the recommendations of age psychology a person has to form his/her own "Self-Concept", that is To Be, during this life period. He/she needs to understand for him/herself who he/she is, what he/she is capable of, to learn to analyze his/her physical and mental state, to develop emotional and mental intelligence, to acquire communication and social skills. It is a period of searching and mastering new things, a period of continuous active learning.

The most authoritative approach to understanding cognitive development is the concept of J. Piaget. The researcher studies a transition from one form of thinking activity to another, from a simple structure of mental activity to more complex and the factors of those transformations. He examines the similarity and difference between mental intellectual life of a child and an adult. Piaget believes that the development of a child's mental activity is influenced by maturation, experience and current social environment (education, upbringing). He considers that biological maturation of an organism plays a primary role in the intellectual development, and the effect of maturation is to open up new opportunities for the organism to develop. J. Piaget himself and most of his followers determine the period from 0 to 20 years of age as the period of final physiological and psychological formation of the basic mental structures [7]. The period from 0 to 19 years of age is characterized by active learning that is why we define it as SCHOOL.

We think that the School subsystem should be divided into the following components:

1. Early development
2. Preschool education (kindergarten)
3. School (Junior + Secondary)

Early development involves a period of 0 to 3 years of age and aims to adapt a child to life. Until recently, education from 0 to 3 years of age has fully been the function and prerogative of an infant's family and has been mostly implemented as child care. However, dating from the 70-80's of the XX century a number of researchers (M.Montessori, G.Doman., J.Dalto, S.Lupan, N.Zaytsev, P.Warner, M.Ibuka, Sh.Suzuki, M.Saas, G.Newfeld and others) have proved that the development of a young child's cognitive processes is well underway: attention, memory, thinking, language are rapidly developing [1].

The paradigm of early development has become relevant. It generalizes a large number of theories and practical methods which are partially implemented in pre-school institutions and mostly represented by various private early development schools, sports and health institutions which children attend together with their parents. In our view, early development is a major component of the general education system. That is why it should be implemented through licensed educational institutions, projects, information channels, under the protection of the national education system.

Preschool education is represented by a network of kindergartens with specific features. Since, as we have noted, intellectual development is derived from physiological development the primary task of pre-school education is to care for a child's health, physiological, psychological and social adaptation to life and sensitive development.

School is the period from 7 to 19 years of age during which all cognitive structures are formed. In our opinion, the successful completion of this training period is the formation of Self-Concept. It will certainly evolve and change over the course of life but if a person aged 20 knows clear answers to the most of questions about him/her - he/she has self-awareness, self-esteem and unique Self-concept accordingly. The formed Self-concept also implies awareness of own professional directions, to which sphere of activity one seeks or has the ability. It will help avoid a mistake during career orientation and choose a specialty by avocation.

Talking about the essence of school education, it seems appropriate to refer to the Theory of Multiple Intelligence by American Psychologist Howard Gardner which has been first published over two decades ago in his book "Frames of Mind: Theory of Multiple Intelligence". According to Gardner's theory, a person has not a single so-called "general intelligence" but a number of intellectual abilities that make up verbal, logical-mathematical, visual, kinestatic, interpersonal, intrapersonal, musical, naturalistic and existential types of intelligence. Each of these types of intelligence has its own structure, functions, language and therefore is a special potential for development. This theory has received worldwide recognition as one of the most innovative theories of cognition of human intelligence. The Theory of Multiple Intelligence confirms what educators deal with every day: people think and learn in many different ways [2]

Therefore, the modern education is designed to give an opportunity to know oneself, to understand one's advantages and limitations. The school should set interdisciplinary goals and teach ways and means to achieve them.

Studies have convincingly shown that the period of 18-25 years of age is characterized by intense development of mental functions, their frontal progress. In this period, memory and thinking develop most intensively. Abstract thinking begins to play a dominant role in cognitive activity, a generalized picture of the world appears, deep links among various aspects of the reality being studied are established. According to D. Wechsler, the evolution of intellectual functions covers the period from 19 to 30 years of age. The apex of lexical functions reaches its maximum at the age of 40. After 30 years of age, there is a decline in intellectual functions associated with motor skills [6]. Therefore, the period of 18-30 years of age is optimal for vocational training and skill development.

HIGH SCHOOL, the second component, is an environment for a person's professional development where he/she learns to DO - to concretize desires, knowledge, efforts, to create his/her own product.

The system of higher education institutions provides an opportunity to master a profession, to become a specialist in the chosen field. Higher education will effectively fulfill its mission if the following principles are observed:

1. Anthropocentrism. It assumes that a student (a cadet, an aspirant, a listener, an applicant, etc.) is always in the highlight of any educational system, any educational institution. The educational process should be focused on the student, his/her interests and aspirations. That is, the High School is not a recruitment hub for industries or the Country. It is rather a professional and scientific Hub (environment) filled with opportunities to create oneself as a specialist and a professional.

2. The Principle of Knowledge Quality. Quality of learning is one of the most debatable issues, due to the lack of clear and definitive criteria. What should we put into the concept Quality for educational activity: academic success of students, scholarly status of staff, effectiveness of study, opinion of students themselves, popularity of an educational institution, rating? Therefore, we are talking about the Principle of Knowledge Quality - knowledge can be delivered in a qualitative, that is, systematic, meaningful, timely, organized, accessible and effective way. When educators work as a cohesive professional team every teacher is interested in creating the best educational products and technologies, the learning process acquires quality characteristics.

3. The Principle of Corporativity. Corporativity in this context is understood as the interconnection of people willing and able to work together. It is extremely important for a person's professional development to communicate with other experienced or well-known representatives of a particular profession, to have examples to follow, to be aware of trends, achievements, best accomplishments in a chosen field. Architect students should be involved in design projects of outstanding and ingenious structures of the present, physics students - in the work of the newest experimental laboratories under the guidance of a well-known professor, medical students seek to consult with doctors who have hundreds of successful surgeries under their belt, and postgraduate students

should continually participate in scientific discourses with distinguished academics and professors. The social experience of student communities (fraternity, team, league, movement, union, etc.) is also useful. For example, everyone knows the power of informal communication and support among Ivy League members. Creation of a single professional reality motivates, develops a future specialist, combines knowledge with practice, widens a circle of acquaintance, makes an educational process rich in events, advances interest in the profession.

Thus, a specialist provided with knowledge, skills, abilities, potential and aspirations for self-realization in a profession, capable of creating his/her own professional reality and professional product, confident in his/her professional choice can be considered a result of the High School, as a part of the educational system.

The third level of our education system is ADULT EDUCATION. It covers the longest period of a person aged 30-80. What do cognitive development professionals say about this period? The second phase of early adulthood is marked by the fact that this period is characterized by a new differentiation of individual sides of intelligence and at the same time - a higher level of its overall integration. Thus, the period of 34-37 years old covers the second peak of the development of an adult's thinking, closer links among imaginative, verbal-logical and practical thinking. W.Owens and L.Sheffeld believe that verbal-logical functions reach the first optimum in early youth, then they can grow till the age of 50. B.D. Bromley has evaluated verbal and non-verbal functions in people aged 20-80. Already at the age of 30-35 there is a gradual stabilization and further reduction of non-verbal functions up to the age of about 40. However, it is during this period that the verbal functions progress most of all and reach a maximum after the age of 40. Verbal-logical functions are progressing even when the involution of old age has already struck the non-verbal intelligence and sensorimotor of a person [6].

When being engaged in various forms of creative activity, an adult's intellectual activity reaches the highest level. Experimental studies of domestic and foreign researchers have shown that the punch line of scientific creativity covers the age of 35-40 and 40-45. The average maximum of creative activity for many specialties is noted at the age of 35-39. In this case, the highest rates of creative ability are manifested up to the age of 30-34 in such sciences as mathematics, physics, and chemistry. Outstanding discoveries in many areas of science are made by individuals abound 40 years old. Later, the probability of such discoveries begins to decline. A period at the age of 30-34 as well as 47-57 is the most favorable for scientific creativity; 47 years old are the most productive in terms of scientific contribution and total usefulness [6].

Thus, after the age of 30 years old, cognitive intelligence continues to transform and social intelligence develops actively. Only after realizing his/her professional abilities (TO DO) a person can expect a reward (TO HAVE). The period after 30 years old is a period of active social life and establishing equal exchange with others.

According to V.Sheiko, a person who successfully copes with a professional definition reaches a certain level of development of independence and moves to another stage of use of cognitive abilities - a period that includes social responsibility. At the

middle age, according to V.Sheiko, a person uses cognitive abilities to solve other people's problems: in the family, in the society, at work, etc. He assets that the core of cognitive development in adulthood is not the increased ability or change in cognitive structures but the flexible use of intelligence at different stages of life [6].

After receiving basic higher education, during all further time a person has an active personal, professional, emotional, social, spiritual life. Therefore, the third educational component - ADULT EDUCATION - becomes relevant. It is the study throughout life. There are a number of reasons for the urgent need of an adult in education:

- The need to build, expand and deepen existing professional skills is a horizontal career. Anyone who wants to be a true pro in his/her field should periodically improve his/her skills, constantly develop, and study new technologies and techniques.

- The need to obtain additional professions. When a teacher goes to the level of a headmaster or a doctor - to the level of a hospital head they need management knowledge, management education. When a skilled IT professional wants to realize him/herself in business he/she will need a high school of business. When any specialist goes into politics he/she needs oratory skills.

- The need to gain new knowledge for personal life. Bringing up children parents may need additional knowledge in child psychology or pedagogy. To solve health problems, people seek medical knowledge and explanations. Development of creating abilities - artistic, musical (hobby), spiritual development - may also require teachers, mentors and technologies.

-The need to completely change professional orientation. Thus a person can work as an economist all his/her life, and then decides to become a landscape designer and fully learns this trade. Or a person's profession has become out of date, and retraining becomes a way out of a difficult life situation.

Conclusions. Therefore, the need for adult learning is urgent and education as a system must formulate an appropriate proposal for public inquiry. The market for lifelong learning services today can be characterized as progressive. It is developing at a rapid pace but is chaotic, dispersed and uncontrolled. Most educational services are provided on-line. High technology usually offers endless opportunities for everyone, educators and listeners alike. It has undeniable advantages - accessibility, saving of time, financial resources, informativeness and more. On-line services provide a great choice for the students: one can study in a prestigious Higher education institution, visit the author's master class of a famous Guru, gain knowledge from different fields simultaneously. However, there is also a significant drawback - such an ease in the implementation of the educational process makes this industry accessible and attractive for lay amateurs who spread pseudoscience.

In our view, adult education should be the prerogative of legitimate educational institutions, a field of realization of the educational potential of teachers who provide knowledge in a professional and qualitative way. Adult education is the third component of the education system that needs further study and development.

Throughout this study, the author has argued for the systematic approach to

education implemented in the Idea of three-dimensional principle SCHOOL – HIGH SCHOOL - ADULT EDUCATION. We have come to the conclusion that at each stage the educational process is designed to form a certain intellectual stratum: Self-Concept-Professional Concept-Social Concept. In this case each subsequent stage includes the previous one and is impossible without it. The aforementioned approach embodies the transparent and clear Socratic formula of TO BE-TO DO-TO HAVE.

References:

1. Gamezo M.V., Gerasymova V.S., Gorelova G.G., Orlova L.M. Age Psychology: Personality from Youth to Old Age: Textbook. - M.: Pedagogical Society of Russia, Noosphere, 1999. - 272 p.

2. G.Gardner. Frames of Mind: Theory of Multiple Intelligence. - M. Dialectic-Williams, 2018. - 512 p.

3. Education as a Planetary Phenomenon: Monograph / L.A.Alexeyeva, R.A.Dodonov, D.E.Muza, F.V.Lazarev, V.M.Talanov et al; Donetsk National Technical University, 2011. - 270 p.

4. Osmanova I.Yu. Systematic and Systematicity - the Basic for Building Content of Higher Education. [Electronic resource] - Access point: https://superinf.ru/view_helpstud.php?id=1500

5. Systematic Approach. Directory 24. [Electronic resource] - Access point: https://spravochnick.ru/psihologiya/metody_prikladnoy_psihologii/princip_sistemnosti/.

6. Development of Cognitive Sphere in Early Adulthood. [Electronic resource] - Access point: https://pidruchniki.com/1728092437111/psihologiya/rozvitok_kognitivnoyi_sferi_period_rannoyi_doroslosti

7. Flavell J.H. The Developmental Psychology by Jean Piaget / Transl. from English; with a foreword by Jean Piaget. - M.: Prosveshcheniye, 1967. - 622 [Electronic resource] - Access point: http://elib.gnpbu.ru/text/fleyvell_geneticheskaya-psihologiya-piazhe_1967/

THE TYPES OF RELEVANCE WITHIN INFORMAL LOGIC

Viktoriia Babyuk,
Ph.D. student,
Taras Shevchenko National University of Kyiv

Annotation. *In the paper I focus on the relevance criterion of argument evaluation. The purpose of the article is to find out the relevance notion base value in argument evaluation. To achieve this goal I, firstly, analyze the peculiarities of a real argument. Secondly, I compare informal and formal-dialectical models of argument evaluation. Thirdly, I review the relevance criteria specific features and try to structure the main types of relevance into one system. I conclude that premissary relevance is necessary for good argument, while dialogical and audience-relevance - for effective argumentation.*

Key words: *informal logic, argument evaluation, audience-relevance, premissary relevance, dialogical relevance.*

Introduction. The notion of relevance firstly appears within logics in the terms of the non-classical logical theory of the middle of XX century, called relevance logic. Here relevance means some content relation between reasoning premises and conclusion. However, the proving of relevance presupposes some artificial procedures, such as complete formalization and mathematical proof. All these moves relevance logics away from analyzing arguments of everyday life, which people really use in their communication.

However, the relevance understanding has got the second life within the argumentation theory. Particularly, I mean informal logics with its evaluation issue. The meaning of the relevance notion has not changed in the broad sense. Nevertheless, the place, role and the subject of relevance has altered fundamentally. It has led to the new senses of this notion, which reveals themselves in the real argument analysis.

Before describing the relevance peculiarities, I would like to outline the main questions, informal logics asks in this regard. What means “a good argument”? What are criteria for its goodness evaluation? What should people do to be relevant in their conversations?

Therefore, one of the main informal logics issues is an argument evaluation. I must admit, there are few approaches to an argument analysis within the argumentation theory. There are pragma-dialectics, formal dialectics, and informal logics among them. All of them produces their own standards and criteria for argument evaluation.

As understood from the text above, this paper is devoted to the relevance criterion. It can be found, first of all, within informal evaluation model. However, relevance criterion also is included implicitly to the formal-dialectical evaluation model, as argued bellow.

An argument evaluation models. The argumentation theory way of argument analysis principally distinguishes from formal-logical way. First of all, it caused by the specific features of an argument informal logics deals with.

Firstly, the argumentation theory analyzes an argument, which is used in real everyday

discourse. A kind of returning to rhetorical and dialectical origins we can observe on such a tendency. The characteristics of an argument content begin to play the key role in its evaluation. Charles Hamblin, the pioneer of formal-dialectics, notes in this respect: "If P, then Q" form is not a real argument at all, but only a hypothetical argument (…). A real argument has real premises and conclusion, not hypothetical ones" [5, p. 233].

The tendency to pragmatism, represented by real argument analysis, is inherent also to the informal logics. Thus, R. Johnson and A. Blair, the informal logics founders, define "argument" as "a claim, together with one or more sets of reasons offered by someone to support that claim" [7, p. 10]. Such a definition clearly represents the pragmatic tendency since it involves "someone", from which is expected some reaction and answer. Therefore, the understanding of an argument used in everyday (including political and social) discourse represents here. It is called "a real argument".

The purpose of real argument author is to make it good (not necessarily valid) and, thereby, effective. The validity as formal-logical evaluation criterion fails in the real argument evaluation. It can provide the following logically form of the premise-conclusion relation. However, real arguments can be good without being valid. The premises supporting of the conclusion is the relation here, which is enough to evaluate an argument as good.

The second specific feature of a real argument is its dialogical nature. Douglas Walton defines a dialogue as a framework of an argument [12, p. 26]. Certainly, people argue in the dialogue, expecting answering or at least silent interpretation of the interlocutor. A real argument uses to persuade or justify the thesis. For this purpose, it has, firstly, to be understood, secondly, to be accepted. Otherwise, if an argument is detached from the real communicative situation, it becomes artificial and hypothetical.

The third real argument feature is its inherent link with the communicative situation context and the participants informational background. In this regard much attention is paid to the missed premises, implicatures and audience-relevance notion within the contemporary argumentation theory.

These things determine the specific way of a real argument evaluation. The classic view to this issue involves three criteria to estimate an argument goodness.

The conventional is RAS-criteria evaluation model within informal logics. It includes three criteria: relevance, acceptability and sufficiency. Besides this, the dialectical evaluation model was formulated by Ch. Hamblin within formal-dialectics. Both of them involve the relevance criterion for argument evaluation explicitly or implicitly.

Let me describe the important aspects of these evaluation models.

An informal evaluation model is formulated in the fundamental book "Logical self-defense" by R. Johnson and A. Blair in 1977. This work gave birth to the informal logic, principally new branch of investigations at that time.

This model includes the criteria of acceptability, relevance and sufficiency. For this reason, it is called ARS-model (ARS-triangle). It provides an argument making without the most common logical fallacies. Incidentally, such criteria set out merely for particular fallacies analysis. However, namely this evaluation model became the most popular with

informal logicians.

The dialectical evaluation model is developed by Charles Hamblin in 1970. It includes next points. Firstly, the premises must be accepted by the speaker. Secondly, the premises-conclusion transmission must be accepted. Thirdly, such a transmission has to be reasonably immediate. Besides these, missed premises must be accepted as omissible, and the conclusion cannot be accepted without premises supporting it [5, pp. 244-245].

At first sight, there is nothing common between informal and dialectical criteria. However, I suppose the nature of informal acceptability and Hamblin's "accepted premises" is similar. Moreover, the second and third dialectical criteria can be described as requirements of relevance. Because the accepted kind of premise-conclusion relation is only relevant kind. To my mind, we can even find some correlations between sufficiency criteria and Hamblin's claim about omissible premises. However, the sufficiency criterion is not enough clearly articulated on Hamblin's set of criteria, and it is presents rather implicitly.

It means both evaluation models involve the relevance, sufficiency and acceptability criteria. The only difference is its explicit presence on ARS-triangle, and availability two extra requirements in the dialectical evaluation model.

The relevance criterion. In this paper I would like to focus primarily on the relevance criterion. Relevance marks the presence of premises-conclusion relation at all, while the other two criteria (sufficiency and acceptability) relate rather to the premise's characteristics.

Thus, my issue is to define, what the relevance criterion means within informal logics? What are the types of relevance?

Answering my first question I would like to appeal to the Anthony Blair view on this issue:

A consideration that is irrelevant to the proposition being argued for just does not belong to the argument, so an argument cannot have irrelevant premises, though of course someone's argument-what is presented as or taken to be an argument-assuredly can. So, relevance is not a criterion of a logically good argument, but of argument itself. [1, p. 147]

The similar is Douglas Walton viewpoint:

The main function of the concept of relevance...is to keep the discussion within productive boundaries. Used for this purpose, relevance fulfills what can be called a gatekeeping or exclusionary function in argumentation [12, p. 2].

As can be seen, both of logicians perceive the relevance function forming boundaries of premise-conclusion relation. Every irrelevant reason intended to be involved to the argumentation has to be excluded from it.

This interpretation stresses on the normative aspect of the relevance criterion. However, on my opinion, it can guide to some misunderstanding of the relevance in argumentation. In the real-life communication participants often fail relevance in their argumentations. The hearer, in most cases, I suppose, perceives such an argument as a whole, including irrelevant premises. Thus, I would like to stress on the practical side of relevance in argumentation. For the hearer, at this point, relevance excludes nothing from

argumentation. He gets all the information speaker puts on the argument. Exclusionary function, therefore, correlates with argument evaluation aspect. However, it plays no practical role for the average hearer.

Returning to the issue of the relevance definition, the most common one looks like the premise correspondence to the conclusion. Actually, both Blair and Walton consider relevance as crossing out every premise irrelevant to the topic of the conclusion. Only those premises, which have probative force to the conclusion, may be involved to the analysis as real reasons on the argument [2, p.92].

Besides this, I'd like to appeal to J. Freeman, who focuses on three factors necessary to be included to an argument. There are premises, conclusion and "a claim that the premises support the conclusion". [4, p. 325] The last component is the most significant in the terms of the relevance notion.

According to D. Hitchcock, an argument relevance presupposes a component, which is common for premises and conclusion. It has to be a field of contextual claims, which provides the understanding of conditional link by the hearer of an argumentation [6, p. 131-137].

Let me admit, D. Hitchcock view is very close to the relevant logics understanding of relevance. Whereath p entails q if and only if q contains information, that is a part of information contained in p, accordingly to the relevance logics [10, p. 226].

To sum up all these definitions, relevance in the broad sense means the criterion to evaluate, do premises really support the conclusion. The fine thread that run through the premises and conclusion meaning to link them into a whole one is provided by namely relevance.

The types of relevance. Relevance provides the connection between the premise and the conclusion it pretends to support. However, relevance is also a contextual notion. The same premise can be relevant in some dialogue or part of dialogue, and irrelevant in the other [11].

Such a complexity relates with the fact that there are few types of relevance within informal logics. I suppose, it is useful to group the types of relevance onto three levels.

I would like to note, I do not take into account the notions of topical and probative relevance, because these types relate to the specific of premise-conclusion supporting. While I describe here the place of relevance type in the argumentative communication in terms of the scope of the argument consideration.

This classification can help to improve understanding of the relevance notion. It includes the main types of relevance identified within informal logics:

- relevance within an argument;
- relevance to the dialogue or other type of communicative discourse;
- the argumentation relevance to the audience (interlocutor, hearer, viewer).

I refer to F. Paglieri and C. Castelfranchi paper called "Trust, relevance and argumentation" in this issue. The authors distinguish external and internal relevance kinds. External, or argument relevance deals with argument connection with dialogue topic. Internal, or premise relevance relates to premise-conclusion supporting [8, p. 217].

The narrowest level of relevance includes only internal elements of an argument. I suppose, it includes two types of relevance identified within informal logics.

Firstly, it is the premises relevance to the conclusion, also called premissary relevance, suggested by A. Blair. Thus, premissary relevance represents the internal relationships within an argument [2]. I must admit, this type of relevance relates to an argument, not to the argumentation process. It does not relate to the pragmatic aspect of communication, but expresses the presence of premises and conclusion contents relation.

Secondly, it is propositional relevance. Referring to G. Bowles, propositional relevance is the kind of relevance, "that one proposition can have to another" [3, p. 65]. Essentially, propositional relevance is very close to premissary one.

To consider a little further the propositional relevance specific, it is appropriately to recall Bowles' distinction of favourable and unfavourable relevance. If propositions are favourably (positively) relevant, then one proposition makes another certain or probable. If propositions are unfavourably (negatively) relevant, it means, in contrast, that one of them makes another uncertain or impossible. Therefore, there is only one case of propositional relationships, which is not above-mentioned. I talk about irrelevance, which takes place, if one proposition makes another neither certain, nor impossible/probable. This is what helps us to understand the relevance essence. Hence, relevance existed between two propositions only if one of these propositions causes in any way the change of the other proposition meaning [3, pp. 66-73].

Obviously, propositional relevance is a broader concept, than premissary one. However, we can equate propositional and premissary relevance in the sense, that they maintain a relation between internal parts of an argument, whether abstract propositions, or particular premise and conclusion.

As can be seen, premissary relevance is the basic level of relevance at all because an argument, irrelevant on this stage, cannot be external relevant. On the other hand, internal relevance is useful for only part of argument evaluation. Taking into account, that argumentation is the speech acts complex, premissary relevance alone cannot provide argument effectiveness.

The next level can be called external relevance according to F. Paglieri and C. Castelfranchi. I compare it with Douglas Walton dialogical relevance notion. Dialogical relevance deals with an argument connection with a dialogue or part of dialogue, on which it occurs. On this view, dialogue is the argumentation frame, which determines an argument relevance or irrelevance. I must admit, dialogue is considered as conversational exchange, which can be shorter or longer, contain different passages and shifts. That is why an argument can be relevant to one of dialogue part, while irrelevant to the others.

I have to note, real argument can never occurs detached from the context in the face of a communicative discourse. An argument is wholly dialogical, it is oriented to the hearer in every case. It is just a type of conversation, which has its own peculiarities. However, an argument nature is the same as other communicative acts. Dialogical relevance shows us the necessity of an argument connection with the other parts of conversation.

The last and the broadest relevance level includes so-called audience-relevance. The

author of this notion is Christopher Tindale, the rhetorical approach to an argumentation representative. I suppose, audience-relevance can be included to the external relevance in spite the fact, that F. Paglieri and C. Castelfranchi are confined to dialogue relevance analogue.

Audience-relevance is the point of intersection between the argumentation theory and pragmatic linguistics. Thus, Ch. Tindale borrows the notions of cognitive effect, cognitive environment and others from relevance theory, one of the cognitive linguistics approaches.

The main idea is the argument has to be relevant to the audience, to which it is directed. An argument is relevant to the audience if it has a contextual effect. In the other words, if it makes context better, completer and more useful for an argument understanding. Thus, the premise is relevant to the audience if it adds some information, without which audience cannot understand the reason of the conclusion. Besides this, an argument has a contextual effect if it, firstly, allows the conclusion supporting; secondly, provides the justification of the thesis (or supports the reasons for its objection) [9, p.178]

The other relevance-audience side relates to the cognitive effect notion. It means the relevant argument always takes into account the audience's cognitive environment. Let me to note, cognitive environment contains all possible audience's beliefs and knowledge on the argument thesis topic. Thus, cognitive environment is the context of argument understanding, that is why its change leads to the change of those premises an audience can perceive. In the other words, we can never justify the thesis about the Mars colonization ability for the audience, which participants know nothing about Mars (for example, for medieval monks). In this regard it is necessary to take into account the other side of this issue. If the argument evaluator (or other independent observer) notices the argument irrelevance despite the fact of speaker and audience understand one another, it says us about the possibility of missed premises. Such premises can be the part of the common context or background [9, p.183].

The other useful notion, borrowed from the relevance theory, is optimal relevance notion. According to Tindale, the argumentation is optimal relevant if it is maximum relevant to the audience, and is possible to be understood with the minimum efforts.

For Tindale, this type of relevance is basic in relation to the other relevance types [9, p.191]. On this point, Blair notes that if an audience favor becomes the criterion of the argument relevance, it can lead to some relativism [2, p.191].

Naturally, it has to be used more basic criteria, besides audience-relevance, which would objectively guarantee an argument goodness. However, Tindale proposes the condition, which save the theory from relativism. The rhetorical approach uses Perelman's notion of universal audience. Rational speaker makes his argument counting on the rationality, or more exactly reasonableness, of the audience of this argument. Thus, belief in the total rationality in the argument interpretation process is the foundation for the proponent to make really rational argumentation, which can be evaluated independently of the concrete audience [9, p.195, p. 217].

It is necessary to admit, audience-relevance does not provide an argument

effectiveness. It is just a necessary condition of its understanding. On my opinion, it is an important feature of rhetorical understanding of relevance, which relates to the origins of audience-relevance notion.

Conclusions. Underlying all above, I must admit that relevance is the basic notion for argument evaluation. It is due to the fact that an argument just cannot exists without relevant relation between premises and conclusion. The other side of relevance principal status in argument evaluation relates with many different levels. Internal relevance (premissary, or propositional), external dialogical and external audience-relevance are among them. All these levels reveal different sides of argument process. I am sure, that rhetorical aim of an argument effectiveness, which correlates with argument practical usefulness, is achieved through argument relevance on all three levels together.

References:

1. Blair J. A. 2004. Argument and Its Uses. Informal Logic, Vol. 24, No. 2: pp.137-151

2. Blair J. A. 2012. Premissary relevance. Groundwork in the Theory of Argumentation Springer Science+Business Media B.V., P. 355

3. Bowles, G. 1990. 'Propositional Relevance', Informal Logic 12, 65–77

4. Freeman J. B. 2005. Acceptable Premises: An Epistemic Approach to an Informal Logic Problem, 395 p.

5. Hamblin, Ch. L. 1970. Fallacies. Methuen young books; 1st edition: P. 326

6. Hitchcock D. 2000. The Significance of Informal Logic for Philosophy Informal Logic, Vol. 20 № 2: pp. 129-138

7. Johnson, R.H., Blair J.A. 1994. Logical Self–Defense. McGraw-Hill, Inc., US edition: P.312

8. Paglieri F., Castelfranchi C. 2014. Trust, relevance, and arguments, Argument & Computation, 5:2-3, 216-236

9. Tindale Ch. 1992. Audiences, Relevance, and Cognitive Environments// Argumentation Vol. 6, pp. 177–188

10. Voishvillo E. 1996. A theory of logical relevance Logique et Analyse. Nouvelle série, Vol. 39, No. 155/156, pp. 207-228

11. Walton D. 1999. Dialectical Relevance in Persuasion Dialogue Informal Logic Vol. 19, No.2&3 pp.119-143.

12. Walton D. 2004. Relevance in Argumentation, Lawrence Erlbaum Associates. Publishers, Mahwah, New Jersey: P. 311.

PEDAGOGY AND PSYCHOLOGY

STUDENT CLUB AS A MEANS OF FORMING CORPORATE CULTURE IN HIGHER EDUCATIONAL INSTITUTION

Oleksandr Tadlya,
Senior Lecturer,
Kyiv National University of Culture and Arts

Annotation. *The stages of formation and improvement of corporate culture in higher education institutions are systematized in the article. The main directions of the improvement of the corporate culture system through means of the activity of student club are determined. Views on the role of the corporate culture in the development of an educational organization are analyzed.*

Key words: *corporate culture, concept of corporate culture, corporate values, corporate rituals and holidays, cultural traditions, formation of corporate culture, manager of socio-cultural sphere, team.*

Corporate culture as a management tool and an effective form of life for educational organizations, plays a coordinating role due to established norms and standards of behavior, basic values that are promoted in the system of higher education. The education system provides for the formation in the youth of students of the modern worldview, social experience, analysis and implementation of their own views, beliefs based on the fundamental achievements of culture. The corporate culture of Ukrainian educational institutions does not yet sufficiently contribute to the fulfillment of their socio-cultural functions. Many unresolved issues remain, and the main one is the creation of a system of purposeful actions through which the formation and development of the corporate culture of a higher education institution is carried out.

The goals and objectives of the corporate culture of a higher education institution are to create a favorable microclimate, a harmonious internal environment, to create a sense of employee involvement, teaching staff, students to realize the mission, goals, objectives and overall strategy of an educational organization to realize the realities. A number of rather inconsolable results in practical activity arise when corporate relationships are not used effectively: lack of communication; misunderstanding by employees of ideas, mission and values; the management process is low; lack of adaptation mechanisms; ruthlessness. This, in turn, reduces the efficiency of the institution of higher education and the ability to manage and coordinate the life of the organization. The phenomenon of corporate relations in higher education institutions began to be investigated relatively recently, as evidenced by the development of such scientists as: A. Belyaev (2007), E. Kapitonov (2005), V. Kozlov (2009), V. Kubko (2012), M. Ovcharenko (2011). Ovchinnikov (2012). V. Rutitskaya (2006), L. Savchuk (2005), E. Sidelnik (2012),

Y.Tunnikov, M. Maznichenko (2015), E. Chizhikov (2010), E. Shane (2002). In these works, special attention is paid to the analysis of the theory of corporate culture in relation to the educational staff, as well as to the definition of organizational foundations of corporate culture in the practice of higher education institutions.

Thus, the relevance, social importance and insufficient scientific elaboration of the issues of corporate culture formation as a necessary condition for the transformation of higher education have determined the choice of the research topic: the student club as a means of forming corporate culture in higher education.

Development and implementation of a model of corporate culture that violates the need to change the style of traditional academic management and the transition to the principles of corporate governance using student club facilities.

Main materials. The very phrase "corporate culture" was first used in the nineteenth century by German Field Marshal G. Moltke (German Helmuth Karl Bernhard von Moltke; 1800–1891) in military terminology, to which he defined relations among the officers of the army [9, p. 86–89]. The concept of corporate culture began to emerge in the 1980s, the twentieth century in the United States under the influence of three scientific areas: strategic management, organizational theory and organizational behavior. The term "corporate culture" itself is not yet fixed as a permanent concept and needs some theoretical understanding. The modern concept of "corporate culture" covers the phenomena of spiritual and material life of the collective of various organizations and is characterized by the moral norms and values, the code of corporate behavior, etc., that dominate in it. In the early 1990s, S. Robbins (1991) reviews corporate culture on the basis of characteristics that are most valued in the organization: personal initiative, managerial support, willingness to take risks, control, clear goals, employee loyalty , coordination of actions, system of rewards [6, p. 48]. E. Shane (2002) describes corporate culture as “a set of self-created, master-crafted, or group-developed frameworks in the way that it learns to address problems of adaptation to the external environment and internal integration that have proven effective enough to be considered valuable, and therefore be transferred to new members as the right way to accept, think and relate to specific problems ”[13, p. 116]. V. Rutitskaya (2006) distinguishes corporate culture as a system of formal and informal rules and norms of activity, relevant customs and traditions, individual and collective interests. This type of culture influences the degree of satisfaction with working conditions, determines the peculiarities of employee behavior, their interaction, leadership style and collective vision of development prospects. Its elements are: values, identity, symbolism, behavior, development of belief [8, p. 42-43].

Thus, corporate culture can be defined as a system of material and spiritual values, rules and standards of activity that are inherent to the members of the organization at all levels of management, forming a brand and in some way influencing the nature of the realization of the goals of the organization.

Corporate culture, as a set of orientations, symbols, traditions, perspectives, values, is able to make constructive actions in order to achieve goals and to manage both internal relations and to build mutually beneficial relationships between higher education

institutions and consumers of educational services.

Higher education institutions are a place of concentration of educational capital, which in turn represents the intellectual potential of the country. It is the personal individual contribution of specialists to the effective functioning of the educational organization that determines the success of the intellectual, scientific and economic development of society. This is due to certain factors:

1) attention is paid not only to the specialty of the teaching staff but also to the correspondence of the specialist's personal criteria to the corporate culture of the higher education institution;

1) both the staff and the student self-government of the university began to be regarded as a creative resource capable of improving the competitiveness of the educational organization among other institutions of higher education;

2) loyalty to the institution of higher education, a unified team spirit of the team is the key to improving the competitiveness of the organization;

3) democracy in the relations between the management of higher education institutions and employees, work on the result, their integration into common goals and objectives;

4) management methods aimed at conflict-free and harmonious interaction between all units of the higher education institution;

5) the quality of educational services, the professionalism of the teaching staff influences the image of the institution of higher education in society.

Due to the fact that the corporate culture of a higher education institution is a tool for managing its internal environment, it should form a sense of personal involvement (professional competence of the teaching staff) to the team (professional culture) of its support, collegiality in achieving the mission and strategy of the organization.

Thus, in this situation, it is necessary to take measures aimed at informing, stimulating and motivating the teaching staff, the administration of the higher education institution, students, who are both individually and collectively the main representatives and promoters of corporate values.

Higher education institutions today have a difficult task, which is focused on adapting the staff and management structures to the new socio-cultural environment. The solution to this problem is connected with the development of corporate culture, which is aimed at shaping the image of higher education institution and increasing its competitiveness.

Researchers point out that new socio-economic relationships determine the need to use characteristics such as "corporation" and "corporate culture" for higher education institutions. Transformation of the conditions of their functioning set new guidelines for the organization of the activity of higher education institution as an independent competitive organization.

E. Sidelnyk states that: "The university or institute, apart from the collection of material values in the form of buildings, libraries, research institutes, bureaus, results of research and development, possesses spiritual values shared by both professors

and staff and students" [10, p. . 42]. Thus, the corporate culture of a higher education institution brings together both consumers of educational service (students) and its producers (teachers) on the basis of a common system of intangible values. A. Belyaev emphasizes the dual nature of the corporate culture of a modern educational institution: “on the one hand, the culture of the university is a culture of achieving interests in the market of educational services, a culture of competition; on the other, it is a traditional academic culture based on preserving and increasing pedagogical values ”[1, p. 62-63]. A comprehensive approach to the corporate culture of higher education institutions is presented in the works of Yu. Tyunnikov, M. Maznichenko [11, p. 71-72], which distinguish in it the following levels:

1) the corporate culture of the professional-pedagogical community is embodied in a system of values and norms shared by the majority of teachers.

2) the corporate culture of the specialist training industry implies that the training of a qualified specialist in a particular area includes the value settings that determine the student's future professional activity. First of all, it is about involving future professionals already in higher education in their professional activities.

3) the corporate culture of the professional community of scientists is implemented in the field of research activities carried out by higher education institutions, along with educational. Therefore, it is necessary not only to carry out research, but also to predict their practical significance, financial profitability.

4) the corporate culture of higher education as an educational institution is included both in the higher education system and due to the influence of the trends of the world educational space. This definitely determines the strategy of higher education development, their goals and objectives in the conditions of competition, which is increasing in the market of educational services. All these levels of corporate culture of higher education institutions are interconnected and interdependent, changes at one level entail adjustments in the content of other levels. [11, p. 71-72]. According to most researchers, a corporation is an organization whose members feel something united, united, with common goals and objectives.

From the point of view of M. Ovchinnikov, higher education institution "is a corporation in the presence of a complex of balanced resources (intellectual, technical, status, infrastructure, basic economic), the presence of common goals in the members of the corporation" [7, p. 101]. However, despite the integrity of this corporation, it has a rather complex structure in which a number of elements (under corporations) can be distinguished [7, p. 101]:

1) a sub-corporation of the State-company whose purpose is to make a profit;

2) undergraduate students whose goal is to get quality education, access to career building, leisure, professional and personal growth;

3) sub-corporation of teachers and staff of the university, whose activities are focused on knowledge transfer, development of science and technology.

Thus, the corporate culture of a higher education institution has a strong managerial potential, as it is able to increase the efficiency of use of material, human and spiritual and

other resources to ensure the competitiveness of a higher education institution, improve the quality of educational and research activities, meet the needs of the individual, society and the state.

Researchers note that in the conditions of socio-economic instability, management activity has become significantly complicated and has touched more on the internal, psychological resources of the individual, leading to an understanding of the changes that occur, attitude to them, self-esteem of the possibilities of influencing them and awareness of the need to adapt these activities and behavior changes.

In general, it can be said that corporate culture is the most important tool for managing the activities of educational organizations, because it contributes to the adaptation of higher education institutions to the changes in the world, in the country, improving the efficiency of human resources, satisfaction of employees and consumers of the educational services market.

This approach to modern management is conceptual for exploring the management potential of the corporate culture of a higher education institution. Within the theory of management, management potential is associated with some general criteria in the field of knowledge, skills and abilities to organizational and management activities.

V.V. Kozlov offers five main steps in forming a corporate culture:

1) developing a mission, defining strategy, core goals and values;

2) a study of already established corporate culture;

3) development of organizational measures aimed at the formation, development or consolidation of desirable values and patterns of behavior;

4) purposeful influence on corporate culture in order to eliminate negative values;

5) assessment of the successful impact on corporate culture and making the necessary adjustments [3, p.135]. According to E. Kapitonov, corporate identity is the only complex design that is the artistic solution of the system forming the elements of corporate and personal image, which allows to identify this organization [2, p. 230].

Corporate culture of students of higher education is a complex system and consists of the following organizational-managerial interconnected components: value-normative subsystem (basic values, corporate norms and rules shared in the student environment); subsystem of organizational structure (formal and informal organizational structure, structure of power and leadership); communication subsystem (structure and informal flows, quality of communications); subsystem of social-psychological relations (sociometry, role system, conflict); signs - symbolic subsystem (myths and legends, corporate legends); subsystem of external identification (image, advertising attributes) [12, p. 13-14].

Corporate values are important, that is, a set of public and private rules by which the administration and staff determine priorities, form a system of behavior to achieve the goals of the institution of higher education. Ethical, socio-economic and communicative values are usually distinguished. [4, p. 482 - 488].

Equally important are corporate rituals - a set of actions and activities that show employees the value of the organization. The corporate style of higher education should

improve and permeate the entire cultural and subject world. [5, p. 7-8].

The model of the process of formation of students' social activity in a club association is a system that includes the target (purpose, laws, principles, tasks), meaningful (functions, directions), instrumental (stages, ways, means, forms, methods, technology), evaluation and regulatory (criteria, indicators) components.

Thus, club activity is a sphere of organized amateur creativity manifested in collective and individual forms of leisure, outlining the systematic development of personality and contributing to the individual accumulation of one's own cultural experience.

It is worth noting that the formation of a corporate culture system is the prerogative of the leader and his organizational team. And since the social culture of the group exists from the moment of enrollment of students to the first year, then the leader who forms the team of the group, it is important to solve two questions. First, to determine whether the culture that has formed in the club team meets the needs of team culture. And secondly, the purpose is to shape the corporate culture of the institution of higher education by means of a student club.

1. Cultural and leisure activities in the system of higher education institutions act as a specific type of socio-cultural activity of students, which was carried out in the field of leisure and social orientation. The degree of sociocultural activity is directly dependent on the social activity of the student as a whole, which is manifested in the attitude towards education and to all other types of social work in higher education. In the cultural and leisure activities, the most organically manifested is the interconnection and interdependence of leisure with study, social life and life of students.

2. In the total amount of cultural and leisure activities of a student club, its main work is the leading one, which is capable of developing socio-cultural activity in the form of student holidays, rituals, celebrations, festivals, competitions, thematic evenings and meetings that broaden the outlook of participants, providing mass , an initiative, creativity, amateur.

3. The leading socio-cultural conditions of the club's transformation into the center of development of corporate culture of student youth are:

a) consideration of artistic, creative, socio-cultural, educational and other areas of club work is carried out the formation of knowledge and skills, the formation of a future specialist;

b) focus on the close relationship of the student club's educational program with the students' activity, first of all, with their training as a professional activity;

c) constant expansion of the public range of its activities, attracting students to it and thereby increasing the prestige of the educational institution;

d) the connection of socio-cultural activities with the constant study of social needs and preferences of students in the field of leisure.

Methods of forming corporate culture in higher education institutions:

1. Discipline-behavior. It is necessary to start forming the corporate culture of your team-group by changing habits, perceptions, constructive actions, feedback, organizational procedures, appearance. In the first stage, there is no need to change the

student value system, it is important to agree on the desired behavior and principles of group functioning. Analyze and develop a system of corporate culture adjustment measures.

2. Identify the mission and purpose of the group. What results we expect from our group, organizational actions. And if we have agreed to start with the discipline of behavior, then it is necessary to specify what will be the end result of this activity.

3. Together with our team, we create rules for all team members. Everything we do - we define the purpose, the problems, we make the plans, the development and the implementation of the projects - we do involve in this team process of our whole group.

4. Analysis and evaluation of the results. Performance of duties, attitude to teamwork, time factor.

5. Identify the problem areas and plan for the implementation of corporate culture. Develop and consider an official presentation of the final version of corporate culture, or other form of events, projects, cultural and artistic events that will demonstrate to the group the importance of creating a new innovative culture.

In order for an academic group to become a team of like-minded people, its corporate culture must be receptive and unite its members in pursuit of common goals, and it must produce a sense of collectivism, involvement in the common cause, motivation, comfort in communication.

In our opinion, the main components that will help to shape the corporate culture in the educational process are the following: implementation of international standards and principles of corporate governance in higher education institutions of the European Union and the USA (Charter, Collective Agreement, Rules of Internal Regulations, regulatory documents that regulate activity of the educational institution and has separate elements of corporate culture); Mission, philosophy governing the corporate culture of relationships in higher education institutions and the adoption of the Corporate Culture Code; implementation of internal corporate culture systems of the academic group; in the formation of the corporate culture system, attention should be paid to the creation of corporate departments of managers-curators of the relevant direction in the implementation of the strategic development plan, etc.

Conclusions. Thus, the implementation of the corporate culture model of a higher education institution makes it possible to:

1) harmonization of norms and values of each participant of educational activity with principles of functioning of educational organization (analysis and evaluation of existing culture and values);

2) coordination of internal processes (mission and values of the institution of higher education);

3) setting up various ways of cooperation (traditions, customs, rituals, rituals, corporate events, symbolism);

4) fostering a sense of united team and formation of space of stability, determination and security (development of corporate standards, code, documents for support of activities of public organizations);

5) substantiation of the management style of higher education institution (system of criteria for evaluation of corporate culture and recommendations for its formation in the educational institution).

To summarize, it should be emphasized that the corporate governance model is at the stage of formation, and today most of these approaches have not been tested for the introduction of corporate culture in the context of Ukrainian realities and may be subject to further analysis.

Prospects for further scientific exploration are a thorough study of the specificity of the implementation of corporate culture technologies in organizations of socio-cultural sphere.

References:

1. Belyaev A. Corporate culture of the university: from theory to practice. Higher education. 2007. № 11. P. 62–65.
2. Kapitonov E. Corporate culture: theory and practice. /Kapitonov E., Zinchenko A. Captains. - Moscow: Alpha Press, 2005. - 352 p.
3. Kozlov V. Corporate culture. Moscow: Alpha Press, 2009. – 304 p.
4. Kubko V. Express diagnostics of corporate culture of higher educational establishments of Ukraine / V. Kubko // Gileya. - 2012. - Vol. 63. P. 482-488.
5. Kubko V. Corporate culture of higher educational establishments of Ukraine: philosophical and cultural analysis. Author's abstract diss. Cand. philosopher. of sciences. Kyiv, 2012. 17 p.
6. Ovcharenko M. Approaches to determining the characteristics of elements of corporate culture / M. Ovcharenko // Bulletin of the Dnipropetrovsk University. Economy series. 2011. 5 (2). - P. 47-52.
7. Ovchinnikov M. Higher education as a corporation: features of the corporate culture of the university. Modern High School. 2012. № 2. P. 53–56.
8. Rutitskaya V. Corporate culture and internal PR / V. Rutitskaya // Personnel manager. - 2006. - № 12. - P. 42–47.
9. Savchuk L. Development of corporate culture in Ukraine / L. Savchuk, A. Burlakova // Staff. - 2005. - № 5. - P. 86–89.
10. Sidelnik E. Corporate culture of the university. PFC news. 2012. № 10. P.39–43.
11. Tyunnikov Yu., Maznichenko M. Corporate culture as a factor of competitiveness of a university. Higher education. 2015. № 10. P. 29–32.
12. Chizhikova E. Formation of the corporate culture of the university student community: author's abstract ... Candidate of Pedagogical Sciences: 13.00.08 / E. Chizhikova; [Inst. of content and teaching methods Ros. Acad. Education] - Moscow, 2010 - 23 p.
13. Shane E. Organizational Culture and Leadership - St. Petersburg: Peter, 2002. - 336 p. - (Management Theory and Practice Series)

HYPERBOLIC GEOMETRY IN THE COURSE OF PROFESSIONAL TRAINING OF FUTURE MATHEMATICS AND PHYSICS TEACHERS

Natalia Shapovalova,
Ph.D. in Physico-Mathematical Sciences, Associate Professor,
Larisa Panchenko,
Ph.D. in Pedagogy, Associate Professor,
Mykhailo Dragomanov National Pedagogical University of Ukraine,
Olena Bashchuk,
Ph.D. in Physico-Mathematical Sciences, Associate Professor,
National University of State Fiscal Service of Ukraine

Annotation. *The article analyzes the peculiarities of teaching hyperbolic geometry in the normative discipline "Foundations of Geometry" in high school in the course of professional training of future mathematics and physics teachers. The article outlines the aim, contents and basic provisions of non-Euclidean Lobachevski geometry and proposes up-to-date approaches and methods of teaching it. The authors suggest the employing in this process of comparative analysis of facts valid for Euclidean geometry with assertions formulated for non-Euclidean geometries, of different models of hyperbolic geometry, of practical and applied use of Lobachevski geometry facts, of dynamic geometry instruments and of interdisciplinary ties of Lobachevski geometry with physics, astronomy, theory of function of complex variable, number theory etc.*

Key words: *hyperbolic geometry, non-Euclidean Lobachevski geometry, model of Lobachevski geometry, Euclidean geometry, foundations of geometry, professional training, competence, interdisciplinary ties, studying process, approach, mathematics, physics, astronomy.*

Formulation of the problem. Geometry can be applied not only to the space in which we live, but also to other spaces that arise in mathematical and physical theories. The geometries of these spaces are different, both Euclidean and non-Euclidean. Thus, the need to construct many different geometries is due solely to the complex nature of the world around us.

A great influence on the development of geometric science in the XX-XXI centuries was carried out by studies in physics, chemistry and biology at the level of micro-phenomena, passing within short distances, as well as studies in astronomy, astronautics, the development of satellite communications, at the level of phenomena that are passing over very long distances. At the same time geometry began to lose visibility, since the human eye cannot observe the phenomena at such distances. Multidimensional and infinite-dimensional spaces are used to describe them.

Lobachevsky's geometry became an example for the construction of other non-Euclidean geometries: spherical geometry, elliptic geometry, or Riemann geometry, non-commercial geometry. These geometries do not make a complete list of all the variety of existing geometries. Non-Euclidean geometries played a decisive role in the

construction of Einstein's theory of relativity, in which it was necessary to accept the fact of distortion of the surrounding space. The laws of addition of velocities in the special theory of relativity were obtained by A. Einstein in the coordinate analytical form. He did not consider the geometrical interpretation of these relations. In 1909, the physicist A. Sommerfeld, and in 1910 the mathematician F. Klein showed that the geometric interpretation of these laws is connected with the geometry of Lobachevsky. The connection of hyperbolic geometry with the special theory of relativity in many of his works was specified by the Serbian mathematician V. Varicak. The coincidence of the space of velocities of the special theory of relativity with the space of Lobachevsky was clearly formulated by AP Kotel'nikov in 1923 and published in 1927 [3].

Even Lobachevsky established that his geometry has a direct relation to stellar geometry, that is, to the geometry of outer space. On our planet, within the limits of ordinary terrestrial scales, people use Euclid's geometry as the simplest and most accurately reflecting reality. Things change when we move from terrestrial scales to macroscopic or microscopic scales. To believe that Euclid's geometry works here would be wrong. The achievements of physics suggest that physical spaces that are too large in scale behave as non-Euclidean.

Analysis of current research. The origins of modern theoretical physics are closely related to the geometry of Lobachevsky, and therefore our well-known academic academicians AS Khristianovich, MA Lavrentyev and SA Lebedev wrote that "Lobachevsky's geometry was the basis for the invention that led to the theory of relativity and the method of calculating processes inside the atomic nucleus. Studies of building an atomic nucleus at incredible speed have led to the creation of the nuclear industry. " NA Chernikov, Ya. I. Smorodinsky and others have successfully used the Lobachevsky geometry in studying and investigating collisions of elementary particles in an accelerator and in solving various problems of elementary particle physics and nuclear reactions [3].

Lobachevsky's geometry cleared the ground to create a modern axiomatic method in geometry, according to which all geometry should be based on basic concepts, basic relationships, and the axiom system. To prove "strictly" any theorem from the point of view of the modern axiomatic method is to obtain it deductively as a consequence of the theorems previously proved, and the drawing and all visual representations will be exceptionally auxiliary. The modern axiomatic method, created under the influence of Nikolai Ivanovich Lobachevsky's ideas in geometry, is now widely used for scientific substantiation of many mathematical disciplines, including some sections of theoretical mechanics [2].

In creating the new geometry, MI Lobachevsky used the known facts of Euclid's geometry, which are not the consequences of Euclid's fifth postulate, that is, all statements that do not depend on the content of the fifth postulate, are a common part of Euclid and Lobachevsky's geometry. Using the axiomatics of Hilbert, which was not in the life of Lobachevsky, we can say that a common part of both geometries is a set of all statements that can be deduced from the axioms of the first four groups of the Hilbert axiom system,

which is called absolute geometry. Therefore, absolute geometry is a common part of Euclid's geometry and Lobachevsky's geometry; all statements of absolute geometry also occur in Lobachevsky's geometry.

Thus, at the heart of Lobachevsky's geometry are all the statements of absolute geometry and Lobachevsky's axiom, which is that at a point not belonging to a given line, at least two lines can be drawn in the plane defined by them intersect.

The plane and space where, along with absolute geometry, the Lobachevsky axiom and its consequences are called, respectively, are called the Lobachevsky plane and space, or the hyperbolic plane and hyperbolic space [1].

This article is devoted to the study of the role and features of teaching hyperbolic geometry in the process of teaching the normative discipline "Fundamentals of geometry" students of mathematical specialties of pedagogical universities and to reveal the main methodological aspects of this process.

Questions related to the study of non-Euclidean geometry of Lobachevsky are very closely intertwined with the peculiarities of psychology and theory of knowledge in general, with questions about how spatial imagination and intuition arise. Famous scientists at various times have been researching these issues - Karl Friedrich Gauss, Janos Bolyai, Georg Friedrich Bernhard Riemann, Eugenio Beltrami, Felix Klein, Henri Poincare and also A.Alexandrov, P.Rashevsky, O.Smogorzhevsky, N.Smogorzevsky, L.Atanasyan, O.Manturov, V.Borovik, V.Yakovets and others.

The purpose of the article is to reveal the main methodological aspects of teaching non-Euclidean geometry of Lobachevsky students of mathematical specialties of pedagogical universities. For this purpose, the purpose, content and basic provisions of hyperbolic geometry are first considered. Then the peculiarities of non-Euclidean geometry of Lobachevsky are analyzed and modern approaches and methods and its teaching are offered. Methodical peculiarities of the use of dynamic geometry in the process of teaching hyperbolic geometry and the basics of geometry, various forms of educational, practical and research activities of students of physical and mathematical specialties are analyzed.

Presenting main material. Projective geometry is the most convenient starting point for explaining the essence of not only Lobachevsky geometry but also other geometric systems [11]. It is with the help of the methods of projective geometry that one can describe the nine known non-Euclidean geometries of the plane and show the possibility of their use in physics.

In the process of teaching non-Euclidean geometry of Lobachevsky and studying other non-Euclidean geometries, a comparative analysis should be used, namely to compare the statements of Euclid's parabolic geometry, Lobachevsky's hyperbolic geometry, spherical geometry, elliptic geometry, or Riemann's geometries, and their active values. The most effective methods of teaching non-Euclidean geometries are explanatory illustrative method and heuristic conversation. It is during the heuristic conversation that students compare the statements of non-Euclidean geometries with their counterparts in Euclidean geometry.

Straight, triangles, quadrilaterals, curves, and other figures in the hyperbolic plane have specific properties. For example, if there are two types of straight lines on the Euclidean plane: intersecting straight lines and parallel straight lines, then there are three types of straight lines on the Lobachevsky plane, namely: intersecting lines or adjacent straight lines - a bundle of lines with its own vertex - elliptical beam; parallel lines are a bundle of lines with a non-custom vertex - a parabolic bundle and divergent lines are a perfect-vertex beam - a hyperbolic bundle.

For parallel lines on the Lobachevsky plane, the direction of parallelism is important, and they have many properties different from those of parallel lines on the Euclidean plane. For example, the distance between the parallel lines on the Euclidean plane is constant, and on the hyperbolic plane the distance between the parallel lines decreases indefinitely in the direction of the parallelism angle and may be smaller than a predetermined, arbitrarily small, segment, that is, in the direction of the right angle approaching; in the opposite direction, the distance increases indefinitely and may become larger than a predetermined, arbitrarily large, segment, that is, in the direction opposite to the parallel angle, parallel straight lines are asymptotically divergent [10].

A significant difference between Lobachevsky's geometry and Euclidean geometry is also indicated by the presence of a Lobachevsky function that connects segments with angles. There is no such function on the Euclidean plane. This explains the need to preserve the Euclidean geometry of the standard of length, despite the fact that there is a natural unit of measure of angles. There is no need for this in Lobachevsky's geometry, since a segment called the arrow of the parallelism angle corresponding to a certain angle of parallelism can be taken here as a unit of length [1].

When considering the sum of the inner angles of triangles on the Euclidean plane, it should be noted that it is constant and is 180 ° or 2π radians. Unlike Euclidean geometry, in Lobachevsky geometry the sum of the inner angles of triangles is a variable value, which depends on the shape and size of the triangle, but always smaller than 180 ° or 2π radians.

Considering the properties of triangles, one should give the definition of equal triangles and consider three signs of equality of triangles, give the definition of such triangles and emphasize the existence of similar triangles, three signs of similar triangles, similar figures in Euclidean geometry. Particular attention should be paid to the fact that in Lobachevsky's geometry there are four signs of the equality of triangles. Proving the fourth sign of the equality of triangles, is that if the two angles of the respective angles are equal, then one pair of the corresponding sides will also be equal to each other, and as a consequence, given the second sign of the equality of the triangles, and all the pairs of the corresponding sides will be equal to one another, we can conclude that the triangles with corresponding equal angles, which are similar in the Euclidean plane, are equal in the hyperbolic plane. Thus, another interesting feature of hyperbolic geometry, in contrast to Euclidean, is the absence of such triangles, similar figures, and general transformations of similarity.

Another difference between hyperbolic geometry and Euclid geometry is the fact that on the Lobachevsky plane not around any triangle one can describe a circle, this can

only be done if the mediatrix (the triangle mediatrix is called a line lying in the triangle plane, one of its sides and perpendicular to this side) or the median perpendiculars to the sides of the triangle intersect, since in this case their point of intersection is equidistant from the vertices of the triangle. If the two mediators of a triangle are divergent lines, then the third mediator is pairwise divergent with them, in which case the equidistant can be described around the triangle. If two triangles of a triangle are parallel lines, then the third triangular is parallel to them and in the same direction, in which case a boundary line or an oricycle can be described around the triangle [5].

In Lobachevsky's geometry there are four types of lines of constant curvature: straight, circle, equidistant (hypercycle) and boundary line (oricycle). The Oricycle can "slide" by itself without deformation, both circle and straight. Equidistant also possesses this property: if the base of the equidistant will "slide" by itself, then the equidistant will "slide" by itself without deformation, since the distances of all points of the equidistant from the base are equal.

A constant curvature curve passes through any three points of the Lobachevsky plane. Unlike the circle, the boundary line (oricycle) and the equidistant (hypercycle) are closed lines in the Lobachevsky plane. And the straight line, as the base of the hyperbolic beam, is a special case of equidistants.

In order to prove the inconsistency of Lobachevsky's geometry, it is advisable to consider several of its models, namely: the interpretation of the Italian scientist E. Beltrami - in the Euclidean space there is a surface of a negative curvature, called the pseudosphere, on which the system of geodesic lines is curved (locometric); interpretation of the German mathematician F. Klein, who proposed an original interpretation of Lobachevsky's geometry on ordinary samples of Euclidean geometry, and not only for all planimetry, but for all stereometry. Klein's work was a great triumph in the final recognition of Lobachevsky's geometry as a logically harmonious geometric system. And to the question of the reality of Lobachevsky's geometry, without any hesitation, one can give a positive answer, namely: Lobachevsky's geometry is real as much as real Euclidean geometry, and that, in turn, is as consistent as the consistent arithmetic of real numbers; the consistency of the latter is proved by the centuries-old practice of human society in the broadest sense of the word. It is also appropriate to consider several models of Lobachevsky's axiomatics of planimetry, proposed by the famous French mathematician and philosopher A. Poincare [4]. As a result, within the framework of Euclidean geometry, all known hyperbolic geometry can be constructed on its known samples.

To understand the geometry of the universe, it is important to use scientific results obtained by physicists, astronomers. It follows from the general theory of relativity that space is distorted. This is because, in the case of bodies with large masses (for example, near the sun, stars), the laws of Newtonian mechanics change, and the geometry of space becomes non-Euclidean. It is well known that one of the common models of the straight line is the beam of light. However, the light passing through the sun or any stars, under the influence of gravity, bends its trajectory.

The discovery of the theory of relativity by A. Einstein, the expansion of the

knowledge of the universe leads us to the conclusion that the universe as a whole cannot be regarded as an immutable system. The contradictory and variable universe is characterized by a change in the metric of space and time.

Important results were obtained by AA Friedman. Friedman's model of the universe was based on the hypothesis that the universe is homogeneous, that is, arranged equally in all its parts. Of course, this is about the universe as a whole. If we talk about a relatively small scale, the heterogeneity of the universe will be visible to the naked eye. Friedman found that if the density of matter in the universe is less than some constant value (critical density), then the curvature of space will be negative, if the critical density is exceeded, then space has a positive curvature. Finally, if the density is critical, then the space curvature will be zero. Thus, as Friedman has shown, under certain conditions the geometry of the universe has a negative curvature, that is, it coincides with the geometry of Lobachevsky [9].

Based on the general theory of relativity, in 1922 Friedman concluded that the universe should expand over time.

The Friedman model of the universe, which was theoretically obtained, was brilliantly validated experimentally by American astronomer Edwin Hubball. Hubble, acting quite independently of Friedman, found the "running" of distant nebulae. Einstein estimated the results obtained by Hubball as a confirmation of Friedman's theoretical propositions. Later, the model of the "expanded" universe was built.

Established by Hubble in 1929, the relationship between the redshift of galaxies and the distance to them came into science as one of the most important cosmological laws, dubbed the Hubble Law.

The current level of science leads to the conclusion that the real space of the universe is a distorted space of alternating curvature. Therefore, the geometry of the universe cannot be either Euclid's geometry or Lobachevsky's geometry, since the Euclidean space and the Lobachevsky space have respectively zero and constant negative curvature. Since the curvature of the Euclidean space is zero, then we can assume that Lobachevsky's space, which has a constant negative curvature, is closer to the geometry of the universe.

The first applications of Lobachevsky's geometry were in the works of M.I.Lobachevsky, who with her help was able to calculate some integrals. At the end of the nineteenth century, the works of A. Poincare and F. Klein found direct links between Lobachevsky's geometry and the theory of functions of a complex variable and the theory of numbers, in particular arithmetic of undefined quadratic forms. Lobachevsky's geometry is now an important application in the theory of functions of a complex variable, which is the mathematical basis of modern hydrodynamics, aerodynamics and the theory of elasticity [7].

Nowadays, the value of Lobachevsky's geometry has increased even more thanks to the work of the American mathematician Thirston, who established its connection with the topology of three-dimensional manifolds. Modern studies of astronomers, mathematicians, physicists, philosophers, cosmologists are increasingly demanding professional knowledge of both Lobachevsky's non-Euclidean geometry and other non-

Euclidean geometries.

Studying the course of the basics of geometry, as one of the fundamental courses of mathematical training of future teachers, opens wide opportunities for their intellectual development, namely for the formation and development of logical thinking, spatial ideas and imagination, algorithmic culture, ability to establish cause and effect relationships, to build mathematical models of the studied processes and phenomena;

The problem of bringing the educational and cultural level of teaching staff in line with the rapid development of science and technology, socio-political and socio-economic processes, and the process of standardization of education is facilitated by the development of informational training of students.

The methodological peculiarities of the use of dynamic geometry are that they can be used both at home, at school, and in higher education institutions in various forms of conducting classes and with different computer equipment of the office or the audience; they allow you to master the higher education geometry faster and more efficiently, increase the ability to memorize material; provide an opportunity to study geometry based on a business approach through the introduction of elements of experiment and research into the educational process; increase the degree of emotional involvement of students, ensure the ability to set creative goals and organize new research projects; show how modern technologies are effectively applied to modeling and visualizing geometric, mathematical and physical concepts.

The program environment allows to organize various forms of educational and practical activity. In learning the basics of geometry, it is advisable to use:

1. Static drawings illustrations.
2. Manipulative models for research.
3. Constructive tasks.
4. Tasks to check the construction or answer.
5. Scenario presentations and simulators.

Although mathematical models always contain insufficiently disclosed characteristics of the studied objects, which impedes the achievement of absolute accuracy and adequacy of these models to real processes, but does not diminish their scientific value as tools for analysis, observation, comparison and prediction of various phenomena in all spheres of scientific and social life.

Organic combination and interrelation of mathematical and computer modeling in student preparation is a necessary element of the educational process and research. Students acquire the ability to independently develop models for use in educational and industrial processes, develop teaching methods using computer simulation, create new models and improve existing ones in their research activities are an integral element of the education of future teachers and physicians.

The complexity of the objects being studied itself encourages scientists to develop and refine the mathematical models that are used to analyze them. Over time, it becomes necessary to introduce more complex desegmented synergistic models of reality, built on the basis of the combination and synchronization of social processes in the course of

scientific knowledge, which is the most pressing task of modern science.

Conclusions. According to the results of the study, the following conclusions can be drawn. When teaching non-Euclidean Lobachevsky geometry, it is advisable to use a comparative analysis of Euclidean geometry and statements of non-Euclidean geometries, dynamic geometry, to consider different models of hyperbolic geometry, practical and applied applications of the facts of Lobachevsky geometry, to identify interstitial geometry variable, with number theory and investigate the application of hyperbolic geometry in different fields of science, technology, bi nology, nuclear physics, elementary particle physics, astronomy, cosmology and others.

Studying the properties of geometric shapes in non-Euclidean geometries broadens students' perceptions of the contemporary picture of the universe, enhances the competence of future teachers of mathematics and physics, and stimulates their own search for new mathematical, geometric and physical ideas and theories.

References:

1. Borovik V. Higher geometry course: a textbook / V.Borovik, V.Yakovets. - Sums: VTD “University Book”, 2004. - 464 p.

2. Kostin V. Fundamentals of geometry / V.Kostin. - Moscow: Uchpedgiz, 1948. - 304 p.

3. Laptev B. Lobachevsky geometry, its history and meaning / B.Laptev. - Moscow: Knowledge, 1976. - 64 p.

4. Trainin, Ya. Foundations of Geometry / Ya.Trainin. - Moscow: Uchpedgiz, 1961. - 326 p.

5. Shapovalova N. Curves on the Lobachevsky plane. Educational method. study guide. Mat. spec. Universities / N.Shapovalova, L.Panchenko. - Kyiv: M.P. Drahomanov NPU, 2011. - 32 p.

6. Shapovalova N. Features of studying non-Euclidean Lobachevsky geometry and its application // New Collegium. - 2011. - № 2. - P. 70-74. - URL: www.nbuv.gov.ua/old_jrn/Soc_Gum/NovKol/2011_2/107.pdf

7. Shapovalova N., Panchenko L. A systematic approach to teaching the basics of the geometry of future mathematics teachers // Scientific journal of the National Pedagogical University named after M.P. Drahomanov. Series 3. Physics and Mathematics in Higher and Secondary School: Coll. scientific works. - Kyiv: NPU named after M.P. Drahomanov, 2011. - № 8. - P. 133-138.

8. Shapovalova N., Panchenko L. The role of studying non-Euclidean geometry of Lobachevsky for enhancing the competence of future teachers of mathematics and physics // Problems of education: Sciences. Sat. / Institute of Innovative Technologies and Content of Education of MONMS Ukraine, - Kyiv, 2012. - Issue. No. 70. Part II. - pp. 29-33.

9. Shapovalova N. Features of teaching hyperbolic geometry to enhance the competence of future teachers of mathematics and physics / N.Shapovalova, L.Panchenko // Physical and mathematical education. Scientific journal. - Sumy: A.S. Makarenko

SSU, 2015. - №3 (6). - P. 109-118.

10. Shapovalova N., Panchenko L. (2017). Features of teaching hyperbolic geometry to enhance the competence of future teachers of mathematics and physics. Education. Innovation. Practice, (1 (2), P.44-48.

11. Shirokov P. A brief sketch of the basis of Lobachevsky geometry / P.Shirokov. - Moscow: Science. Main edition of physical and mathematical literature, 1983. - 80 p

12. Sosinskiy A. Geometries / A.Sossinskiy. – Providence, Rhode Island: American Mathematical Society, 2012 – 322 p.

MEDICINE AND PHISIOLOGY

THE INFLUENCE OF GENISTEIN, RESVERATROL AND QUERCETIN ON FUNCTIONAL STATE OF KIDNEY IN RATS WITH EXPERIMENTAL CHRONIC KIDNEY DISEASE. CONNECTION WITH HYDROGEN SULFIDE SYSTEM

Natalia Voloshchuk,
Doctor of Medical Sciences, Professor,
Serhiy Konjuch,
Andriy Melnyk,
Doctor of Medical Sciences, Professor,
Olha Denysiuk,
Candidate of Medical Sciences, Associated Professor,
National Pirogov Memoriaal Medical University

Annotation. *The article presents a comparative analysis of nephroprotective activity of natural poliphenol compounds (genistein, resveratrol and quercetin) on the model of chronic kidney disease (5/6 nephrectomy) in rats. The data obtained demonstrate the clear nephroprotective effect of all three compounds used in chronic kidney disease. The use of polyphenols improved filtration functions of kidneys, water reabsorption processes, electrolyte exchange, the state of tubular apparatus). The nephroprotective properties of the compounds are mediated through the effects on H2S system in kidneys, namely activation of H2S-producing enzymes, decrease in the rate of exogenous H2S utilization in kidneys, and increase of H2S content. Among poly phenols, genistein had the most pronounced corrective effect on renal functional parameters and the state of H2S system in CKD.*

Key words: *chronic kidney disease, genistein, resveratrol, quercetin, hydrogen sulfide, nephroprotection, rats.*

Chronic kidney disease (CKD) is an integrated diagnosis characterized by morphological, functional, clinical and laboratory features of kidney damage lasting more than 3 months; or glomerular filtration rate (GFR) < 60 ml / min / 1,73 m2. The urgency of the problem of kidney damage is increasing all the time, as this pathology covers from 10 to 16% of adult population in the world. In 2011, UN experts named kidney disease the most important noninfectious diseases of today [1-5]. Every seventh U.S. resident has chronic kidney disease, which accounts for about 20% of total medical costs [Coresh J, et al., 2007]. In 1990, chronic kidney disease (CKD) ranked 27th among all causes of mortality, while in 2010 it ranked 18th (grew by approximately 82%), making it the third highest mortality cause among the 25 major causes of death (after HIV / AIDS - 39%, and diabetes - 93%) [R. Lozano, etal. 2012; Jha V., etal. 2013]. In Ukraine, at the beginning of 2004, there were 9647 CKD patients, 1634 of whom were registered for the first time.

By the end of 2007, there were already 435 468 patients diagnosed with chronic kidney disease (CKD), 49 267 of whom were firstly identified [6].

CKD can be a consequence of various kidney pathologies, among them chronic glomerulonephritis, glomerulosclerosis, polycystic kidney disease, glomerulosclerosis against diabetes, arterial hypertension, hyperhomocysteinemia and other systemic diseases, congenital and acquired disorders of tubules function and other bilateral disorders and so on. Equally important is iatrogenic nephrotoxicity, which is a consequence of xenobiotics activity, incl. medicines.

Nowadays, there are a large number of drugs and biologically active compounds with nephroprotective action. Each of these drugs has its own pharmacodynamic characteristics, its indications and contraindications, which often limit the effective pharmacocorrection of excretory organs diseases. Therefore, the search for new approaches to enhancing the protective effect on kidney remains a topical challenge in pharmacology. It is undoubtedly expedient to use the most physiological and complex active agents that have sufficient organoprotective activity and a minimal number of adverse reactions, even under conditions of prolonged use [8].

These requirements are met by natural polyphenolic compounds, in particular, flavonoid quercetin recommended in chronic glomerulonephritis as an angioprotective drug. It has a polytropic organoprotective effect. In preclinical studies nephroprotective activity of modern grug forms of quercetin has been proved [9, 10].

Multifaceted nephroprotective activity is characteristic not only of flavonoids, but also of representatives of other groups of plant BAS [11]. Among them there is stilbenoid resveratrol, which has often become the focus of numerous studies, mainly due to its powerful antioxidant, anti-inflammatory and anti-apoptotic action, which is important in treatment and prevention of numerous cardiovascular and oncological diseases. [12]. A powerful antioxidant effect is also characteristic of the class of isoflavones, among which genistein has the greatest antiradical action. It can have a direct antioxidant effect and also increase the activity of antioxidant protection enzymes [12]. Antioxidant, cytoprotective, osteotropic, antiapoptotic and antitumor effects of genistein are also due to its property of being an estrogen receptor antagonist-antagonist [13]. Previous studies [14] established the ability of genistein and quercetin to exhibit renoprotective effect under diclofenac-induced nephrotoxicity in the experiment.

It is known from the literature that in kidney damage pathogenesis in experimental chronic kidney disease in rats, an impaired process of enzymatic formation and utilization of endogenous H2S in kidneys plays an important role [15]. Nowadays, information about the effect of natural polyphenolic compounds on the state of hydrogen sulfide system in the rat body is very limited. The effects of genistein, resveratrol and quercetin on H2S metabolism in rat kidney in chronic kidney disease remain unexplored. The role of H2S system in realizing nephroprotective potential of these bioflavonoids has not been elucidated. This work is dedicated to solving these problems.

The purpose of the research is to study the effect of flavonoids (quercetin, resveratrol) and isoflavonoids (genistein) on the markers of glomerular and tubular

apparatus of excretory organs and to establish their effect on hydrogen sulfide system in kidneys of rats with experimental chronic kidney disease (CKD).

Materials and methods of the research. The research was performed on Wistar male rats weighing 300-330 g obtained from the vivarium of Institute of Pharmacology and Toxicology of the National Academy of Medical Sciences of Ukraine, which were under the conditions of Vinnytsya National Pirogov Memorial Medical University (VNMU) vivarium. The rats were kept on standard balanced diet, day / night (12 hours) illumination with free to water, which meets the current sanitary and hygienic standards of keeping laboratory animals.

The studies were conducted according to the general ethical principles of animal experimentation and approved by Bioethics Commission of VNMU. The experimental animals were divided into 5 groups of 10 animals in each. Chronic kidney disease was caused by unilateral nephrectomy followed by subtotal (5/6) resection of contralateral kidney [16]. Sham-operated animals had tissue resection, followed by suturing without removal of the kidney. Group 1 consisted of CKD animals without treatment (control). The rats of the three study groups were once daily intragastrically injected with genistein (5 mg / kg), resveratrol (50 mg / kg) and quercetin (20 mg / kg) (Sigma-Aldrich, St. LouiS, MO, USA) respectively in 30% dimethyl sulfoxide solution at the rate of 0,5 ml per 100 g of animal weight. Doses were borrowed from the literature and responded to have a positive effect on the kidney function of animals without experimental lesions [17]. The Sham-operated and control rats received equivolume solvents.

Functional and biochemical changes in kidneys were evaluated on 41st day after CKD reproduction. Animal euthanasia was performed under thiopental anesthesia (30 mg / kg by weight intraperitoneally). The study used blood, urine, and supernatants samples of post-nuclear kidney homogenate. The assessment of the functional state of the kidneys was determined after water loading (5% of body weight). The content of H2S in kidney supernatant was determined spectrophotometrically by reaction with N, N-dimethyl-para-phenylenediamine in the presence of FeCl3 [18.]. The activity of H2S-synthesizing enzymes - cystathionine-γ-lyase (CSE, EC 4.4.1.1), cystathionin-β-synthase (CBS, EC 4.2.1.22), cysteine aminotransferase (CAT, EC 2.6.1.3) was evaluated for the growth of sulfide anion [19]. Substrate and cofactor concentrations, pH values, and incubation time, which provided optimal enzyme activity determination conditions, were selected a priori. The ability of kidneys to utilize exogenous H2S was determined by the rate of decrease in sulfide anion concentration in incubation medium [20].

Creatinine content in serum and urine was determined by Jaffa method using standard sets of Filisit-Diagnostics, Ukraine. Creatinine clearance and water reabsorption coefficient were calculated by the formulas [21]. Sodium and potassium content in serum and urine were determined by spectrophotometric method according to the standard set of Filisit-Diagnostics, Ukraine.

Total protein content in post-nuclear renal and urinary supernatant kidney homogenate was determined by microburette method, [22].

All quantitative data were expressed as the mean ± standard deviation. The data

were analyzed by ANOVA (Analysis of variance) followed by Dunnett's test (Statistical Package for Social Sciences, SPSS 17.0, USA). The distribution of traits in the sample was corrected using Shapiro-Wilk test. Differences were considered significant in the case of $p < 0,05$.

Results and discussion. According to the data obtained, the use of polyphenolic compounds under the conditions of experimental chronic kidney disease in rats had a positive effect on main pathogenetic links of CKD development. In particular, their administration reduced azotemia and restored nitrogen balance in animals. Thus, in the CKD + Genistein group, blood plasma creatinine content was significantly lower by 24,8% and in urine by 24,2% higher than in the untreated group. The effect of resvetartrol and quercetin was less pronounced: plasma creatinine level was lower by 19,2 and 13,8%, and in urine - by 17,1 and 13,6%, respectively, compared with the group of untreated animals (Table 1).

The use of bioflavonoids was accompanied by normalization of water-electrolyte shifts: probable increase in diuresis and filtration function of kidney under CKD, with genistein having the highest influence on these processes, which increased diuresis by 23,1%, and GFR - by 102% ($p < 0,05$)) compared to the group of untreated animals. In CKD + Resveratrol animals, diuresis was 19,1% higher and GFR 72,1% higher ($p < 0,05$) compared with the untreated group. Under quercetin administration, diuresis and GFR increased by 14,2 and 49,8%, respectively ($p < 0,05$).

Table 1

The influence of bioflavonoids on nitrogen balance, glomerular filtration and diuresis in rats with experimental chronic kidney disease (CKD) (M±m, n=10)

	Diuresis, ml / 8 h.	Plasma creatinine, μM / l	Urine creatinine, mM/ l	GFR, ml / min
Sham control	5,38±0,13	86,0±2,45	7,07±0,19	0,461±0,011
CKD (model control)	3,50±0,14*	130±4,36*	4,91±0,18*	0,139±0,008*
CKD + genistein	4,31±0,11*#	97,8±3,03*#	6,10±0,27*#	0,281±0,013*#
CKD+resveratrol	4,17±0,15*#	105±3,05*#	5,75±0,25*#	0,239±0,014*#
CKD + quercetin	4,00±0,18*#	112±3,36*#	5,58±0,21*#	0,208±0,011*#

** - p<0,05 versus sham control*

 # - p<0,05 versus model control

The use of bioflavonoids corrected impaired sodium and potassium content in blood and urine under CKD, but the efficacy depends on the compound selected. Thus, untreated animals showed probable increase in sodium and potassium (by 38,0 and 110%), with a simultaneous decrease in their urinary excretion (by 30,8 and 176%), respectively. The most pronounced normalizing influence on these indicators was shown by genistein. Its administration was accompanied by a significant decrease of sodium content in plasma by 17,9% and an increase in urinary excretion by 17,5%, as well as a decrease in blood plasma potassium content by 30,3% and 84,1% increase in urinary excretion relatively

to animals of group "CKD" (table. 2). The vector of changes in the potassium-sodium balance when quercetin and resveratrol were used was similar, but their effect was not as powerful.

Table 2

The influence of bioflavonoids on electrolit balance in rats with experimental chronic kidney disease (M±m, n=10)

Experimental groups	Sodium		Potassium	
	Blood plasma, мМ/l	Urine, μM / 8 h.	Blood plasma, мМ/l	Urine, μM / 8 h.
Sham control	142±4,07	2,40±0,12	4,60±0,14	38,2±1,06
CKD (model control)	196±3,11*	1,66±0,08*	9,68±0,17*	13,8±0,74*
CKD + genistein	161±3,52*#	1,95±0,07*#	6,75±0,29*#	25,4±0,83*#
CKD+resveratrol	170±3,32*#	1,91±0,08*#	7,26±0,34*#	20,1±0,78*#
CKD + quercetin	172±3,26*#	1,86±0,04*#	7,73±0,35*#	17,6±0,65*#

** - p<0,05 versus sham control*
 # - p<0,05 versus model control

Bioflavonoids also had positive effect on tubular apparatus of kidneys under CKD. All three compounds stimulated the reabsorption of water, and, as in other indicators, the onset of the effects was genistein. Resveratrol and quercetin stimulated the processes of water reabsorption in nephron tubules under CKD by 95,7-96,9% and 95,2-96,5%, respectively (Fig. 1).

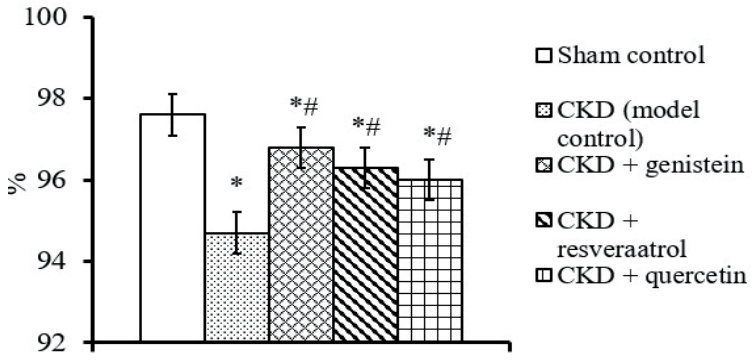


Fig. 1. The influence of bioflavonoids on the water reabsorbtion ratio in rats with experimental chronic kidney disease (M±m, n=10). * - p<0,05 versus sham control; # - p<0,05 versus model control

Another clinical indicator of impaired renal function in CKD is proteinuria. In untreated animals, 69,6% increase in urinary protein content was observed relative to animals without pathology. Against the background of administration of genistein,

resveratrol and quercetin, a significant decrease in proteinuria was observed by 22,8, 17,2 and 12,4%, respectively, relatively to untreated animals (Fig. 2).

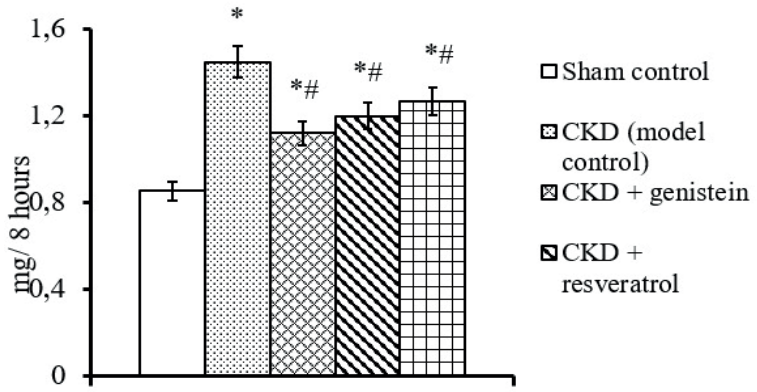


Fig. 2. The influence of bioflavonoids on the protein excretion in rats with experimental chronic kidney disease (M±m, n=10). * - p<0,05 versus sham control; # - p<0,05 versus model control

The data obtained demonstrate pronounced nephroprotective effect of all three compounds used in chronic kidney disease. The use of polyphenols in CKD improves filtration functions of kidneys, processes of water reabsorption, electrolyte exchange, the state of the tubular apparatus.

It is reasonable to ask about the mechanisms through which the positive re-protective effect of these compounds is realized. According to the literature, the plant polyphenols preparations are inherent in their powerful antioxidant, anti-inflammatory, anti-apoptotic effect, etc. []. However, as our previous results have shown in conditionally healthy rats, the molecular mechanisms of action of these compounds also include effects on hydrogen sulfide system. It was shown that bioflavonoids genistein, resveratrol and quercetin stimulated H2S production in kidneys and exhibited potent nephrotropic action in intact rats [pharm. and tox 2019]. Therefore, we further evaluated the effect of these polyphenols on H2S metabolic rates in kidneys and the parameters of kidney function under experimental CKD.

Applied polyphenols were found to stimulate enzymatic H2S formation in rat kidney in CKD (Table 3). Their effect on the activity of H2S-producing enzymes depended on the polyphenol selected. Thus, the use of genistein in CKD had the most potent effect on H2S synthesis in kidneys. Under these conditions, activity of CSE, CBS and CAT in kidneys exceeded by 18,7, respectively; 18,0 and 22,5% (p <0,05), respectively, in the untreated group.

Administration of resveratrol had a less pronounced effect on H2S-producing enzymes activity in rat kidney under CKD compared with genistein. Under these conditions, activity of CSE, CBS and CAT in kidneys exceeded, respectively, by 12,7;

13,9 and 15,6% (p <0,05) were those in the group of CKD animals that did not receive polyphenolic correctors.

Quercetin had the least potent effect on H2S enzymatic formation in rat kidney under CKD. It was found that administration of this polyphenol was accompanied by a significant increase in CBC activity in kidneys by 21,6% (p <0,05). At the same time in the CKD + Quercetin animals, activity of H2S production in the reactions catalyzed by HCG and CAT was not significantly different from the ones in CKD animals that did not receive polyphenolic correctors.

Table 3

The influence of bioflavonoids on the activity of H2S-producing enzymes in rats kidney with experimental chronic kidney disease(M±m, n=10)

Experimental groups	Enzyme activity, nMH2S / min·mg of protein		
	CSE	CBS	CAT
Sham control	1,72±0,06	2,24±0,10	2,43±0,12
CKD (model control)	1,23±0,05*	1,56±0,04*	1,60±0,08*
CKD + genistein	1,46±0,05*#	1,84±0,06*	1,96±0,07*
CKD+resveratrol	1,39±0,03*#	1,78±0,08*#	1,85±0,07*#
CKD + quercetin	1,15±0,06*	1,90±0,06*#	1,67±0,08*

** - p<0,05 versus sham control*

 # - p<0,05 versus model control

The introduction of the tested bioflavonoids reduced, induced by CKD, acceleration of non-enzymatic degradation of H2S in kidneys of rats (fig.2). It has been shown that administration of genistein for animals with CKD had the least potent effect on H2S utilization in rat kidneys. In CKD + Genistein group, the average rate of exogenous H2S utilization in kidneys was 18,9% lower (p <0,05) compared to CKD group, but remained significantly higher than in the control group.

In its ability to slow the oxidative degradation of H2S in kidneys of rats, the polyphenolic compound resveratrol is slightly inferior to that of genistein. Under these conditions, the average rate of utilization of exogenous H2S in kidneys was 17,6% lower (p <0,05) compared with CKD group, but remained significantly higher than in the control group.

Of all the polyphenols, quercetin had the least effect on processes of H2S utilization in th kidneys. In CKD + Quercetin animal group, the average rate of exogenous H2S utilization in kidneys was 20,5% lower (p <0,05) compared with CKD group, but remained significantly higher than in the control group.

The selected polyphenolic compounds reduced H2S deficiency in rat kidneys, which occurs under the conditions of CKD modeling (Fig. 3). In this case, the most pronounced effect on H2S level was of genistein. In animals treated with genistein, H2S content in the kidneys exceeded by 30,8% (p <0,05) than in the group of untreated CKD animals.

The other two flavonoids were inferior in their severity.

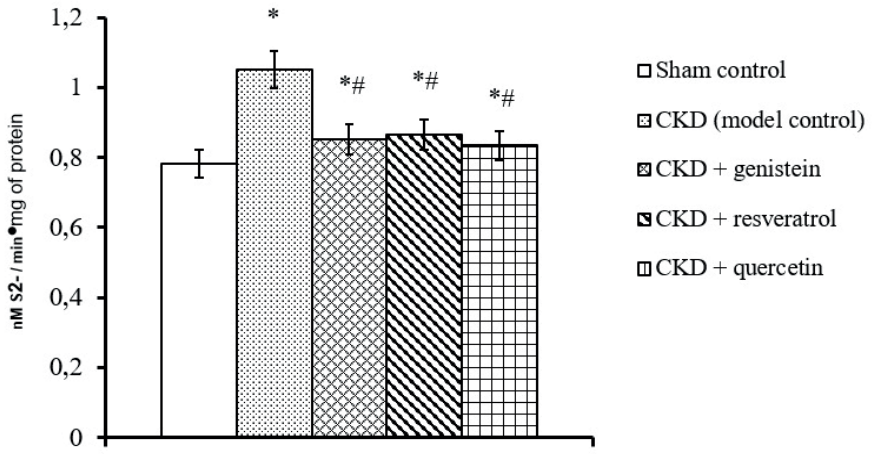


Fig. 3. The influence of bioflavonoids on the rate of exogenous H2S utilization in rats kidney with experimental chronic kidney disease (M±m, n=10).
* - p<0,05 versus sham control; # - p<0,05 versus model control

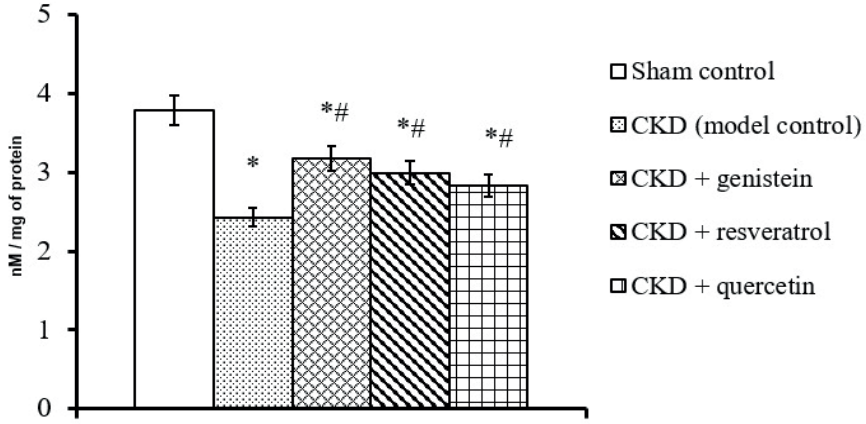


Fig. 4 The influence of bioflavonoids on the H2S level in rats kidney with experimental chronic kidney disease (M±m, n=10). * - p<0,05 versus sham control;
- p<0,05 versus model control

Thus, we have shown that the nephroprotective properties of the bioflavonoids genistein, resveratrol, and quercetin are mediated through effects on renal H2S system. The use of the investigated polyphenolic compounds, especially genistein, was accompanied by an increase in renal H2S content. However, the mechanisms of their

action on H2S system differed depending on the compound selected. Thus, genistein and resveratrol increased H2S production by activating the three enzymatic systems CSE, CBS, and CAT, while quercetin increased CBS activity only. All investigated polyphenols decreased the rate of H2S utilization, and quercetin most prevented its oxidative degradation.

Conclusions. Adminitration of polyphenols under CKD exhibits nephroprotective properties (for example, GFR significantly increases by 49,8-102%, proteinuria is significantly reduced by 12,4-22,8%, $p < 0,05$), which is coupled with the activation of H2S-producing enzymes (by 12,7-22,5%, $p < 0,05$), decrease in exogenous H2S utilization rate in kidneys (by 17,6-20,5%, $p < 0,05$) and increase in H2S content (by 16,4 -30,8%, $p < 0,05$). Among polyphenols, genistein had the most pronounced corrective influence on the functional parameters of the kidneys and the state of the H2S system in CKD.

Prospects for further research. Further study of hydrogen sulphide system in the kidneys, changes in its activity in various pathological states of excretory organs and the impact of medicinal substances and biologically active compounds on it will allow substantiate the role of hydrogen sulphide as a molecular target for improving nephroprotection and will be a theoretical foundation for development of new approaches to prevention and medical treatment of kidney lesions.

References:

1. Ene-Iordache, B., Perico, N., Bikbov, B., Carminati, S., Remuzzi, A., Perna, A. … Remuzzi, G. (2016). Chronic kidney disease and cardiovascular risk in six regions of the world (ISNKDDC): a cross-sectional study. Lancet Glob. Health. Vol. 4, no 5, pp. 307–319.

2. Sanyaolu, A., Okorie, C., Annan, R., Turkey, H., Akhtar, N., Gray, F. … Nwaduwa, C. (2018) Epidemiology and management of chronic renal failure: a global public health problem. Biostatistics Epidemiol. Int. J., Vol. 1. no1, pp. 11-16.

3. Hall, Y.N. (2018). Social Determinants of Health: Addressing Unmet Needs in Nephrology. Am. J. Kidney Dis., Vol. 72, no 4, pp. 582-591.

4. Kidney Disease: Improving Global Outcomes (KDIGO) Acute Kidney Injury Work Group. (2012). KDIGO Clinical Practice Guideline for Acute Kidney Injury. Kidney Inter. no 2, Suppl. pp. 1–138.

5. Babenko, Z.V. (2019). Epidemiological aspects of chronic kidney disease (literature review). Journal of Marine Medicine, 2(83), pp.135-140.

6. Ivanov, D.D. (2018). Chronic kidney disease: Differention renoprotection practice [Khronichna khvoroba nyrok: dyferentsiyna taktyka renoprotektsiyi]. Ukrainian Medical Journal. III/IV, no 2(124), pp. 1-5.

7. Levey, A.S., Stevens, L.A., Schmid, C.H., Zhang, Y.L., Castro, A.F. 3rd, Feldman, H.I., … Coresh, J.; CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) (2009) A new equation to estimate glomerular filtration rate. Ann Intern Med. 150(9), pp.604-612.

8. Smirnov, A.B., Yesayan, A.M., Kayukov, I.G., Kucher, A.G., Dobronravov, B.A.,

Tugusheva, F.A. (2004). Modern approaches to slow the progression of chronic kidney disease [Sovremennyye podkhody k zamedleniyu progressirovaniya khronicheskoy bolezni pochek] Nephrology, no 3, pp. 89-99.

9. Kovalev, V.B., Kogan, V.V, Kolchina, E.Yu. (1999). The mechanisms of the therapeutic effect of bioflavonoid quercetin [Mekhanizmy lechebnogo deystviya bioflavonoida kvertsetinu] Механизмы лечебного действия биофлавоноида кверцетину. Ukrainian Medical Almanac, no 4, pp. 176-182.

10. Zupanets, I.A., Shebeko, S.K., Kharchenko, D.S. (2009). Experimental study of the pharmacological properties of the parenteral form of quercetin in condition of development of chronic renal failure [Eksperymental′ne vyvchennya farmakolohichnykh vlastyvostey parenteral′noyi formy kvertsetynu v umovakh rozvytku khronichnoyi nyrkovoyi nedostatnosti]. News of Pharmacy, no 2 (58), pp. 75-78.

11. Tovchiga, O.V., Strygol, S.Yu., Koiro, O.O. (2012). Medicinal plants and excretory function of the kidneys [Lekarstvennyye rasteniya i vydelitel'naya funktsiya pochek] Bukovinian Medical Herald, 16 (63), part 2, pp. 29-31.

12. Chu, C., Lu, F.J., Yeh, R.H., Li, Z.L., Chen, C.H. (2016). Synergistic antioxidant activity of resveratrol with genistein in high-glucose treated Madin-Darby canine kidney epithelial cells. Biomed Rep., 4(3), pp. 49-354.

13. Levitskiy, A.P., Makarenko, O.A., Sukmanskiy, O.I. (2002). Phytoestrogens (biochemistry, pharmacology, medical application) [Fitoestrogeny (biokhimiya, farmakologiya, primeneniye v meditsine)] Odessa: Moryak, 95 p.

14. Voloshchuk, N.I. (2008) Comparative evaluation of the nephrotoxic effect of diclofenac sodium, nimesulide and celecoxib in male and female rats and the nephroprotective effect of flavonoids and isoflavonoids [Porivnyal′na otsinka nefrotoksychnoyi diyi dyklofenaku natriyu, nimesulidu ta tselekoksybu u samtsiv ta samok shchuriv ta nefroprotektyvna diya preparativ flavonoyidiv ta izoflavonoyidiv]. Pharmacology and drug toxicology, no 5-6, pp. 68-74.

15. Feliers, D., Lee, HJ, Kasinath, BS. (2016). Hydrogen Sulfide in Renal Physiology and Disease, Antioxid Redox Signal, 25(13), pp.720-731.

16. Strygol, S.Yu., Lisoviy, V.M., Zupanets, I.A., Shebeko, S.K., Maslova, N.F., Gozenko, A.I. ... Kharchenko, D.S. (2009) Methods of experimental renal involvement for pharmacological studies [Metody eksperymental′noho urazhennya nyrok dlya farmakolohichnykh doslidzhen′] Guidelines. Kiyiv, 36 p.

17. Voloshchuk, N.I. Konjuch, S.A., Denysiuk, O.M., Saenko, A.V. (2019). Research of the effects of genisteine, resveratrol and quercetin on the indicators of hydrogen sulphide exchange in the kidneys and the markers of the functional state of kidneys in conditionally healthy rats [Doslidzhennya vplyvu henisteyinu, resveratrolu ta kvertsetynu na pokaznyky obminu hidrohen sul′fidu v nyrkakh i markery funktsional′noho stanu nyrok v umovno zdorovykh shchuriv]. Pharmacology and drug toxicology, no 13 (3), 187–196.

18. Wiliński, B., Wiliński, J., Somogyi, E., Piotrowska, J., Góralska, M. (2011) Amlodipine affects endogenous hydrogen sulfide tissue concentrations in different mouse organs Folia Med Cracov. 2011. 51(1-4), pp. 29-35.

19. Zaichko, N.V., Melnyk, A.V., Olchovskiy, O.S., Zaichko, K.O. Method for determining of H2S-producing activity in animal myocardium [Sposib vyznachennya H2S-produkuyuchoyi aktyvnosti miokarda tvaryn]. Patent 75683 Ukraine no u2012 06388; publ. 10.12.2012; bulletin no 23.

20. Zaichko, N.V., Olchovskiy, O.S., Yurchenko, P.O., Melnyk, A.V., Shtatko, O.I. (2013) Method for determining of H2S utilization in animal organs [Sposib vyznachennya utylizatsiyi H2S v orhanakh tvaryn]. Patent 87884 Ukraine no u2013 10024; publ. 25.02.2014; bulletin no 4.

21. Menshikov, V.V. (editor). (1987). Laboratory research methods in the clinic [Laboratornyye metody issledovaniya v klinike] M.: Medicine, 368 p.

22. Kochetov, G.A. (1980) Practical guide on enzymology. M.: Vysshaya shkola, 272 p.

ROLE OF UROFLOWMETRY IN A CLINICAL STUDY OF PATIENTS WITH CHRONIC PROSTATITIS

Tatyana Kvyatkovskaya,
Doctor of Medical Sciences, Professor,
SE "Dnepropetrovsk Medical Academy of the Ministry of Health of Ukraine",
Yevgeniy Kvyatkovsky,
Candidate of Medical Sciences,
Clinical hospital N9 of the Dnipro city,
Valentin Kosse, *MD, Professor,*
Dnipro Medical Institute of Traditional and Non Traditional Medicine

Annotation. *We studied 154 patients with chronic prostatitis aged 20-70 years (mean age 48.9 years). The control group consisted of 66 patients aged 20-70 years (mean age 48.7 years) without urinary tract pathology. All patients underwent uroflowmetry using a Potok-K uroflowmeter and an ultrasound examination of the bladder and prostate with determination of post-void residual volume and prostate volume. During uroflowmetry, the average volumetric urine flow rate, maximum volumetric urine flow rate, urine flow acceleration, flow time, time to maximum flow and voiding waiting time were determined, and nomograms of the maximum and average volumetric flow rate were used and a qualitative assessment of uroflowgrams was performed. A normal type of uroflogram was detected in 42.9% of patients with chronic prostatitis, intermittent in 12.3%, superflow in 9.1%, preobstructive in 9.1%, obstructive in 13.6%, and interrupted in 13% patients.*

For patients of a younger age, intermittent and superflow types of uroflograms are characteristic, which may indicate detrusor sphincter dysinergy and hyperactivity of the bladder. In older patients, obstructive and obstructively interrupted uroflowgram types are more often observed. In patients with chronic prostatitis, the earliest indicator of urodynamic disturbance is a decrease in urine flow acceleration. Marked changes in uroflowgrams were noted in 26.6% of patients with obstructive and obstructively interrupted type of voiding. These patients are shown the appointment of alpha-1-blockers that improve the function of the detrusor and the neck of the bladder. The proposed pharmacurodynamic test with a single dose of silodosin allows you to develop indications for the appointment of alpha-1-blockers.

Key words: *uroflowmetry, chronic prostatitis, urodynamics of the lower urinary tract.*

Chronic prostatitis is one of the most common urological diseases, often accompanied by the manifestation of dysuric symptoms, pain in the genitourinary system and is often associated with sexual dysfunction [1]. The frequency of chronic prostatitis among the male population is 5-8%, among men 20-50 years old – up to 10%, older than 50 years old – 9-16% [2-4], in Ukraine among men 20-60 years old – about 19% [5]. Approximately 50-60% of men with chronic prostatitis experience lower urinary tract symptoms [6].

An impressive layer of publications on the diagnosis and treatment of chronic prostatitis, unfortunately, contains few works on the urodynamics of the lower urinary tract. An objective assessment of urodynamic disorders in chronic prostatitis is an

important factor in the development of therapeutic tactics. At the same time, the need to use uroflowmetry as a non-invasive method for assessing urodynamics of the lower urinary tract with prostatitis has not yet been sufficiently argued.

The purpose of the study was to clarify the significance of uroflowmetry data in the examination of patients with chronic prostatitis.

Materials and methods. 154 patients with chronic prostatitis type III A (19 patients) and III B (135 patients) aged 20 to 70 years (mean age 48.9 years) were studied. Disease duration varied from 1 year to 6 years. The control group consisted of 66 patients without pathology of the urinary tract, aged from 21 years to 70 years with an average age of 48.7 years similar to the age of patients with chronic prostatitis. All patients underwent examination, including digital rectal examination, microscopy of prostate secretion, urethral scraping by PCR, bacteriological examination of prostate and urine secretion, urinalysis, ultrasound with determination of post-void residual volume (PVR) and prostate volume (PV), as well as uroflowmetry.

Studies of urine flow during urination were performed using a Flow-K uroflowmeter (Ukraine, developer A.E. Kvyatkovsky). Uroflowmetry results were evaluated by the following parameters: voided volume (ml), average volumetric urine flow rate Qav (normal 10-20 ml/s), maximum volumetric urine flow rate Qmax (normal 15-30 ml / s), urine flow acceleration UFA (about 5 ml/s^2), flow time TQ (normal <20 s), time to maximum flow Tmax (normal 4-12 s), voiding waiting time Twait (normal 1-5 s) [7]. Using the Liverpool Nomograms, the average and maximum volumetric flow rates corresponded automatically to the age norm regardless of the volume of urine excreted. Considering that the graphical type of curves is of no small importance in the interpretation of uroflograms, a qualitative assessment of uroflograms was carried out.

Studies of the prostate gland, bladder, determination of prostate volume and PVR were performed using a HONDA HS-2000 ultrasound machine. Statistical data processing was carried out in Excel; Student's test was used to compare statistical data.

Results and discussions. As a result of the analysis of the obtained uroflograms in patients with chronic prostatitis, the following types of curves were distinguished: “normal”, “superflow type” uroflograms (with high flow rate, rapid achievement of the maximum flow rate and flow time), “intermittent type” uroflograms (with alternating significant increase and decrease in flow rate), "obstructive type" uroflograms (with a significant decrease in flow rate parameters, values of speed indicators for nomogram below the line of the 25% distribution of normal indicators), uroflowgrams of the “preobstructive type” (with a slight decrease in velocity indicators and a slight deviation from the norm on the nomograms), “uroflowgrams of the obstructively interrupted type” (with a significant decrease in the velocity of urine flow and interruption of voiding) (tab. 1).

In chronic prostatitis, the normal type of uroflowgrams reflecting normal urination was found in 42.9% of cases, deviations from the norm were observed more often - in 57.1% of cases.

Of the uroflowgrams with deviations from the norm, uroflowgrams with signs of dynamic infravesical obstruction of various degrees of severity (preobstructive,

obstructive, obstructively interrupted type) were most often found – more than a third of uroflowgrams (35.7%). Of all cases with a deviation from the normal type of uroflowgram, they amounted to 62.5%.

Table 1

Frequency of various types of uroflowgrams in patients with chronic prostatitis

Types of uroflowgrams	Number of patients	Frequency	The average age of patients (age limits), years
Normal	66	42,9 %	42,8 (20-70)
Superflow	14	9,1 %	31,2 (22-55)
Intermittent	19	12,3 %	46,9 (27-70)
Preobstructive	14	9,1 %	52,5 (27-70)
Obstructive	21	13,6 %	54,3 (30-70)
Obstructively interrupted	20	13 %	57,4 (25-70)

In a quarter of cases (25.3%), uroflowgrams with an unstable flow and sharp fluctuations in the volumetric flow rate (intermittent and obstructively interrupted types) were observed, which of all cases with deviations from the norm was 44.3%. The irregular nature of intermittent uroflowgrams is inherent in disorders such as detrusor sphincter dysinergy and dysfunction of the bladder neck. With the obstructively interrupted type of uroflowgram, apparently, there is a combination of mismatch between the detrusor and the sphincter apparatus of the urethra, as well as dynamic infravesical obstruction due to inflammation and venous stasis in the prostate.

Rarely, there was a rapid type of uroflowgram (9.1%), moreover, in patients of a younger age, which reflects their tendency to hyperactivity of the bladder.

The data on the prostate volume and PVR obtained as a result of ultrasound examination of patients with chronic prostatitis are presented in table. 2.

Table 2

Voided volume, prostate volume and PVR in patients with chronic prostatitis, M ± m

Types of uroflowgrams	Voided volume (ml)	Prostate volume (cm3)	PVR (ml)
Normal	235,5±10,3	16,95±0,68	8,79±0,88
Superflow	221,6±21,8	15,53±1,55	8,14±1,49
Intermittent	252,3±18,2	16,42±1,13	9,64±1,36
Preobstructive	212,6±23,8	18,59±1,58	15,96±2,87
Obstructive	243±20,1	17,57±1,02	29,02±4,82
Obstructively interrupted	207,9±22,5	21,20±1,26	27,30±7,48

The average values of prostate volume and PVR in patients of the first four types of uroflowgrams were within normal limits. In patients with chronic prostatitis with obstructive urination, the average prostate volume did not statistically differ from that in patients with a normal type uroflowgram, but PVR was 3 times large on average ($p < 0.01$). We conditionally divided this group of patients with chronic prostatitis into two subgroups: patients with PVR ≤ 30 ml and patients with PVR > 30 ml. It turned out that in patients with PVR > 30 ml the average prostate volume was 1.35 times greater ($p < 0.01$), and the average PVR was 3.88 times greater ($p < 0.001$) compared with the first subgroup. A slight increase in prostate volume in the second subgroup is explained by swelling of the prostate gland, flattening of the median groove, which was detected by palpation. The average age of patients in the first subgroup was 51.9 years, the second – 58.1 years. An increase in PVR in the second subgroup can be associated both with stagnation in the prostate gland and with an age-related decrease in the compensatory capabilities of the detrusor.

Uroflowmetric indicators of patients in the control group, as well as patients with chronic prostatitis, depending on the type of uroflowgram are presented in table. 3.

Table 3

Uroflowmetric indicators of urine flow in the control group and patients with chronic prostatitis, M ± m

Types of uroflowgrams	Qav (ml/s)	Qmax (ml/s)	UFA (ml/s^2)	TQ (s)	Tmax (s)	Twait (s)
Normal (control group)	17,47±0,67	30,24±1,08	4,97±0,40	14,45±0,49	7,43±0,37	4,90±0,48
All types of uroflowgrams (prostatitis)	12,49±0,53	22,55±0,85	3,02±0,22	23,84±1,27	11,81±0,70	9,95±1,74
Normal	14,66±0,53	25,17±0,91	3,37±0,21	17,00±0,94	8,83±0,67	5,22±0,70
Superflow	11,36±0,84	23,89±2,10	2,04±0,20	23,43±1,91	13,02±1,15	12,55±2,83
Intermittent	25,88±1,14	41,25±1,83	8,68±0,64	8,45±0,62	5,12±0,47	10,17±2,59
Preobstructive	8,41±0,57	16,21±1,92	1,93±0,54	24,67±1,48	10,6±1,13	13,58±8,95
Obstructive	5,47±0,44	12,30±0,99	1,36±0,35	48,67±4,57	17,22±2,89	6,84±1,88
Obstructively interrupted	7,25±0,74	14,70±1,55	1,36±0,54	30,95±2,95	20,35±2,40	22,11±10,07

If we do not differentiate the results of uroflowmetry in chronic prostatitis depending on the types of uroflowgrams, then all quantitative indicators, with the exception of the urine flow acceleration, which was reduced, on average corresponded to the generally accepted norm. At the same time, in comparison with the control group, the indicators of the volumetric flow rate were lower, and the time indicators were higher. The urine flow acceleration was reduced by 1.6 times compared with the control group, Qmax – by 1.3 times.

In the group of patients with chronic prostatitis with a normal type of uroflowgram, the average quantitative values of the uroflowmetry parameters did not go beyond the generally accepted norm, and on the Qmax and Qav nomograms exceeded the 50th percentile. The only indicator whose average value was lower was UFA. However, when comparing the uroflowmetry parameters of this group of patients with chronic prostatitis with a control group of men, similar in quantitative, age composition and average voided volume, all speed indicators were significantly lower ($p < 0.05$). The flow time was significantly greater ($p < 0.05$) than in the control group, Tmax and Twait did not differ significantly ($p > 0.05$).

In patients with chronic prostatitis with intermittent type of uroflogram, the flow rate of urine during urination underwent significant fluctuations, and uroflograms were intermittent. These manifestations are associated with the alternation of episodes of uncontrolled contraction and relaxation of the urethral sphincter during urination. The frequency and amplitude of the fluctuations in the volumetric flow rate had a wide spectrum of patterns – from slow-wave to "staccato". The urine flow acceleration in these patients on average was significantly lower compared with the group of patients with the normal type of curve ($p < 0.01$), other indicators of velocity were within normal limits, although slightly reduced compared with the control group. Flow time increased by more than 2 times ($p < 0.01$). At the same time, the average values of TQ and Tmax only slightly exceeded the indicators of the generally accepted norm.

Patients with a superflow type of uroflogram had a significant increase in urine flow rate, especially UFA, and a decrease in TQ and Tmax relative to the control group and the group of patients with a normal curve type ($p < 0.05$), which indicated detrusor hyperactivity. It is necessary to pay attention to the fact that the average age of patients in this group was less than in other groups, and averaged 31.2 ± 2.5 years. In patients with a superflow and frequent urination, a mirabegron beta-3-adrenergic agonist, which has a relaxing effect on the detrusor, can have a good effect.

In the group of patients in which uroflograms corresponded to unexpressed obstruction, Qmax and Qav were on average slightly lower than the generally accepted norm and significantly lower than in the control group ($p < 0.01$), the rate of urine flow acceleration was most reduced (on average 2.6 times). Often the dome of the curve was shifted to the right, which may indicate a slow opening of the neck of the bladder. TQ and Tmax were increased. Increased by 2.8 times was the voiding waiting time.

Thus, unexpressed changes in the flow of urine in chronic prostatitis in young people were more often manifested by an intermittent and superflow type of urination, in men older than 50 years – the appearance of signs of preobstructive type, which may be associated with age-related changes in the genitourinary system.

In the group of patients with obstructive urination, urine flow rates with uroflowmetry were reduced by 2 or more times, especially UFA (2.5 times on average), and TQ and Tmax were increased compared to the group with the normal type of uroflowgram ($p < 0,01$).

In patients with chronic prostatitis with an obstructively interrupted type of uroflowgram, uroflowmetry indicators were almost at the same level as in the group

of patients with obstructive type of uroflowgram. There was a significant decrease in all velocity indicators and an increase in all time indicators compared with the group of patients with the normal type of uroflowgram ($p < 0.05$), regardless of the number of PVR. The indicators of uroflowmetry in the subgroup of patients with PVR > 30 ml did not differ significantly from the subgroup of patients with PVR ≤ 30 ml, with the exception of UFA, which was significantly lower by 1.79 times, and Twait, which was the largest among all groups of patients (41.71 ± 24.76 s). An increase in the voiding waiting time in patients with chronic prostatitis may be associated with difficulty opening the neck of the bladder due to dynamic infravesical obstruction. An obstructively interrupted uroflowgram type was more often detected in patients with chronic prostatitis older than 50 years old, and was observed both in patients with an increased amount of residual urine and in patients with a small amount of residual urine. The quantitative parameters of uroflowmetry were independent of PVR, and PVR was not associated with PV.

The use of alpha-blockers for the treatment of patients with chronic prostatitis, along with the appointment of antibacterial, non-steroidal anti-inflammatory and other drugs, can significantly improve urination [8, 9]. Alpha-adrenergic blockers, in addition to affecting the smooth muscles of the prostate and the internal sphincter of the urethra, being vasoactive substances, improve hemomicrocirculation in the prostate gland, impaired in chronic prostatitis. Their use is most relevant for the treatment of patients with obstructive and obstructively interrupted uroflowgram type. However, it can also be used to treat patients with manifestations of detrusor-sphincter dysinergy: with an obstructively intermittent and intermittent type of uroflowgram. The solution to the question of the appropriateness of the appointment of alpha-1-blockers is greatly simplified, thanks to the pharmacurodynamic test with silodosin, proposed by A.E. Kvyatkovsky [10]. Pharmacourodynamic test consists in uroflowmetry with determination of the maximum and average volumetric urine flow rate before taking and 2.5-3 hours after taking 8 mg of silodosin. Given the increase in the maximum and average volumetric urine flow rate by 25-30%, drug therapy with silodosin is prescribed, in the absence of changes or a slight increase in the maximum and average volumetric urine flow rate, treatment with alpha-1-blocker is considered inappropriate. In this case, further examination is necessary in order to identify the organic cause of obstruction. Pharmacourodynamic test is a highly informative method for predicting the expected result of treatment with silodosin. According to our, together with a team of authors, data [7], the use of alpha-1-adrenergic blocking agents in the complex treatment of chronic bacterial prostatitis gives good results: an improvement in lower urinary tract urodynamics was noted in 96% of patients.

Conclusions. Considering that more than half of patients with chronic prostatitis of type III A and III B have urination disorders (57.1%), uroflowmetry is important for their objectification.

The normal type of uroflowgram was detected in 42.9% of patients with chronic prostatitis. Unexpressed changes in the parameters of uroflowgrams (in patients with intermittent, superflow and preobstructive type of uroflowgrams) were detected in

30.5% of patients, pronounced changes in the parameters and nature of uroflowgrams (in patients with obstructive and obstructively interrupted type of uroflowgrams) – in 26.6% of patients.

Intermittent and rapid types of uroflowgrams, indicating detrusor sphincter dysinergy and hyperactivity of the bladder, are more often observed in patients of a younger age, obstructive and obstructively interrupted types, reflecting dynamic infravesical obstruction, in older patients.

The importance of the urine flow acceleration indicator for the early detection of urodynamic disorders in patients with chronic prostatitis is indicated by its primary decrease in patients with uroflowgram type, identified by other indicators and nomograms as normal, as well as its significant decrease in patients with preobstructive urination.

Quantitative indicators of uroflowmetry in chronic prostatitis are not directly dependent on the prostate volume and the post-void residual volume.

Patients with obstructive and obstructively interrupted uroflowgrams, which make up about a quarter of all patients with chronic prostatitis, are indicated for the use of alpha-1-blockers. The proposed pharmacurodynamic test with a single dose of silodosin allows you to develop indications for the appointment of alpha-1-blockers.

References:

1.Boyko N.I., Proschakov K.V. Comparative evaluation of the effectiveness of Prostatilen Zinc suppositories with other well-known analogues in the treatment of patients with chronic prostatitis and excretory toxic infertility. Urology. 2010.3: 92-98. Russian.

2.Goroviy V.I., Golovenko V.P., Kostyuchenko S.A. Dosvid congestion of the phytochymic prostatoprotector Pravenor in the complex therapy of illness for chronic abacterial prostatitis (category IIIB). Men's health. 2014.1 (48): 114-118. Ukraine.

3.Schaeffer A.J. Clinical practice. Chronic prostatitis and the chronic pelvic pain syndrome. N. Engl. J. Med. 2006.335 (16): 1690-1698.

4.Acute bacterial prostatitis: diagnosis and management. Coker T.J., Dierfeldt D.M. Am. Fam. Physician. 2016.93 (2): 114-120.

5.Gorpinchenko I.I., Gurzhenko Yu.N., Fedoruk A.S. A non-standard phytotherapeutic approach to the treatment of chronic pelvic pain syndrome in men. Men's health. 2011.4.57-63. Russian.

6.Nickel J.C. Lower urinary tract symptoms associated with prostatitis. Can. Urol. Assoc. J. 2012.6 (5 Suppl. 2): 133-135.

7.Kvyatkovskaya T.A., Kvyatkovsky E.A., Kvyatkovsky A.E. Uroflowmetry: a monograph. Dnipro: Lira, 2019.276 s. Russian.

8.Mehik A. Alas P., Nickel J.C., Sarpola A., Helstrom P.J. Alfuzosin treatment for chronic prostatitis / chronic pelvic pain syndrome: a prospective, randomized, doubleblind, placebocontrolled, pilot study. Urology. 2003.62: 425-429.

9.Gurzhenko I.M., Spiridonenko V.V. Combination of selective α1-blocker and organotropic peptide in relapsed recurrent prostatitis in young people. Medical aspects

of men's health. 2016.4 (23): 26-32. Ukraine.

10.Kvyatkovsky E.A., Kvyatkovsky E.A., Kvyatkovskaya T.A. Prediction of the expected efficacy of silodosin in the treatment of lower urinary tract symptoms in patients with benign prostatic hyperplasia. Men's health. 2017.2: 91-94. Russian.

EXPERIMENTAL DETERMINATION OF THE INFLUENCE OF CADMIUM SALT ON CARDIOGENESIS OF A RAT

Olena Nefedova,
Doctor of Medical Sciences, Associate Professor,
SI «Dnipropetrovsk Medical Academy of the Ministry of Health Ukraine»,
Oleksander Galperin,
postgraduate student,
Yuri Filippov,
Doctor of Medical Sciences, Professor,
Dnipro Medical Institute of Traditional and Non Traditional Medicine

Annotation. *The results of an experimental effect on the cardiogenesis of intragastric administration of cadmium chloride / cadmium citrate to pregnant female rats are discussed in the article. Except for groups of isolated cadmium salts administration, there were groups of combined administration of cadmium with citrates of germanium, cerium and composite iodine + sulfur. The second task was to study the effect of the studied salt solutions on the cardiogenesis of rat embryos, for which serial histological sections of the heart were made and the thickness of the chambers of the heart and interventricular septum were measured. The thickness of the compact myocardium of the heart chambers was measured as the main indicator of cardiogenesis.*

The effect of the indicated doses of cadmium salts on cardiogenesis in rats influenced differently on the thickness of the myocardial layer of various chambers of the heart: cadmium chloride thickened the wall of the left and right ventricle, both atriums with thickening of the interventricular septum. Cadmium citrate provokes thinning of the myocardium of the walls of both ventricles and local thickening of the interventricular septum. In the groups of combined administration, indicators of the thickness of the compact myocardium recovered, which indicates the modifying effect of citrates of the studied microelements on the cardiotoxicity of cadmium salts.

Key words: *rat embryo, cardiogenesis, cadmium, metal citrate, heart.*

Formulation of the problem. Increasing urbanization will inevitably complicate the environmental situation in areas occupied by industrial enterprises, transport highways together with adjacent territories. The influence of heavy metal compounds during prenatal development period, when major morphogenetic events occur and restructuring of the structural components of the embryo happen, birth defects are formed was studied. Data collected during this age period is of particular importance concerning the development and formation of the organism.

Among the urgent fundamental and applied problems of modern morphology, the attention of researchers is attracted by the study of regularities of the basic processes of morphogenesis and organogenesis under the influence of adverse environmental factors, among which heavy metal compounds are the most harmful [1,2].

Analysis of recent research and publications. Human activity has led to the redistribution of microelements, increase of the pollution of the environment with toxic substances, that is why modern medical researchers are paying more attention to

microelements and microelementosis. The stability of the chemical composition is one of the most important and necessary conditions for the normal functioning of the body. Deficiency of vital microelements and increased concentration of toxic in the environment lead to adverse effects on human life and the course of embryogenesis and organogenesis [3, 4]. The mechanisms by which cadmium may contribute to cardiovascular disfunction are being actively investigated: increase of blood pressure, increase of blood cholesterol level, increase of mutations in arterial wall cells [5, 6]. Cadmium, as some other metals, directly affects the vascular endothelium, which is accompanied by endothelin secretion, to which mast cells have specific receptors. The mechanism of action of endothelin is associated with activation of calcium ion input through potential-dependent calcium channels [7]. Contineous influense of cadmium cloride on the bodies of experimental animals leads to considerable morphological changes of the myocardium at all levels of its structural organization. Together with significant increase in the mass of different parts of the heart, dilatation of their chambers, injury of cardiomyocytes, endothelial cells, reduction of the reserve volumes of the ventricles, reduction of the capacity of the arteries, expansion of the venous part of the heart, hypoxia, etc. [8, 9, 10, 11], however, the effect of cadmium on the development of the heart during embryogenesis remains a poorly understood area. Thus, an actual trend in morphological experimental studies is to identify the spectrum of cardiogenesis disorders under the influence of cadmium salts on pregnant females and during compensation.

The purpose of the article – to determine experimentally the effect of cadmium salts administration on the course of cardiogenesis of rats. And to compare the influence when administration of cadmium salts is isolated and in combination with metal citrate.

Materials and methods. Experimental studies were performed on female rats of the strain Wistar (ursery «Далі», c. Kiev). Before the experiment, all animals were examined, weighed. Their motor activity and skin condition were taken into account. After external inspection and culling, the experiment started simultaneously with the control group. Rats were in the vivarium of State Institution Dnipropetrovsk medical academy of Health of Ukraine before and during the experiment. At a temperature of 20-25oC, humidity of not less than 50%, in ventilated rooms and day / night light mode in standard plastic cages no more than 3-4 species in each. On a standard diet. For carrying out the embryological experiment, females with a dated pregnancy calculated by the method of vaginal smears. To simulate the effects and toxic effects of exposure to cadmium salts, we administered enteral solutions of the test substances daily to pregnant females of the Wistar rats throughout pregnancy. The solutions of germanium citrate, cerium, sulfur composite and iodine obtained by aquananotechnology were used in experimental models. Citrates (citric acid salts) of biometals are safe. Moreover, they have antioxidant and radioprotective effect, have a positive effect on the cardiovascular and immune systems of the body. All rats were divided into 8 groups:

Group 1 - control (n females = 8; n 13th day embryos = 77; n 20th day embryos = 76); Group 2 - animals that were administered a single solution of cadmium chloride at a dose of 1.0 mg / kg (n females = 8; n 13th day embryos = 68; n 20th day embryos

= 63); Group 3 - animals that were administered a single solution of cadmium citrate at a dose of 1.0 mg / kg (n females = 8; n 13th-day embryos = 69; n 20th-day embryos = 70); Group 4 - animals who were administered a solution of cadmium chloride at a dose of 1.0 mg / kg and a solution of cerium citrate at a dose of 1.3 mg / kg (n females = 8; n embryos of the 13th day = 70; n embryos of the 20th day == 68); Group 5 - animals that were administered a solution of cadmium citrate at a dose of 1.0 mg / kg and a solution of cerium citrate at a dose of 1.3 mg / kg (n females = 8; n embryos of the 13th day = 71; n embryos of the 20th day = 72); Group 6 - animals who were administered a solution of cadmium chloride at a dose of 1.0 mg / kg and a solution of germanium citrate at a dose of 0.1 mg / kg (n females = 8; n embryos of the 13th day = 70; n embryos of the 20th days = 68); Group 7 - animals who were administered a solution of cadmium citrate at a dose of 1.0 mg / kg and a solution of germanium citrate at a dose of 0.1 mg / kg (n females = 8; n embryos of the 20th day = 71); Group 8 - animals who were administered a solution of cadmium chloride at a dose of 1.0 mg / kg and a solution of citrate sulfur and iodine at a dose of 0.003 mg / kg (n females = 8; n embryos of the 13th day = 71, n embryos of the 20th days = 73),

On the 13th and 20th day of embryogenesis, an operative slaughter of animals was performed. Embryos were removed from the uterus, weighed, length was measured, photographed, and the heart was removed for further histological examination. Taking into account the specificity of the goal of the study, the following indicators of cardiogenesis were quantified on the histological sections :

- cardiofetal index (%), M±m; which we calculated by the formula:

$$КФИ = \frac{m}{M} \times 100\%$$

- where CFI – cardiofetal index;
- m – weight of the heart;
- M – the weight of the rat embryo.

- thickness of compact atrial and ventricular myocardium of normal embryo heart and in experiment (μm), M±m;

- thickness of the interventricular septum of normal embryo heart and in experiment (μm), M±m;

A camera for light microscopy ZEISS Axiocam ERc 5s with adapter P95-C 1/2" 0,5x was used to obtain digital images with subsequent size calculation of structures. Determination of heart structures sizes was performed using ZEN 2.0 software, which is software for ZEISS Primo Star series light microscopes. We used software tools to measure the linear dimensions of structures.

Statistical analysis and analysis of results were performed according to conventional methods using licensed statistical analysis software Statistica v.6.1 (StatSoft Inc., Serial

No. AGAR909E415822FA) and Microsoft Excel. The probability of statistical studies was performed using Student's t-test.

Animal studies were conducted in accordance with the "General Ethical Principles for Animal Experiments" (Kyiv, 2001), which are consistent with the European Convention for the Protection of Experimental Animals (Strasbourg, 1985).

Results and Discussions. All experimental females survived, normally consumed food, moved actively, had no external signs of disease. We have not detected external injuries, ectopia, hernias and other defects after the administration of indicated doses to embryos. Cosequently, cadmium salts and other test substances did not cause teratogenic effect with this route of administration and doses.

Disruption of the course of cardiogenesis in the experiment was already detected at the level of determination of the heart weight of embryos of rats, namely: in the cadmium intoxication group, not only the weight loss of the embryos was observed, but also a significant decrease in the weight of the heart. In order to eliminate errors regarding the effect of weight loss of embryos and heart weight on cardiotoxicity indices, we calculated the cardiofetal index. According to analysis of the results obtained, there are changes not only in the number of live embryos in the afterbirth, but also changes in the massometric parameters of the embryos themselves when pregnant female is exposed to cadmium chloride. Thus, with respect to the control group, a significant decrease in the number of live embryos was determined in the cadmium salts influence group, although the average fetal and heart mass values did not have a significant difference (table 1).

Table 1

Indicators of the number and weight of rat embryos and cardiofetal index on the 20th day of embryogenesis in groups of isolated administration

Indicator	Control	Influenced groups	
		Cadmium chloride	Cadmium citrate
Number of live fetuses per female	9,50±0,13	7,88±0,40*	8,75±0,27*
Body weight of 1 fetus, g	2,76±0,07	2,72±0,08	2,64±0,05
Embryo heart mass, mg	34,08±0,53	34,80±0,58	31,10+1,29*
Cardiofetal index	1,23±0,02	1,33±0,04*	1,22±0,06

*Note. * - $p<0,05$; in relation to control.*

At the same time, the quantitative indices of the embryos in the cadmium citrate exposure group were closer to the controls, and the heart mass decreased compared to both groups. An increase in the index of cardiofetal index in the group of exposure to cadmium chloride indicates an increase in weight indicators of the heart in the group while reducing the body weight of the embryo due to intoxication. In the cadmium citrate exposure group, the index of cardiofetal index was almost equal to the control value, although embryo body weight was the lowest of the studied groups.

Analysis and calculation of changes in the mean values of fetus number, heart mass,

and cardiofetal index in the groups of combined administration of cadmium chloride with metal citrate and iodine + sulfur composite showed the following dynamics (Table 2). The highest number of fetuses per female was observed in the group of combined introduction of sulfur and iodine. This indicator had no significant difference with the control group, but was significantly higher than the isolated cadmium chloride administration group ($p \leq 0,001$).In groups with combined administration of cerium citrate and germanium the number of embryos was significantly fewer than in the control group($p \leq 0,05$), but still higher than the cadmium chloride isolated administration group. The weight of the embryo in the presented groups did not have a significant difference, but we found a tendency to increase of the heart mass in the groups of combined administration. The highest indicator was in the group with iodine and sulfur. This situation led to a significant increase in cardiofetal index to 1,97±0,11, which exceeded not only the control values, but also this indicator in the group of isolated administration of cadmium chloride (table 2).

Table 2

Indicators of the number and weight of rat embryos and cardiofetal index on the 20th day of embryogenesis in groups with administration of cadmium chloride in different combinations.

Indicator	Cadmium chloride + cerium citrate	Cadmium chloride + germanium citrate	Cadmium chloride + composite iodine + sulfur
Number of live fetuses per female	8,25±0,40	8,50±0,20	9,13±0,13
Body weight of 1 fetus, g	2,71±0,05	2,71±0,04	2,68±0,04
Embryo heart mass, mg	33,04±3,41	40,01±1,82	46,10+3,59
Cardiofetal index	1,22±0,06	1,48±0,03	1,97±0,11

Comparison of the presented data demonstrates the modifying effect of metal citrate and iodine + sulfur composite on the embryotoxicity and cardiotoxicity of cadmium chloride when combined in rats at indicated doses and route of administration.

The analysis of the studied indicators in the groups of combined introduction of these elements with cadmium citrate had the following trends (table.3). As you can see from the calculations, the highest number of embryos is observed in these groups. That is, cerium citrate and germanium reduce the embryotoxic effects of cadmium citrate compared to the isolated administration group. Average values of embryo mass and heart mass also increase, which in turn leads to an increase in cardiofetal index in embryos that have undergone the influence of these factors. Compared to control group, the cardiofetal index increases in the following directions: in the group of cadmium citrate + cerium citrate in 1.18 times, and in the group of cadmium citrate + germanium citrate in 1.19 times. This indicates a possible myocardial hypertrophy and dilation of the heart chambers in the experimental embryos. Such data can be considered as a result of the compensatory action of germanium and cerium on the cardiotoxicity of cadmium citrate.

Table 3

Indicators of the number and weight of rat embryos and cardiofetal index on the 20th day of embryogenesis in in groups with administration of cadmium citrate in different combinations

Indicator	Cadmium citrate + cerium citrate	Cadmium citrate + germanium citrate
Number of live fetuses per female	9,00±0,29	8,88±0,24
Body weight of 1 fetus, g	2,78±0,06	2,73±0,05
Embryo heart mass, mg	40,04±5,80	40,06±2,53
Cardiofetal index	1,45±0,07	1,46±0,07

Based on the results of the calculation of the number and weight of embryos of all the experimental groups, we can conclude that the cadmium citrate is less embryotoxic compared to cadmium chloride and determine the modifying effect of cerium citrate, germanium, iodine + sulfur on embryotoxicity and cardiotoxicity.

To achieve this goal, we conducted morphometric studies of the histological sections of the embryos hearts of all experimental groups. To determine the morphogenetic changes of the heart chambers under the influence of cadmium salts, we determined the thickness of the compact ventricular myocardium, interventricular septum and atrium on the 13th and 20th days of the experiment.

Investigating the heart-formation processes of rats on the 13th day of embryogenesis and the formation of the walls of the heart chambers, we made serial histological sections of the whole embryo to determine the correspondence to the normal course of cardiogenesis. The process of heart septation begins with delamination of the upper part of the ventricular myocardium. Endocardial cushions play a significant role in the formation of the cusps. Endocardial cushions are transient organs for future atrial-ventricular valves. Together with the formation of valves of the atrioventricular orifice, the formation of the papillary-trabecular apparatus of the ventricles and the atrium of the heart of the embryo occure.

The myocardium of the ventricles is divided into 2 plates due to the delamination: internal, which together with the remnants of the endocardial cushions initiates the formation of valve cusp. It forms the primary tendon string, and the primary mastoid muscles. The formation of tendon strings, trabecular myocardium, and ventricular pelvic muscles is the process that occurs together with the formation of valve cusps during the delamination process. The endocardial cushions continue into the conotrunk in the form of endocardial ridges that further participate in the distribution of total conotrunk on the aorta and pulmonary trunk. Particulary during this period of cardiogenesis the primary myocardial layer of the ventricles of the embryonic heart is rebuilt and compact and trabecular layers of the wall of the heat are formed. In general, the heart of the embryo is formed for this period of development, the ventricles are separated from the atrium by the atrioventricular valve, the endocardial cushions are filled with mesenchymal cells. We also investigated the processes of septation of the chambers of the heart, namely

the formation of the interventricular septum. The muscular part of the interventricular septum, which was formed as an outgrowth of the myocardium of the primary ventricles to the atrioventricular orifice, was determened during the study period. The upper part of the septum (membranous) has a completely different origin. It is an outgrowth of endocardial cushions of atrioventricular canal. Combining these two sources gives begining to the interventricular septum.

Investigating the results of the influence on the development of the heart of cadmium salts, we compared ventricular myocardial thickness and determined the compliance of the heart development with the standart criteria. Under the influence of cadmium chloride administration on the 13th day of embryogenesis we determined a 26-29% thickening of the ventricular wall in comparison with the control group. Although no significant changes in ventricular wall thickness were detected in the cadmium citrate exposure group, but the thickness of the atrium increased significantly in comparison with the control group. The primary venous sinus is the source of the origin of the embryonic human atrium and the formation of the atrium in time is lagging behind the formation of the ventricles, where cardiomyocytes develop and specialize earlier. Therefore, in response to the influence of the exogenous factor, the response of early atriums and ventricles is quite different.

The study of morphometric parameters demonstrated the influence of the investigated cadmium salts on cardiogenesis on the 13th day of embryonic development. Determining the thickness of the atrium in the influenced groups, we measured the thinnest and thickest sections of the walls due to the significant heterogeneity of the structure of these heart chambers. In the control group this indicator reached 25,38 ± 1,60 μm and 43,75 ± 1,06 μm, when exposed to cadmium chloride, the atrium wall was 30.63 ± 1.28 μm and 53.25 ± 1.92 μm therefore the the thickness was determined at this stage ($p \leq 0.05$). Exposure to cadmium citrate did not show a significant difference with the control group and was 21.38 ± 0.64 and 42.85 ± 0.71 μm, respectively. But it should be noted that in 27.3% of embryos the thickness of the atrium clearly increased compared to the control group($p \leq 0.05$). Namely, it was 28.31 ± 2.52 μm and 67.75 ± 4.14 μm, respectively, in the thin and thick regions.

The thickness of the ventricular wall of the early embryonic heart (13th day) in the control group was 61.13 ± 2.44 μm, and when exposed to cadmium chloride, it thickened to 64.87 ± 1.24 μm. The effect of cadmium citrate did not lead to a significant difference with this indicator in control group and constituted 61.88 ± 1.28 μm. The study of the formation processes of the interventricular septum showed no disorder in the formation of this structure, which is important for the septation of the heart. The interventricular septum at this stage of development consisted of a muscular ridge that grew in the direction of the longitudinal axis of the heart from the apex to the atrioventricular canal. The measurements were carried out in the middle part of the interventricular septum and showed the following changes in the formation of the thickness of the myocardial septum: in the control group it was 420.75 ± 7.82 μm, in the group of exposure to cadmium chloride it was 441.16 ± 3.06 μm, and under the influence of cadmium citrate it

was 415.50 ± 2.77 μm. Thus, according to the results of morphometric studies in 13-day-old embryos that have been exposed to cadmium salts, the following changes occur in the development of heart chambers: administration of cadmium chloride to females leads to increased thickness of the atrium, ventricles, and interventricular septum, and the effect of cadmium citrate is not significant in comparison with control group.

The thickness of the ventricle on the 20th day of embryogenesis was determined taking into account the peculiarities of the structure of the heart chamber in 3 zones: apical part, middle part and basal part. In the control group, the lowest indicators of the thickness of the compact myocardium of the ventricles were determined in the apical part of the left and right ventricles and were respectively: 241.38 ± 10.34 μm and 163.38 ± 4.11 μm. The most significant is the compact myocardium of the middle part of the ventricles, which thickness in the control group reached 512,13 ± 3,98 μm in the left and 314,88 ± 5,17 μm in the right. The thickness of the interventricular septum (in its middle part) in this group was 420.75 ± 7.82 μm. The atria had a distinctly heterogeneous thickness, so measurements were made of the thinnest and thickest sections of the wall for further calculation. The thickness of the myocardium of the right atrium ranged from 40.25 ± 1.33 μm, 133.63 ± 2.79 μm, the left - 52.13 ± 1.86 and 142.63 ± 3.71 μm. At this stage of development well-formed trabeculae and considerable epicardial layer were in control group.

In the ventricles, the compact myocardium contains advanced vessels, and the trabecular layer consists of separated formed trabeculae. The epicardium fits snugly the myocardium. The interventricular septum is fully formed.

Histological examination showed that in the group of exposure to cadmium chloride changes in the structure of the atrium and ventricles were detected. In 12.3% of the studied objects, atrium endocardial hyperplasia was detected, but ventricular endocardium remained normal. Processes of hyperplasia may indicate the formation of compensatory mechanisms by the endothelium in response to the toxic effect of cadmium chloride during embryogenesis. There was no endothelium hyperplasia in the cadmium citrate exposure group. Exposure to cadmium chloride also led to a local thickening of the atrial wall during this development period. The heterogeneity of the thickness of the atrium wall prompted us to measure the thickest and thinnest sections of the atrium. If in the control, the average thickness of the right atrium was 40.25 ± 1.33 μm in the thin sections,but when exposed to cadmium chloride, a thickening of up to 49.88 ± 1.72 μm was observed, and in the cadmium citrate exposure group, the thinning of the wall was determined up to 35.50 ± 2.30 μm.

Under the influence of cadmium chloride, the thickness of the interventricular septum of the heart of the embryo increased from 420.75 ± 7.82 μm in control to 494.16 ± 6.71 μm, and in the group influenced by cadmium citrate a decrease in the thickness of the interventricular septum was determined to 381.50 ± 8.11 μm although a local thickening of the middle part of the septum was observed in 12.4%.

Thus, different heart chambers respond to the influence of cadmium salts in different ways, which is explained by the different hemodynamic load of the heart chambers.

The right half of the heart does not carry a large haemodynamic load in the embryo due to the presence of arterial duct and lack of gas exchange in the lungs. The small circulatory system does not work and the effect on the myocardium of this part of the organ is not significant. The left half is more damaged, which is associated with a large circulation and has a higher hemodynamic load. It should be said that at the time of the embryo's birth, the rat's heart is not the definitive organ. Vessels, the valve apparatus and the myocardium are finally formed within the first 2 weeks after birth. But when exposed to equal doses of different salts of cadmium, different directional processes of cardiac development were determined, namely: exposure to cadmium chloride led to an increase in the compact layer of the myocardium of all the chambers of the heart and the interventricular septum, and the administration of cadmium citrate reduced the thickness of the walls of the chambers and septum together with heart weight loss. In the groups of combined administration of cadmium salts with citrates of the investigated microelements the indicators of compact myocardium recovered, which testifies the antagonistic nature of the influence of the tested substances on the cardiotoxicity of cadmium.

Conclusions. 1. The effect of indicated doses of cadmium salts on cardiogenesis in rats influenced morphogenesis of different heart chambers in different ways: cadmium chloride led to an increase in heart mass by increasing the thickness of the myocardial layer of the ventricles and atrium walls with local thickening of the interventricular septum. The administration of cadmium citrate led to a decrease in heart mass in embryos due to thinning of the myocardium wall of both ventricles and interventricular septum.

2. In groups of combined administration of cadmium salts with citrates of metals recovery of cardiofetal index and thickness indicators of compact myocardium were determined. The data obtained indicate the reduction of cardiotoxicity of cadmium salts due to administration of citrates of germanium, cerium, iodine + sulfur during pregnancy in a rats experiment.

References:

1. Oberlis D, Skalny AV, Skalnaya MG, Nikonorova AA. [Pathophysiology of microelementoses]. Pathogenesis. 2016; 14(2): 20-27. Russian.Apykhtina OL. [Changes in the biochemical parameters of the blood serum of experimental animals after exposure to cadmium chloride and cadmium sulfide nanoparticles of different sizes]. Biomedical and Biosocial Anthropology. 2017; 1: 47-51. Russian.

2. Shafran LM, Pikhtieva OG, Bolshoy DV [An algorithm for laboratory tests for suspected dyshomeostasis of heavy metals]. Actual problems of transport medicine. 2014; 4, Vol.1 (38-1): 97-105.

3. Grzhegotsky MR, Sukhodolskaya NV. [The effect of copper, zinc, cadmium and lead on the likelihood of developing a threat of termination of pregnancy in women]. Reproductive health. Eastern Europe. 2014; 1 (31): 43–49. Russian.

4. Shatorna VF, Chekman IS, Garets VI, Nefyodova OO, Kaplunenko VG

[Experimental study of the influence of nanometals on embryogenesis and heart development]. Integrative Anthropology. 2017; 1: 59-63. Ukrainian.

5. Apykhtina OL. [Changes in the biochemical parameters of the blood serum of experimental animals after exposure to cadmium chloride and cadmium sulfide nanoparticles of different sizes]. Biomedical and Biosocial Anthropology. 2017; 1: 47-51. Russian.

6. Chowdhury R, Ramond A, O'Keeffe LM, Shahzad S, Kunutsor SK, Muka T, Gregson J, Willeit P, Warnakula S, Khan H, Chowdhury S, Environmental toxic metal contaminants and risk of cardiovascular disease: systematic review and meta-analysis. BMJ. 2018; 362:k3310. doi: http://doi.org/10.1136/bmj.k3310

7. Lamas GA, Navas-Acien A, Mark DB, Lee KL. Heavy metals, cardiovascular disease, and the unexpected benefits of edetate chelation therapy. J Am Coll. Cardiol. 2016;67:2411–8.

8. Nefyodova OO, Yeroshenko GA, Zadesenets IP, Shatorna VF, Nefyodov OO. [Effect of low doses of cadmium citrate on the cardiogenesis of rat embryos]. The world of medicine and biology. 2019;1 (67):166-170. Ukrainian.

9. Skalny AV. [Assessment and correction of the elemental status of the population is a promising area of domestic health care and environmental monitoring]. Microelements in medicine. 2018;19 (1): 5−13. Russian.

10. Garets VI, Shatorna VF, Ostrovskaya SS, Kononova II, Krasnov OO. [Methodical approaches to determination of embryotoxicity and teratogenicity of heavy metals in morphological experiments[. Ukrainian Journal of Medicine, Biology and Sports. 2015;1(1): 189-194. Ukrainian.

11. Dinerman AA. The role of environmental pollutants in impaired embryonic development. M .: Medicine, 1980. 191 p. Russian.

RATES WEIGHT CHANGE AND STEEL AFFECTIONS BY LEAD ACETATE INTOXICATION

Inna Shevchenko, *Ph.D., Surgeon,*
SE "Dnepropetrovsk Medical Academy of the Ministry of Healht of Ukraine",
Zoya Alekseyenko, *MD., Professor,*
Dnipro Medical Institute of Traditional and Non Traditional Medicine,
Olena Kefeli-Ianovska, *Ph.D., Associate Professor,*
Kyiv International University, Medical Institute

Annotation. *The study of the effect of lead acetate on embryo morphogenesis was initiated from the analysis of changes in embryo and rat mass. The main method of measurement was the weighing of animals, embryos and the heart. Animals of the control and experimental groups were characterized by habitual social behavior, changes in nutrition, and bowel movements. Changes in the weight of rats that were toxic by lead acetate were analyzed, and a comparative analysis of the incidence of congenital heart defects and morphometric parameters of the embryonic hearts of animals in the control and experimental group of rats was performed. Detection of structural alterations of the embryonic heart exposed to lead acetate during the prenatal ontogeny period. The difference in changes in embryo weight and offspring of rats due to lead acetate was determined, the negative effect of the intoxicant on prenatal and postnatal development of rats was proved.*

The cardioprotective effect of lycopene and inulin, as well as their restorative function, affecting the weight gain of embryos and rats at all times of the experiment have been investigated and proven.

Key words: *heart, morphogenesis, lead acetate, toxic effect, inulin, lycopene.*

Formulation of the problem. Establishing peculiarities of morphogenesis of organs of different systems in the comparative-embryological aspect in the norm, as well as changes in their structural and functional organization due to the negative impact of the environment is a priority task of modern morphology. Research into the patterns of development of tissues, organs and systems of the human and animal organisms at various stages of ontological and phylogeny, respectively, should play an important role in the development of general questions of biology and medicine. Scientific interest in the effects of anthropogenic factors on the body is caused by significant environmental pollution by heavy metals, with lead and its compounds being the priority toxicant. In the last decades, the industry's demand for lead has increased significantly, leading to irrational use of natural resources and an increase in the level of natural gas.environmental pollution [1]. An unfavorable environmental situation increases the risk of lead entering the human and animal body, and there is a risk of contamination of this heavy metal with food, especially in man-made areas. Lead is a metal with high accumulative toxicity [2].

Experimental studies have identified therapeutic and toxic doses of some substances, but to date there is no information on doses that are teratogenic [3, 4]. One of the urgent tasks of modern embryology and toxicology is to establish the influence of

lead acetate on prenatal development of organs of different systems and morphological preconditions for possible formation of developmental defects [5, 6, 7, 3]. However, the effect of lead acetate on cardiogenesis under experimental conditions has not yet been sufficiently studied. The sources of literature contain reports on the accumulation of lead in the heart [8] and the features of pathobiochemical changes due to acute and chronic lead intoxication, which causes the accumulation of reactive oxygen species and cyclooxygenase-dependent vasoconstrictors, as well as exerts an inhibitory effect on itself, to expressed endothelial dysfunction [9, 10]. Long-term oral administration of lead acetate causes focal ischemia and myocardial damage [11, 8].

Main results of the study. The experimental study was performed on laboratory rats, the morphological material of the study were the hearts of embryos at 14, 16 and 18 gestational days and the hearts of rats at 1, 5 and 7 days postnatal development with the action of 2.5% lead acetate solution and with correction of lycopene and inulin.

Observations on pregnant females of the Wistar rats during pregnancy showed the preservation of social and research behavior, grooming, consumption of water and food, reaction to stress factor (urination and deficiency during examination and work of the researcher with animals), bending and grasping reflexes of extremities. Behavioral disorders that would indicate acute toxicity of lead acetate were not detected in the experimental groups of rats. There were also no behavioral changes in the rats treated with lead acetate with lycopene and inulin. At the same time, the weight of the experimental rats (according to the weight monitoring diary) varied over the observation deadline, which did not reach the values of the control group of rats. The main method of measurement was the weighing of animals, embryo and the heart. Animals of the control and experimental groups were characterized by habitual social behavior, changes in diet, defecation, and reflex reactions to the researcher were not recorded. No manifestations of acute intoxication in laboratory rats were detected.

A statistically significant decrease in the weight of the experimental group of rats with lead acetate (1st series of experiment - animals from which received embryos at stages E14, E16 and E18 prenatal development) was found in almost the entire observation period, except 10-12 days, from 7.4% up to 9.2% in the first 9 days of the experiment and from 7.2% to 15.7% on the 13 and 18 days of the experiment ($P \leq 0.05$).

An analysis of the changes in the weight of the study groups of rats treated with lead acetate and the investigational agents - inulin and lycopene - showed the following results. Until the 13th day of the experiment, no statistically significant difference was found between the comparison groups. At 14-18 days of observation, the weight gain of rats in the inulin group was greater than in the lead acetate group. However, this weight of the experiment showed a lower weight gain in the lycopene group compared to the inulin group ($P \leq 0.05$).

The changes in the weight of pregnant rats in the second series of experiments, that is, groups with offspring at the early stage of postnatal development (P1, P5, P7), were statistically significantly smaller than controls.

Long-term use of lead acetate resulted in a decrease in weight gain over the whole

experiment - an average of 13.2% (with a maximum difference of 20.8% at 14 days of experiments, P <0.05). Indicators of the 1st and 2nd series of experiments had no significant difference. No statistically significant difference in the lead acetate group was found in the study drug groups.

Thus, the average weight gain of intact rats was 34.1% (P <0.05), in rats with lead acetate - 19.6% (P <0.05), and lead acetate with the introduction of inulin - 18.7% (P <0.05), lead acetate with the introduction of lycopene - 14.5% (P <0.05). That is, the mean difference in the weight gain of pregnant females was 17.1% (P <0.05). The rat mass in the comparison groups with lycopene and inulin did not differ from the main group, which showed a negative effect of lead acetate on the metabolism and morphogenesis of pregnant rats.

The next stage of the study was to evaluate changes in the weight of embryos and rats at the prenatal and postnatal stages of development. The mean weight gain of embryos at day 18 compared to day 14 in the control group was 151.7% (P <0.05), in rats with lead acetate - 145.5% (P <0.05), and lead acetate with inulin administration - 168.7% (P <0.05), lead acetate with the introduction of lycopene - 154.8% (P <0.05).

The weight of the embryos in the lead acetate group was statistically significantly lower at all times in the experiment. The indicator in the drug groups approached the values of the control group at 16 and 18 days (P <0.05). These data indicate the delayed prenatal development of rats under the action of lead acetate and the prevention of toxic effect on embryonic morphogenesis with the introduction of inulin and lycopene.

The results of the analysis of the weight of newborn rats and the assessment of the dynamics of growth in the next 7 days postnatal development showed the following results. The toxic effect of lead acetate led to a delay in the weight gain of rats by an average of 17.4% (P <0.05). No significant weight loss was detected in the pharmacocorrectional groups (data were within the statistical error of the intact rat group), which is evidence of a reversible morphogenesis process in early postnatal development.

Before sampling the material for histological examination, the weight of the heart and the ratio of the weight of the heart to the weight of the embryos / rats were further evaluated. The results of the studies are shown in Table 1.

A decrease in the average heart mass was found on the background of a lack of weight gain in rats. The ratio (index) of organ weight to offspring mass was less than the control values only at day 7 postnatal development in the lead acetate group, at days 1 and 7 in the lead and inulin acetate group. The action of inulin and lycopene is indicated by an increase in heart weight.

Table 1

Changes in heart mass in the prenatal and postnatal stages of development

Development period	Indicator	Control group	Lead acetate	Lead acetate + inulin	Lead acetate + lycopene
E18	Body weight, g	1,93±0,04	1,67±0,05*	1,90±0,04^	1,85±0,03
	Weight of heart, mg	8,66±0,08	7,45±0,16*	7,96±0,11^	7,75±0,10*^
	Weight of heart / body, mg / g	4,48±0,10	4,43±0,21	4,45±0,06	4,47±0,03
P1	Body weight, g	5,73±0,15	4,83±0,20*	5,55±0,24	5,51±0,19
	Weight of heart, mg	23,1±0,45	17,15±0,30*	20,73±0,62*^	20,88±0,78*^
	Weight of heart / body, mg / g	4,05±0,15	3,58±0,18	3,76±0,14*	3,81±0,20
P5	Body weight, g	7,25±0,14	6,20±0,16*	7,26±0,17^	6,98±0,22
	Weight of heart, mg	43,33±1,02	35,83±1,49*	42,5±1,02^	39,66±0,88*
	Weight of heart / body, mg / g	5,98±0,18	5,77±0,09	5,85±0,12	5,70±0,13
P7	Body weight, g	9,45±0,19	7,96±0,31*	8,81±0,37*	9,00±0,36
	Weight of heart, mg	59,10±0,53	45,43±1,21*	51,73±1,03*^	53,38±1,18*^
	Weight of heart / body, mg / g	6,27±0,18	5,73±0,15*	5,92±0,26*	5,96±0,16

*Note: * - likely to control (P <0.05); ^ - likely in the lead acetate group (P <0.05)*

Conclusions. The elucidation of changes in the structural and functional organization of the heart in the process of histo- and organogenesis under the action of lead acetate under the conditions of experiment and the expediency of the development of cardioprotective agents for the treatment of diseases, the etiological factor of which was the influence of technogenic compounds of lead, determined the relevance of this study.

Thus, during 2 series of experiments we found a natural delay in the weight gain of pregnant female rats receiving lead acetate and delayed prenatal and early postnatal development of rats. The inhibition of morphogenesis can be explained by the toxic effect of lead acetate on metabolic processes in the body of pregnant rats, which negatively affected the morphogenesis of embryos. The use of lycopene and inulin as pharmacological agents with detoxifying effect affected the recovery of weight gain at 16 and 18 days prenatal development and postnatal period. It should be noted that the effect of lycopene and inulin did not differ in terms of the weight of embryos and rats, indicating the non-selective effect of the investigated agents. Indices in pregnant females

did not change or increased compared with the main experimental group, and in embryos increased from 16 days and reached control values in postnatal development, which was interpreted as a positive effect of agents on morphogenesis.

The dynamics of changes in the structural organization of the heart of rats under the influence of lead acetate at the stages of prenatal and postnatal development were first established. A regular delay in the recruitment of pregnant female rats, embryos and newborn rats under chronic intoxication with lead acetate was detected.

References:

1. Ivanitskaya, N.F., Stepanova, M.G., Usikova, Z.L., Zykov, D.S.(2013). Comprehensive assessment of lead content in environmental objects of Donetsk region: Medico-social problems of the family, № 18 (2), 133–137

2. Shatornaya, V.F., Garets, V.I., Nefedova, O.O., Kononova, I.I. (2016). Influence of low doses of lead acetate on rat cardiogenesis in experiment: Bulletin of problems of biology and medicine,vol. 2 (2), 375-379

3. Kulikova, G.V. (2012). Effect of low lead concentration on the placenta and fetus (experimental study): abstract. diss: Cand. biol. Sciences, 27

3. Alba, A., Carleton, L.L., Dinkel, R. [et al.] (2015). Increased lead levels in pregnancy among immigrant women: J Midwifery Womens Health,vol. 57 (5), 509-514

4. Gryzlova, L.V. (2006). Effect of lead acetate on the placental barrier and on the development of bone tissue in early ontogeny (experimental studies): author. diss. on the nipple. uch. Steppe: Cand. biol.21

5. Dovgal, G.V. (2014). Influence of lead acetate on the survival of rat embryos and the possibility of correction : Bulletin of problems of biology and medicine,vol. 1 (106), 93-96.

6. Nefedova, O.O. (2013). Determination of the influence of lead acetate on the course of rat cardiogenesis in experiment: Bulletin of problems of biology and medicine,vol. 4 (2), 243-246

7. Winiarska-Mieczan, A., Krusiński, R., Kwiecień, M.(2013). Tannic Acid influenza on lead and cadmium accumulation in the heart and lungs of rats: Adv Clin Exp Med,vol. 22 (5), 615-620

8. Silveira, E.A., Lizardo, J.H.F., Souza, L.P. [et al.] (2010). Acute lead-induced vasoconstriction in the vascular beds of isolated perfused rat tails is endothelium-dependent: Braz J Med Biol Res,vol. 43 (5), 492-499

9. Barbosa, F. Jr,. Sertorio, J.T., Gerlach, R.F., Tanus-Santos, J.E.(2006). Clinical records for lead-induced inhibition of nitric oxide formation: Arch Toxicol,vol.80 (12), 811-816

10. Debosree Ghosh., Benazir Firdaus, Syed., Elina Mitra. (2013). Aqueous leaf extract of Murraya koenigii protects against lead-induced cardio toxicity in male wistar rats: International Journal of Phytopharmacology,vol. 4 (2), 119-132

THE EFFECT OF CADMIUM SALTS ON THE DEVELOPMENT OF VESSELS AND ATRIOVENTRICULAR VALVES OF RAT HEART UNDER THE CONDITIONS OF ZINC CITRATE CORRECTION

Olena Nefodova,
Doctor of Medical Sciences,
Igor Zadesenets,
Olena Shevchenko,
Department of Clinical Anatomy, Anatomy and Operative Surgery,
SE "Dnepropetrovsk Medical Academy of the Ministry of Health of Ukraine"

Annotation. *The article presents the results of an experimental study of the effect of cadmium salts on the development of blood vessels and atrioventricular valves of the rat heart during isolated administration and under the condition of correction of zinc citrate. The internal diameters of the vessels, the thickness of the atrioventricular valves, as well as the accumulation of cadmium and zinc in the heart of embryos of the rat of the 20th day of development were studied.*

Key words: *cadmium, zinc citrate, cardiogenesis, cardiac vessels, atrioventricular valves.*

The increasing pollution of industrialized countries requires the study of the effects of environmental factors on human health. Heavy metals are one of the most common and dangerous environmental pollutants. The latter, when they enter the human body, lead to acute and delayed complications, change the balance of trace elements, the course of diseases, pregnancy, and cause different malformations [1,2,3].

Together with lead, mercury and arsenic, cadmium belongs to a group of heavy metals that pose a serious health risk. Cadmium is one of the few toxic metals that has no known physiological functions in the body. It is toxic at very low levels, has acute and chronic effects on human health. Cadmium accumulates in the human body throughout life and has a long biological half-life (17-30 years) [4]. Investigating the morphological changes that occur under the influence of cadmium in both postnatal and prenatal ontogenesis is an important task for scientists. Due to scientific and technological progress, compounds of heavy metals with different physical and chemical properties (nanometals) have appeared. Their effects on the human body have differences compared to ionic forms [8,9,10]. The search for antagonists that reduce the toxic effect of cadmium is a priority in scientific researches [5,6].

The aim of the study. To investigate the effect of cadmium salts on the development of blood vessels and atrioventricular valves and the accumulation in the heart of rat embryos during isolated administration and in combination with zinc citrate.

Materials and methods. To simulate chronic toxicity during cadmium exposure throughout pregnancy, female Wistar rats were administered cadmium citrate or cadmium chloride on a daily basis per os via the probe in isolation (at a dose of 1.0 mg/kg) or in combination with zinc citrate. The selected dose of cadmium-containing compounds

corresponds to 1/100 LD50 for cadmium [7].

In the experimental model, solutions of cadmium and zinc citrate obtained by the aquananotechnological method were used [10].

Solutions of citrate forms of metals (cadmium and zinc) were obtained according to the agreement on scientific cooperation at the Scientific Research Institute of Nanobiotechnology and Resource Conservation of Ukraine (Kyiv).

Given the pronounced antagonistic properties of zinc-containing compounds with respect to cadmium in vivo, it was decided to use the zinc citrate form as a potential biological antagonist against cadmium intoxication [11,12,13].

In accordance with the requirements of embryonic experiments, pregnant rats were provided with a complete nutritional diet, water ad libitum and careful care. Intra-gastric injection of metal solutions was performed from the first day of pregnancy daily at the same time of day (from 9 to 11 hours).

Female rats with a dated pregnancy were divided into 5 groups:

1. Control (animals received 0.5 ml of 0.9% NaCl solution). Number of females - n = 8; number of embryos - n = 71

2. Cadmium chloride (dose 1.0 mg/kg). Number of female rats - n = 8; number of embryos - n = 62

3. Cadmium citrate (dose 1.0 mg/kg). Number of female rats - n = 8; number of embryos - n = 68

4. Cadmium chloride and zinc citrate (received doses of 1.0 mg/kg and 1.5 mg/kg, respectively). Number of female rats - n = 8; number of embryos - n = 72

5. Cadmium citrate and zinc citrate (received doses of 1.0 mg/kg and 1.5 mg/kg, respectively). Number of female rats - n = 8; number of embryos - n = 69

For embryonic studies, female rats with a dated term of pregnancy were obtained. On the 20th day of pregnancy, female rats were. The embryos were removed from the uterus, tested for a “live-dead”, weighed, photographed and fixed in 10% formalin solution for further histological examination. After fixation of 20-day-old embryos, the hearts of embryo rats were separated from body. From isolated hearts, sections of 4-6 microns thick (hematoxylin-eosin staining) were made using standard histological methods for further morphometric studies.

Part of the 20-day-old embryos of all the experimental groups were frozen to measure cadmium and zinc accumulation in the thoracic organ complexes using the atomic emission method with electric arc atomization. The study was conducted at the State Enterprise "Ukrainian Research Institute of Transport Medicine" of the Ministry of Health of Ukraine (Odessa) according to the agreement on scientific and technical cooperation (2018).

ZEISS Axiocam ERc 5s light microscopy camera with P95-C 1/2 "0.5x adapter was used to obtain digital images with subsequent structure size calculations.

The size of the heart structures was determined using the ZEN 2.0 software, which is software for ZEISS's Primo Star series of light microscopes. We used software tools to measure the linear dimensions of structures.

On histological sections of the heart of the rat embryos of the 20th day of development

in all groups we measured:

1) average width of the atrioventricular valve (AVV) flaps in the middle third (μm), M ± m;

2) average internal diameters of subepicardial vessels and myocardial vessels of compact myocardium in the middle part of both ventricles on identical sections of embryonic heart;

3) average internal diameter of the coronary arteries in the proximal part (μm), M ± m;

Statistical processing and analysis of results were performed according to conventional methods using the licensed statistical programs Statistica v.6.1 and Microsoft Excel. The reliability of the statistical surveys was performed using the Student's t-test. A level of $p < 0.05$ was considered to be statistically significant.

Animal studies were conducted in accordance with the "General Ethical Principles for Animal Experiments" (Kyiv, 2001), which are consistent with the European Convention for the Protection of Experimental Animals (Strasbourg, 1985).

Results and discussion. All the female rats in the experiment survived. Defects of embryonic development were absent. Isolated exposure to cadmium chloride leads to a decrease in the internal diameter of the vessels of the myocardium against the background of thickening of the walls of the vessels and pronounced perivascular edema. Subepicardial vessels were dilated (see Table 1).

In the ventricles of the heart of embryos of the cadmium citrate influence group, the tortuosity of the subepicardial vessels was determined. Also in this group we observed a large number of subepicardial vessels, among which there were single vessels with increased internal diameter and with increased blood filling compared with the control group and a large number of vessels of small diameter.

To find out the compensatory potential of zinc citrate in relation to cadmium salts, we compared the groups of combined exposure with the respective groups of isolated exposure and control. The results obtained for the cadmium chloride + zinc citrate group were compared with the control and isolated administration of cadmium chloride groups.

In the cadmium chloride group, there was a significant increase in the average internal diameter of the subepicardial vessels by 1.54 and 1.83 times in the left and right ventricles, respectively, compared to the control group ($p < 0.001$). In the cadmium citrate group, there was a significant decrease in the average internal diameter of the subepicardial vessels by 1.43 ($p < 0.001$) and 1.33 times ($p < 0.01$), respectively, in the left and right ventricles compared to the control group.

In the cadmium chloride group, there was a significant decrease in the mean diameter of the myocardial vessels by 1.4 times ($p < 0.001$) and 16% ($p < 0.05$) in the left and right ventricles, respectively, compared to the control group. In the cadmium citrate group, the mean diameter of the myocardial vessels was 22% less than that of the control group in the left ventricle ($p < 0.001$). The mean internal diameter of the right ventricular myocardial vessels was significantly greater by almost 1.5 times that of the same group ($p < 0.001$). Also, myocardial vessels of the right ventricle of the cadmium citrate group were 22% larger than the control group ($p < 0.01$) and 1.42 times larger compared to the

cadmium chloride group (p <0.001).

Table 1

The average inner diameter of the vessels of the rat embryos heart on the 20th day of embryonic development, (μm), M ± m

Control group	Left ventricle	Right ventricle
Subepicardial vessels	47.31 ± 3,17	48.73 ± 2.61
Myocardial vessels	38.83 ± 2,19	38.69 ± 2.06
Cadmium chloride	Left ventricle	Right ventricle
Subepicardial vessels	72.84 ± 2.89 ***	89.22 ± 3.49 ***
Myocardial vessels	27.83 ± 1.71 ***	33.32 ± 1.66 *
Cadmium citrate	Left ventricle	Right ventricle
Subepicardial vessels	33.06 ± 2.06***,###	36.51 ± 2.84 **, ###
Myocardial vessels	31.83 ± 2.07 *	47.28 ± 1.9 **, ###
Cadmium chloride + zinc citrate	Left ventricle	Right ventricle
Subepicardial vessels	59.09 ± 2.58 **, ###	68.9 ± 2.85 ***, ###
Myocardial vessels	33.9 ± 1.1 *, ##	37.68 ± 1.37 #
Cadmium citrate + zinc citrate	Left ventricle	Right ventricle
Subepicardial vessels	42.74 ± 1.53 @@@	43.9 ± 1.9 @
Myocardial vessels	36.71 ± 1.34 @	40.31 ± 1.37 @@

*Notes: * - p <0.05; ** - p <0.01; *** - p <0.001; in relation to control. # - p <0.05; ## - p <0.01; ### - p <0.001 in relation to the cadmium chloride group. @ - p <0.05; @@ - p <0.01; @@@ - p <0.001; in relation to the cadmium citrate group.*

In the CdCl2 + Zn citrate group, a 23.3% reduction in the diameter of subepicardial vessels was observed compared to the cadmium chloride group (p <0.001). In the control group, the inner diameter of the subepicardial vessels was 24.9% less than in the CdCl2 + Zn citrate group. A similar result was obtained in the CdCl2 + Zn citrate group for the inner diameter of the subepicardial vessels of the right ventricle, namely: the latter was 29.5% less than in the cadmium chloride group (p <0.001), and 41.4% greater than in the control group (p <0.001). In the Cd citrate + Zn citrate group, an increase in the internal diameter of the subepicardial vessels was obtained by 29.3% (p <0.001) and 20.2% (p <0.05) for the left and right ventricles respectively compared to the cadmium citrate group.

Comparing the internal diameters of the myocardial vessels of the cadmium chloride + zinc citrate group with the isolated cadmium chloride administration group, the latter increased by 21.8% (p <0.01) and 13.1% (p <0.05) for the left and the right ventricle, respectively. Zinc citrate in the combination with cadmium citrate showed an increase in the internal diameter of myocardial vessels by 15.3% (p <0.05) for the left ventricle and a

decrease by 17.3% (p <0.01) for the right ventricle compared with group of cadmium citrate.

In the cadmium chloride group, wall thickening and perivascular coronary artery edema were registered. In the cadmium citrate group, the primitive media of the coronary vessels was also significantly distinguished in the histological examination compared to the control group.

A statistical comparison of the inner diameters of the coronary vessels of the rat embryos of the 20th day of development in the groups of combined and isolated administration is given in Table 2.

Table 2

The average internal diameter of the coronary arteries of rat embryos on the 20th day of embryonic development, (μm), M ± m

Group	Right	Left
Control	47.62 ± 2.07	45.56 ± 2.01
Cadmium chloride	55.56 ± 2.3 *	56.45 ± 2.25 ***
Cadmium citrate	46.82 ± 1.86 ##	51.14 ± 1.8 *
Cadmium chloride + zinc citrate	49.73 ±1.47 #	49.8 ± 1.76 #
Cadmium citrate + zinc citrate	48.49 ± 1.46	45.12 ± 1.65 @

*Notes: * - p <0.05; ** - p <0.01; *** - p <0.001; in relation to control. # - p <0.05; ## - p <0.01; ### - p <0.001 in relation to the cadmium chloride group. @ - p <0.05; @@ - p <0.01; @@@ - p <0.001; in relation to the cadmium citrate group.*

Analysis of the results showed a significant increase in the internal diameter of the coronary arteries in the cadmium chloride group by 16.7% (p <0.05) and by 23.9% (p <0.001) for the left and right arteries, respectively, compared with the control group.

In the Cd group of citrate + Zn citrate, a significant reduction of the internal diameter of the right coronary artery by 13.3% (p <0.05) was obtained compared to the cadmium citrate group. With the combined administration of cadmium chloride with zinc citrate, we observed a decrease in the diameter of the coronary vessels by 11.7% (p <0.05) and 13.4% (p <0.05) for the left and right coronary arteries, respectively, compared with the isolated group introduction of CdCl2.

The results of the obtained measurements of the middle part of the valves of the atrioventricular (PSC) valves and their statistical analysis are shown below (Table 3).

Analyzing the data obtained and comparing them with isolated exposure groups, we received reliable differences. In the combined groups of cadmium and zinc introduction, positive dynamics was obtained in relation to the parameter of the average thickness of the cusps of atrioventricular valves. Isolated administration of cadmium chloride led to a significant decrease in this parameter, and in the cadmium citrate group the opposite result was obtained - the average thickness of the leaflets of the atrioventricular valves increased reliably. In the CdCl2 + Zn citrate group, this indicator was 36.4% less than in the control group (p<0.001) and almost twice greater the same as that of the cadmium chloride group (p<0.001) for the mitral valve and 25% less than in the control group (p<0.05) and 44.5% greater than the cadmium chloride group (p<0.001) for the tricuspid valve. The obtained

data indicate a positive effect of zinc citrate on the index of thickness of the flaps of atrioventricular valves on the background of intoxication with cadmium chloride.

Table 3

The average thickness of the middle part of the inner flaps of the mitral and tricuspid valves of the heart of rat embryos on the 20th day of embryonic development in the experiment, (μm), M ± m

Group	Mitral valve	Tricuspid valve
Control	52.58 ± 3.01	43.84 ± 2.82
Cadmium chloride	19.18 ± 1.46 ***	24.26 ± 2.04 ***
Cadmium citrate	69.87 ± 4.28 **,###	59.72 ± 3.46 ***,###
Cadmium chloride + zinc citrate	38.55 ± 1.91 ***, ###	35.06 ± 1.93 *, ###
Cadmium citrate + zinc citrate	59.51 ± 2.96 @	51.2 ± 2.53@

*Notes: * - p <0.05; ** - p <0.01; *** - p <0.001; in relation to control. # - p <0.05; ## - p <0.01; ### - p <0.001 in relation to the cadmium chloride group. @ - p <0.05; @@ - p <0.01; @@@ - p <0.001; in relation to the cadmium citrate group.*

In the Cd citrate + Zn citrate group, the thickness of the AVV flaps was non-reliably greater (13.2% for the mitral valve (p=0.1) and 16.8% for the right PNC (p=0.053)) than in the control group, and reliably less (17.4% for the mitral valve (p<0.05) and 16.6% for the right AVV (p<0.05)) than in the cadmium citrate alone group. This fact also indicates the positive effect of zinc citrate on the thickness of the AVV cusps on the background of cadmium citrate intoxication.

Studying the accumulation of cadmium and zinc in the hearts of embryos by the method of atomic emission with electric arc atomization revealed changes in the accumulation of the trace elements under study (see Table 4).

Table 4

Accumulation of cadmium and zinc in rat embryos hearts at the 20th day of embryogenesis in the experiment (μg/g)

Group	Zinc	Cadmium
Control	6.04±0.27	0.00046±0.000024
Cadmium chloride	14.36±0.43***	0.00096±0.000047***
Cadmium citrate	4.62±0.35 **,###	0.,0052±0.00033 ***,###
Cadmium chloride + zinc citrate	9.21±0.63 ***,###	0.00049±0.000035 ###
Cadmium citrate + zinc citrate	7.05±0.25 **,###,@@@	0.00162±0.000039 **,@@@

*Notes: * - p <0.05; ** - p <0.01; *** - p <0.001; in relation to control. # - p <0.05; ## - p <0.01; ### - p <0.001 in relation to the cadmium chloride group. @ - p <0.05; @@ - p <0.01; @@@ - p <0.001; in relation to the cadmium citrate group.*

In the cadmium chloride group, the average cadmium accumulation was 0.00096±0.000047 μg/g, ie, twice higher than in the control group (p <0.001). The

introduction of cadmium chloride increased the average zinc content to 14.36±0.43 μg/g ($p<0.001$) in the heart embryos of rats of the 20th day of development. Isolated administration of cadmium citrate led to an increase in cadmium accumulation in the rat embryo heart to 0.0052 ± 0.00033 μg/g, which was 11.3 times higher than in the control values ($p <0.001$).

In the combined exposure group of cadmium chloride + zinc citrate, the content of cadmium in the hearts of embryos of the 20th day of development was 0.00049±0.000035 μg/g, that is, there was no statistically significant difference with the control (0.00046±0.000047 μg/g). These results suggest a modifying effect of zinc citrate on the ability of cadmium chloride to accumulate in embryonic tissues and to overcome the placental barrier. The level of zinc in the same group exceeded the control values by 1.5 times and amounted to 9.21±0.63 μg/g ($p<0.001$). In the group of cadmium citrate combination with zinc citrate, the level of cadmium accumulation was 0.00162±0.000039 μg/g, which is 3.2 times less than the isolated cadmium citrate administration group ($p<0.001$). It is interesting to note that in the cadmium and zinc combined administration groups, we obtained the above cadmium accumulation level without significantly increasing the zinc accumulation level observed in the cadmium chloride isolated administration group. With high cadmium accumulation, we observed a slight increase in zinc compared to the control group (16.7% ($p<0.01$)) and a significantly lower (2.04 times ($p<0.001$)) zinc accumulation level compared to of the cadmium chloride group and 1.53 times higher than in the cadmium citrate group ($p <0.001$).

Thus, it should be noted that the simultaneous use of cadmium citrate and zinc citrate leads to a decrease in cadmium accumulation and increased zinc accumulation, however, when comparing the cadmium chloride groups and cadmium citrate and cadmium citrate + zinc citrate, the zinc level is much higher in the group of the isolated administration of cadmium, despite the fact that no additional zinc was administered to the female rats during pregnancy. It also makes sense that zinc exhibits high antagonistic activity against cadmium, which is not inconsistent with literature data and has also been confirmed in our experiment [11, 13].

The interaction of heavy metal citrate forms exhibiting antagonistic properties requires further investigation. In our opinion, the mechanism of accumulation of citrate forms of cadmium and zinc differs from their ionic forms.

Conclusions. Summarizing all mentioned above, we can assume that, despite the use of identical doses of different cadmium salts in the experimental groups, as compounds with toxic properties, we obtained different results for the citrate and ionic forms of cadmium, indicating the excellent mechanism of toxic action of these forms of cadmium. Zinc citrate reduced the cardiotoxic properties of cadmium salts: the thickness of the AVV cusps, the internal diameter of the myocardial and subepicardial vessels, the coronary arteries approached the values of the latter of the control group. However, the combined administration of zinc and cadmium citrates had a different effect on the accumulation of cadmium and zinc in the heart of rat embryos. In view of the above, we believe that the interaction of heavy metal citrate forms in vivo needs further investigation. Zinc citrate can be regarded as an antagonist for cadmium compounds. However, its toxicological profile needs in-depth study.

References:

1. Skalny A.V. Assessment and correction of the elemental status of the population is a promising area of domestic health care and environmental monitoring. Microelements in medicine. 2018;19(1):5−13. [in Russian]

2. Nefedova O.O., Zadesenets I.P. Influence of heavy metals on the morphofunctional state of the heart (literature review). Bulletin of problems in biology and medicine. 2018;issue 1, 2(143):31-35. [in Ukrainian]

3. Trakhtenberg IM, Kolesnikov SV, Lukovenko VP. Tyazhelyye metally vo vneshney srede Sovremennyye gigiyenicheskiye i toksikologicheskiye aspekty. Minsk. 1994. 123 p. [in Russian]

4. Järup L, Åkesson A. Current status of cadmium as an environmental health problem. Toxicol Appl Pharmacol. 2009;238(3):201-8. DOI:10.1016/j.taap.2009.04.020

5. Shatornaya V.F., Garets V.I., Kononova I.I., Stepanov S.V., Dikhno N.I. Combining effect of heavy metals on rat embryogenesis in experiment. World of Medicine and Biology. 2014; 4: 170-174. [in Russian].

6. Nefedova O.O., Zadesenets I.P. Evaluation of the influence of cadmium chloride on the rat embryogenesis indicators in the condition of correction by zinc citrate during intragastric administration. Bulletin of problems in biology and medicine. 2018;3(145):309-314. [in Ukrainian]

7. Fedorenko VI . Substantiation of allowable daily doses of lead and cadmium in diets. Medical perspectives. 2019;24(1):73-80. [in Ukrainian]

8. Nefyodova O.O., Yeroshenko G.A., Zadesenets I.P., Shatorna V.F., Nefyodov O.O., Kuznetsova O.V. Influence of cadmium citrate low doses on rat embryo's cardiogenesis. World of medicine and biology. 2019;1(67):166-170. [in Ukrainian]

9. Nefedova O.O., Zadesenets I.P. Influence of cadmium chloride and cadmium citrate on rats embryogenesis indicators in conditions of intragastric administration Ukrainian Journal of Medicine, Biology and Sport. 2018; vol 3, 6(15):52-57. [in Ukrainian]

10. Borisevich V.B. Nanomaterials in Biology. Fundamentals of nano-veterinary medicine / V.B. Borisevich, V.G. Kaplunenko, M.V. Kosinov. - Kiev: Avicenna VD, 2010. - 416 p.

11. Krebs, N.E. Zinc metabolism and homeostasis: the application of tracer techniques to human zinc physiology / N.E. Krebs, K.M. Hambidge // Biometals. 2001; Vol. 14. 3(4):397-412.

12. Brin V.B., Kokayev R.I., Babaniyazov H.H, Pronina N.V. [Vozmozhnosti profilaktiki toksicheskikh effektov kadmiya metallokompleksom soli tsinka – atsizolom]. Journal of new medical technologies.2008;15(4):213-216. [in Russian].

13. Ashraf El-Sayed1, Salem M. Salem, Amany A. El-Garhy, Zeinab A. Rahman, Asmaa M. Kandil. Protective effect of zinc against cadmium toxicity on pregnant rats and their fetuses at morphological, physiological and molecular level. African Journal of Biotechnology. 2013;12(16)2110-2119. DOI:10.5897/AJB12.2829

EFFECTS OF ELECTROMAGNETIC RADIATION ON THE STRUCTURE AND FUNCTION OF MALE REPRODUCTIVE ORGANS AND THEIR CORRECTION WITH IMMUNOTROPIC DRUGS (LITERATURE REVIEW)

Elena Sharapova, *Ph.D.,*
SE "Dnipropetrovsk Medical Academy of the Ministry of Healht of Ukraine",
Elvira Topka,
Doctor of Medical Science, Professor,
Dnipro Medical Institute of Traditional and Non Traditional Medicine,
Vlada Gruzd,
SE "Dnipropetrovsk Medical Academy of the Ministry of Healht of Ukraine"

Annotation. *In this work the literature sources on the negative effects of magnetic fields of different frequencies and power on the testes, the epididymis of the testicles of human, rat and some animals were analyzied. In addition in this literature review the authors explored the use of some immunocorrective drugs, also their combinations in treatment of inflammatory diseases of the testicles and prostate in experiment and the clinic.*

Also authors identified the results of the effect on the genitals of human and animals by the another immunomodulating drug – echinacen purpurea are absent in modern scientific literature and may be summarized in subsequent studies.

Key words: *electromagnetic radiation, electromagnetic field, testicle, epididymis, immunotropic drugs.*

Introduction. 13 - 19% couples of fertile age suffer from the absence of children. Recently, there has been a tendency for an increase in the number of infertile marriages, according to the data of the expatriates and the thinner age 8-20%. In the structure of infertile marriages 25-54% is a male factor. Among the infertile examined men, the presence of occupational harmful factors was noted in 31.5% of patients, which confirms the importance of the influence of the electromagnetic field (EMF) on the development of reproductive sexual disorders.

The purpose of the work was the systematization of literary sources which changes are reflected in different organs and systems of human and animals that occur after the action of the electromagnetic field of different radiation parameters on the male genital organs and genitals of some animals as well as the effect of immunomodulating drugs on them.

Results and discussions. According to this, the interest in studying the features of structural and functional changes of the male sexual system under the influence of EMF is growing. In the literature, there were shortcomings in the number of sources in which the effects of electromagnetic field of different frequencies on the structure and function of male sexual organs could be fully raised.

One of the essential indicators of the biological action of an electromagnetic field is condition of the genetic apparatus and generative function, because the effect of a long-acting factor can be manifested only in subsequent generations. The most sensitive to the modifying influence of environmental factors is the early period of development of the organism (from the moment of fertilization to birth), when the formation, growth and differentiation of tissues, organs and systems occur: the current factors often become limiting at this time [1]. Prolonged EMF action under certain conditions can cause disrupt of the reproductive function and genetic apparatus. Based on the experimental data it was established that an electric field with a voltage of 4 to 25 kV/m causes a disrupt of the reproductive capacity in rats, giving an unfavorable influence on the function of the testicles and ovaries.

The testicles of rats have a high sensitivity to irradiation in low frequency EMF that can be attributed "to the critical organs" in relation to the influence on the body of this new adverse factor by the components of the productive environment. Especially detected components of the spermatogenic epithelium are the most differentiated cell elements - spermatozoon. The degree of detected regressive tissue changes depends on the intensity of the field and the duration of the irradiation. Dumansky Y.D., Andrienko L.G. [2] conducted experimental studies by the experimental animals that were exposed to industrial frequency EMF that may occur in the operating area of transmission lines (transmission lines). The authors determined the morphological changes of the testicles during repeated influences of industrial frequency EMF at different periods of the ontogeny of human. Clinical and experimental studies have revealed the development of individual consequences of embryotoxic, gonadotoxic and teratotenic effects of EMF. EMF with a voltage of 1 to 5 kV/m in conditions prolonged continuous action, without causing sterility in the subjects, adversely affects the germ cells of females and males, in the embryogenesis and postnatal progeny development. Lundsberg L.S. didn’t reveal correlation between the magnitude of electromagnetic field induction and the subsequent appearance of anomalies in the reproductive organs and the effect on male fertility have not been identified.

Budyanska E.M. [3] was studying the effect of video display terminals (VDT) on the hormonal status of their users. Hypersensitivity of the sexual steroid metabolic system to occupational stress was determined. Men that work on VDT, have manifest changes in the content and ratio of sexual steroids - decreasing testosterone level and increasing estradiol level.

N.V. Kokoreva, T.A.Chuvpilo [4] testify the changes in the testicles because of the influence of a constant magnetic field (CMF). These changes are characterized by sperm damage in the tubules, the number of his spermatozoa, increased sperm anomalies. Cytological analysis of the spermatogenic epithelium of mice under the action of CMF induction of 0.4 and 1.6 Tl showed a decrease in the number of all cell types of spermatogenic epithelium by 35-40%, with the most pronounced changes observed from the mature forms of sperm. After short-term effects, the recovery process ended up to 40 days, after chronic effects it was longer. The authors may suggest that the reproductive function of the males is impaired by the effect of the CMF.

The Chornobyl disaster has led to significant damage to the immune system of the victims. As a result of the accident, about 1.1 * 1019 becquerels of radionuclides were emitted into the environment, leading to radioactive contamination of the territory of Ukraine. Currently, the main pollution of the territory of country is determined by cesium-137 and to a lesser extent - strontium 90. Transuranium elements of Chornobyl origin are distributed almost all over Ukraine [5; 6]. However, according to departmental statistics 1999-2003, there was no increase in the frequency of unauthorized miscarriages up to 12 weeks of pregnancy, which mainly occur as a result of chromosomal abnormalities of the mathers, living in radioactively polluted territories [7].

I.D. Kirpatovsky, S.S. Pisarenko [8] have conducted a morphological examination of the testicles of 41 men, who were residing throughout 7-9 years in radiation contamination zones in the Kaluga region after the Chernobyl accident, found changes in the seed canals of varying degrees of severity in 75.6% of cases. Different degree of complexity of changes of gonads is revealed at men of different age. Male germ cells are more sensitive to ionizing radiation. Irradiation with a relatively low intensity of 0.15 Sv can cause transient azoospermia. Full sterility in 100% of men will develop with single exposure at a dose of 63 and above.

Bandazhevsky Y.I. [9] in 2011 was investigated that for a long time (1.3 and 6 months) after of the irradiation of male rats at a dose of 3 Gr, the content of sperm in the epedidymis of the testicles, the content of nucleic acids and protein in the testes were decreased. The fertility of animals significantly reduced.

The dependence of the degree of lesion of the seed epithelium on the dose and power of irradiation is established. The degree of damaging germinative tissue increasing as the dose was accumulated, but this dependence was not linear. The predominant effect of the dose rate on the lesion processes was noted in the early days of prolonged and chronic irradiation. Irradiation dose rate becomes paramount in the processes of damage of seed tissue as the duration of the radiation exposure increases. From literature sources it has shown that ionizing radiation leads to the development of an autonomous process in an irradiated organism, which is primarily directed against cells of radiosensitive organs. At the same time, it is known that the testicles are one of the radio-sensitive organs. The cells of the spermatogenic epithelium are themselves foreign to their own body and are protected by a special barrier. Damage of the latter is established at EMF action and at occurrence of pathological conditions as a result of which an autoimmune pathological process develops [10; 11].

The violation of the structures of the hematotesticular barrier and microcirculation is an important aspect in the process of the development of male infertility and sexual disorders. It is established that a harmful factor of all genesis (trauma, hypothermia, the effect of pollutants, etc.) leads to the development of ischemic changes, a disorder of microcirculation, which leads to a decrease in the total number of cells of the spermatogenic row and disorder of the processes of sperm differentiation [12].

The problem of male infertility becomes more relevant from year to year, since the parenchyma of the testes has been quite sensitive to the influence of environmental

factors [13]. According to authors of Ukraine, the average age of patients suffering from chronic urogenital pathology is up to 80%, ranged from 21 to 50 years, and up to 30 years from 40 to 60% [14].

The fact that inflammatory diseases of the genital organs (chronic prostatitis, vesiculitis and urethritis) occur mainly men of reproductive age, aggravates the medical and social significance of the problem, since the disease reduces the sexual function of men, and in some cases, leads to impaired fertility. Sexual maladaptation of a married couple survived by the sick mans and destroy the marriage opportunity [15]. Injection of infertility is an acute and chronic circulatory disorder in it because developing germ cells are very sensitive to hypoxia. Circulatory disorders in the testicles can occur with changes in temperature, the effect of EMF, varicocele, accompaning by circulatory hypoxia [16; 17].

In order to restore the structure and function of the male genital organs after the action of damaged factors, including EMF, various immunoregulatory agents are used in the medical practice of urologists and pediatric surgeons.

According to Belotsky S.M., Spivak N.Ya. these drugs can be either immune (immunoglobulins) or chemical or biological agents (corticosteroids, cytostatics, etc.) [18]. Efremenko E.A. [19] in 2018 investigated the medicinal properties of pumpkin seeds, extracts of which include in the composition of rectal suppositories that are used in the treatment of acute and chronic diseases of the prostate gland. According to the author, pumpkin seed extracts also have reparative, antispasmodic, antimicrobial and antiandrogenic properties.

Musica N.Ya. [20] in terms of scientific research that preparations based on a vegetable raw materials are perspective group for treatment of the male genital organs including inflammatory organs. Among the natural compounds a complex of biologically active substances (BAR), removed from the inflorescence of alder birch "Altabor", attracted the most attention of the author. The theoretical prerequisite for the development of the test substance was information about the properties of BAR, in particular, their reparative, anti-inflammatory and antioxidant effects. Substance "Altabor" does not make allergic, immunotoxic, locally irritant and gonadotoxic actions that are essential to improve the effectiveness of therapy for male genital diseases.

Pastukhova V.A. [21] in 2012 used an applied leaf extract of Ginkgo biloba and the drug inosine after influence on the male genital organs of action of the chronic hyperthermia. Morphological analysis of the structure of the internal male genital organs during the application of extract from Ginkgo biloba leaves shows the reducing the dyscirculatory disorders investigated organs, the depth of their damage. This drug prevents destruction all components of the hematotesticular barrier of the testicles.

Workers exposed to electromagnetic fields are more likely to have infertility. There are many herbal antibacterial and antispasmodic effect. Spore and remedies that are used to treat male infertility. There are plants that have a regulatory effect on the hormonal background. Such property has sage, which, among other things, still has anti-inflammatory and antiseptic action, helps in the treatment of prostatitis. Peony, like

sage, restores hormone levels and also regulates the nervous system. In some forms of infertility such herbs as plantain and spore are used. Plantain are still excellent in removing swelling [22].

There are herbs that can reduce the autoimmune processes in the testicles. These properties have a composition that combines plantain leaves, nettles, mothers-stepmothers, cranberries, birch buds, tansy flowers, oregano, yarrow, bird's mountaineering, goose fingerlings, marsh drought and dandelion root. For the treatment of male infertility, herbs can brew and drink tea made from goritzvit, Adam's root, sage, pine uterus, hawthorn and elder. Treatment is often based on the principle of general health promotion and restorative processes in the body.

Treatment of male infertility usually involves the use of various plant components, as well as bee products, which activate the body's natural functions. Sometimes honey, flower pollen, tincture of wax moth, mummy and propolis are used in combination with apple cider vinegar or carrot juice and medicinal plants. Bee products help with infertility as they contain many vitamins, microelements and acids. Bee products reduce inflammation, swelling and continue chronic remission diseases, immunity, soothe, heal, restore metabolism [23].

Treating the disease with herbal remedies will not help eliminate all the problems, as there are a number of points that require the use of medicines or even surgical treatment. But, nevertheless, these methods help in the basic therapy of infertility and perfectly restore the general health.

Biologically active additives are important for the treatment of diseases of the testicles and the reduction of potency. Reduced potency - the result of unhealthy nutrition, psycho-emotional overloads, hypodynamic lifestyle. To solve this delicate problem, there are many medicines. Unfortunately, most of them have a number of contraindications and side effects. Support the elimination of potency problems without disrupting the functionality of other organs and harming health, possibly through dietary supplements. The widespread use of dietary supplements is due to their natural composition. Potency boosters are designed based on natural components.

Biologically active supplements are made up of several ingredients that have a positive effect not only on the male potency, but comprehensively on the whole body. Supplements are developed on the basis of natural raw materials. Almost all products contain polyunsaturated fatty acids, which improve the quality of sperm, selenium and zinc, responsible for the production of testosterone, amino acids for endurance, vitamin complexes. Due to its natural composition, supplements for men are allowed to use for a long period of time with short breaks [24].

Due to its natural composition, supplements for men are allowed to use for a long period of time with short breaks. Supplements are not addictive and have no withdrawal syndrome. They can be taken to restore the functionality of the genitals, and to prevent problems with potency. In addition, biologically active supplements have a beneficial effect on the immune system, normalize sleep, increase the overall tone of the body.

Conclusions. Thus, in modern times, there is not such drug, that would completely

restore the structure and function of the human genital organs. The combination of some drugs can only improve the condition of these organs.

1. Many years of medical treatment shows that if the deviations and components of the phytocomposition are properly evaluated and corrected, then most of the disorders are corrected. This is probably due to duplication of pharmacological effects (using plants of the same directional effect), increasing the likelihood of induction of the main desired effect by indirect actions; utilization of the whole pharmacological potential of used medicinal plants (thousands of chemical compounds), full-scale use of multiple duplication of functions in the body.

2. The use of medicinal plants and preparations based on them for thousands of years confirms that the plant is a biogenetically formed complex, such a complex that exists in a living cell, is more similar to the human body than individual chemicals, and therefore easier to assimilate and give fewer side effects.

3. Treatment with medicinal plants immunomodulatory action indicates that the correct selection of components of the phyto composition increases the likelihood of achieving the main pharmacological effect.

References:

1. Dumansky YD, Andrienko LG, Tomashevskaya LA. Analysis of embryogenesis and the state of amniotic fluid in white rats under electromagnetic loading. Human hygiene. 2010; 37: 279 - 280. Russian.

2. Dumansky YD, Andriyenko LG, Polka NS. Sexual maturation and the state of reproductive function of experimental animals exposed to a complex of physical computer factors. Human hygiene. 2017; 37: 280 - 285. Russian.

3. Budyanska EM. About premature age changes by major homeostatic systems of the body of users of video display terminals (VDT). Materials of the I Intern. cong. «Weak and weak fields and radiation in biological and medical», St. Petersburg; 2017. p. 219. Russian.

4. Kokoreva NV, Chuvpilo TA, Pustynnikova AM. Influence of high-intensity constant magnetic field on the reproductive function of male rats. Space Biology and Aerospace Medicine. 2013; 24(1): 28-30. Russian.

5. Vozianov VF, Romanenko AM. Uropathological aspects of chronic action of small doses of radiation after the Chernobyl accident. T: Ukrmedkniga, 2003. 148p.

6. Muck K., Prohl G., Meckbach R., Likhtarev J., Kovgan L., Golikov S.A. New approach to Assess the Doses to the Population in the 30-km Zone after the Chernobyl Accident. Report JRPA. 2017; 12(3): 11-27.

7. Serdyuk AM. Gene Fund and Health: Ionizing Radiation. Kiev; 2011. 191 p.

8. Pisarenko SS, Lysenko AI, Kirpatovsky ID. Morphological changes of the sexual glands of the male population in the zones of radioactive contamination of the Kaluga region. Archives of pathology. 2010; 62 (4): 27-31. Russian.

9. Burned LI. Features of general and local immunity in patients with chronic

abacterial prostatitis (chronic pelvic pain syndrome). Author of diss. ... Ph.D.: Kyiv; 2010. 20 p.

10. Grigoriev VV, Ogurtsov RP, Zubzhitsky Yu.L. Immuno-morphological changes of the testes under the action of a high-frequency electromagnetic field. Archive of Anatomy, Histology and Embryology. 2015; 80(2): 69-75. Russian.

11. Stus VP. Features of the combined influence of radiation and chemical factors of the intensive industrial region on the genitourinary system. Dnepropetrovsk; 2016. 352 p.

12. Narbutova TE. Structural and functional changes of the testes during cumulation of lead compounds and pharmacological correction. Author's abstract diss. ... Ph.D. Symph.; 2017. 19 p.

13. Krutskikh TV. The study of the pharmacological and technological properties of the substance Altabora. Odessa medical journal. 2015; 4: 11-3.

14. Lyulko AV, Stus VP. Influence of ionizing radiation on sexual function and spermatogenesis. Dnepropetrovsk; 1995. 257 p.

15. Potapenko OA. Sexual maladaptation of the couple in inflammatory diseases of the genital organs in men. Author's abstract diss. ... PhD.: Kharkiv; 2010. 16 p.

16. Ivasyuk IYu. Morphofunctional state of blood vessels and parenchyma of testes in normal and after their trauma: Abstract. diss. ... Ph.D. Ternopil; 2016. 20 p.

17. Topka EG, Baibakov VM. Method of treatment of vaginal process of the peritoneum in surgical welding of the testis and the spermatic cord in children. Clinical Anatomy and Surgery. 2012; 11(1): 56-58.

18. Zalikina ZhG. Damage and restoration of the seminal epithelium of mice when irradiated with different dose rates. Space Biology and Aerospace Medicine. 2018; 14 (4): 80-83. Russian.

19. Efremenko EA. Investigation of the pharmacological properties and experimental justification of the prostatoprotective action of the extract of hop leaves. Author. diss. ... Cand. honey.Sciences: Kharkov; 2018. 20 p.

20. Musica NYa. Experimental substantiation of the clinical application of the original prostatoprotective agent of plant origin - altabor suppositories. Author. diss. ... Cand. honey. Sciences: Kharkov; 2016. 20 p.

21. Pastukhova VA. Morphofunctional peculiarities of internal male genital organs in conditions of general chronic hyperthermia (anatomical expert study). Dis. ... Dr. honey. Sciences: Lugansk; 2018. 458 p.

22. Garna SV, M. Vladimirova IM, Burd NB Modern Physical Therapy. Kharkiv: Drukarna Madrid; 2016. 580 p.

23 . Annamohammedova OO, Annamohammedov AO. Medicines in the tables and charts. Zhytomyr; 2016 . 187 p.

24. Kovalenko VN, Vyterova AP. Medicines. K: Morion; 2009. 2224 p.

CHANGE OF INDICATORS OF RAT EMBRYOTOXITY UNDER ISOLATED INJECTION OF CADMIUM COMPOUNDS AND COMBINED WITH CERIUM

Vera Shatornaya, *Dr. hab., Biology, Professor,*
Irina Kolosova, *Ph.D., Biology,*
Vera Garets, *MD, Professor,*
State Institution "Dnipropetrovsk Medical Academy of Health Ministry of Ukraine"

Annotation. *In the scientific researches the general toxicity was determined, the peculiarities of metabolism were studied, the degree of carcinogenic, teratogenic, gonadotoxic, embryotoxic and mutagenic influence on the body of cadmium was established, but the scientific information concerning the influence on the general course of embryogenesis is extremely insufficient.*

Key words: *cadmium chloride, cadmium citrate, cerium citrate, embryogenesis, embryotoxicity.*

This study is a fragment of the interdepartmental planned scientific topic "Biological basis of morphogenesis of organs and tissues under the influence of nanometals in experiment" (state registration number 0115U004879), which was performed at the State Institution "Dnipropetrovsk Medical Academy of the Ministry of Health of Ukraine".

Modern functioning of the economy is accompanied by an increase in technogenic load.

Heavy metals are priority pollutants of atmospheric air, water of reservoirs and soils on a global and regional scale.

Due to their high migratory capacity, tendency to bioaccumulation and polytropicity, metals pose a risk to humans not only through direct action but also through a negative impact on the environmental health of the environment [1].

According to the literary data in the body of children is determined by the excess of biologically acceptable levels of a number of toxic metals, among which a significant place is the accumulation of cadmium [1], attributed to the second class of danger [2].

Cadmium and its compounds are widely used for the manufacture of nuclear reactor cores, chemical power sources, paints, colored glass; as a plastic stabilizer; in electroplating and in the automotive industry.

Very small amounts of cadmium are present in the body of any person. It is entering our body from the air and soil, that actively polluted by this metal and its compounds through human activity: tobacco smoke (tobacco stores cadmium well), food of plant origin (mushrooms, sunflower seeds, cereals, wheat, nuts), polluted air (combustion products of coal, diesel, galvanic, glass, cement production) [1,3].

In a case of excess admission of cadmium to the body, it adversely affects the liver, kidneys, central nervous system, reproductive organs, and in conditions of chronic exposure exhibits mainly nephrotoxic, immunotoxic and osteotoxic effects [1,4,5,6].

Like most heavy metals, cadmium has a high cumulative capacity: its half-life is 10-35 years.

Cadmium is deposited mainly in the kidneys (30-60%) and the liver (20-25%) [7,8].

Its action is related to the synthesis of the metallothionein protein in the body, which binds and transports cadmium ions [9].

Excess cadmium impairs the absorption and metabolism of a number of microelements: zinc, copper, selenium, iron [6,10,11].

A characteristic feature of heavy metals, including cadmium, after entering the body is their uneven distribution between cells and tissues and the ability to form a depot in the body, and secreted through the urinary tract, the mucous membranes of the digestive canal and various glands cause pathological changes in them [11,12].

The actual problem is the identification of substances or compounds that have the ability to reduce the adverse effects of heavy metals on humans and animals.

Nanotechnology has opened up new and promising areas in modern biology and medicine.

A promising area is the use of microelements in the form of carboxylates of food acids, especially in the form of citrates, which is a natural protective system against many toxicants.

Cerium nanoparticles have antihypoxic and antioxidant activity, that are essential during pregnancy and lactation, growth, development and normal functioning of the body.

Organic and complexing compounds of cerium. exhibit immunomodulatory, antitumor, antiviral, neuro-, cardio-, hepatoprotective, detoxifying, membrane-protecting effect, capable of increasing the life span of micro- and macro-organisms, affecting meiotic maturation of oocytes and follicles in the ovaries of aging mice [12,13,14].

The purpose of the article. The aim of this study was to determine the effect of low cadmium chloride and cadmium citrate on isolated administration and in combination with cerium citrate on the overall course of rats' embryogenesis.

As a biological test-object there were used mature female Wistar rats, at the beginning of the experiment exposed to research of estrous cycle by examining vaginal smears, at the stage of estrus matched with intact males by the scheme 2:1. The first day of pregnancy was determined by the presence of spermatozoons in vaginal smears, animals were divided into groups and administration of the test substances started: solutions of cadmium chloride, cadmium citrate and cerium citrate,, obtained by means of aquananotechnology (manufacturer – Research Institute of Nanobiotechnologies and resource of Ukraine, the city of Kyiv).

Materials and methods. The experimental part of the work was performed on 80 white pregnant female Wistar rats, which were divided into 5 groups of 16 animals in each: Group 1 (E № 1) - animals that were administered a solution of cadmium chloride at a dose of 1.0 mg / kg; Group 2 (E № 2) - animals that were administered a solution of cadmium citrate at a dose of 1.0 mg / kg; Group 3 (E № 3) - animals that were administered a solution of cadmium chloride at a dose of 1.0 mg / kg and a solution of

cerium citrate at a dose of 1.3 mg / kg; Group 4 (E № 4) - animals that were administered a solution of cadmium citrate at a dose of 1.0 mg / kg and a solution of cerium citrate at a dose of 1.3 mg / kg body weight of the animal, group 5 was control.

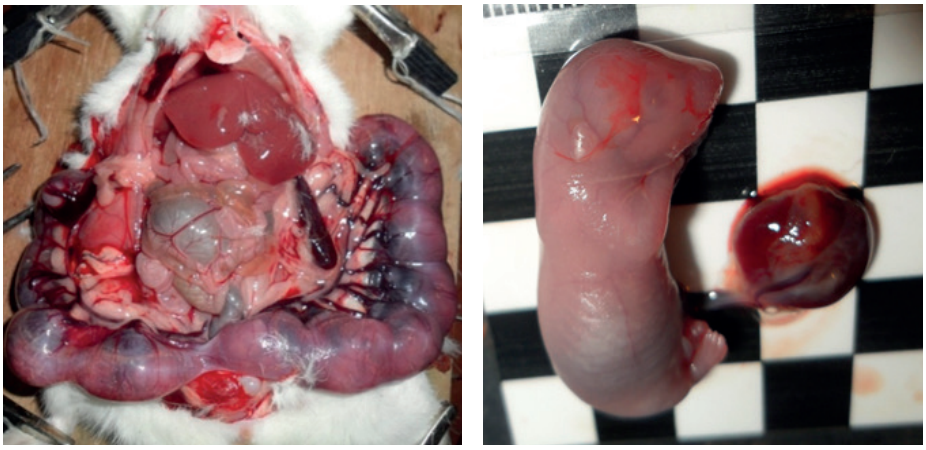
The solutions of the test substances were administered to the females intragastrically through the probe once a day, at the same time throughout pregnancy.

During the administration of solutions, the status and behavior of females, the dynamics of body weight, rectal temperature, and duration of pregnancy were registered.

In each group, the females were divided into 2 subgroups of 8 animals in each depending on the pregnancy period that was studied.

On the 13th and 20th day of pregnancy, an operative slaughter was performed.

At autopsy, the rats were removed from the uterus, tested for the live-dead test, weighed, determined the fetal development to be normal, performed macroscopic examination of the embryos to detect external abnormalities, photographed and fixated in 10% formalin for further histological examination. (Fig. 1)



A B

Fig. 1 - Photograph of a two-sided uterus with the results of a pregnant female of a control (A) rat during surgery on the 20th day of pregnancy and (B) fetal placenta removed from the uterus.

In the ovaries were determined the number of yellow bodies of pregnancy, weight and size. (Fig. 2)

Investigation of the morphofunctional state of ovaries and their remodeling with defining changes of general course of rats' embryogenesis in terms of enteral injection of isolated cadmium chloride and cadmium citrate isolated and in combination with cerium citrate was conducted by means of: modeling, anatomical preparation, macroscopic examination, histological morphometric one, cytological and bio-statistical methods.

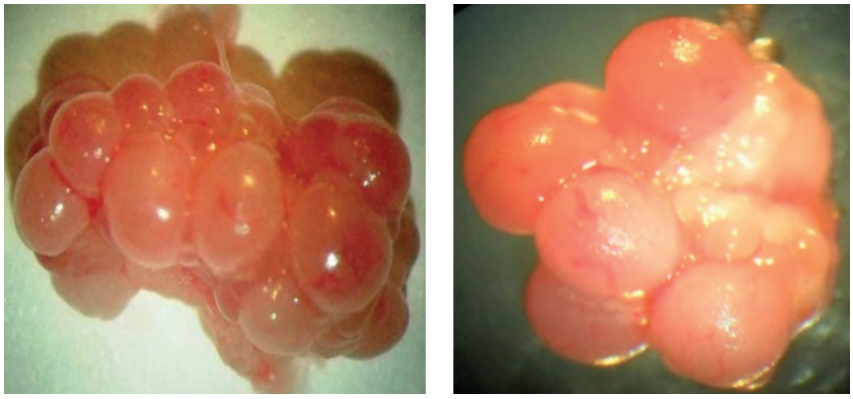


Fig. 2 - Ovaries of female rats of control (A) and experimental group # 1 (B) of the 20th gestation day. Reduction of the number of yellow bodies of pregnancy in study group # 1 can be observed with the isolated action of cadmium chloride.

Results and discussions. In the analysis of indicators of the number of yellow bodies per 1 female, it was found that on the 13th day of gestation there was an unreliable change of this indicator as follows compared with the control group: E№2 (+ 4.9%) = E№3 (+4.9%) > E№ 4 (+ 1.9%)> E№ 1 (- 9.7%). On the 20th day of prenatal development, indicators of the number of yellow bodies were arranged as follows in the order of decrease relative to the control group: E№3 (+ 27,7%) > E№4 (+ 9,9%)> E№2 (+ 2,5%)> E№1 (- 3.0%).

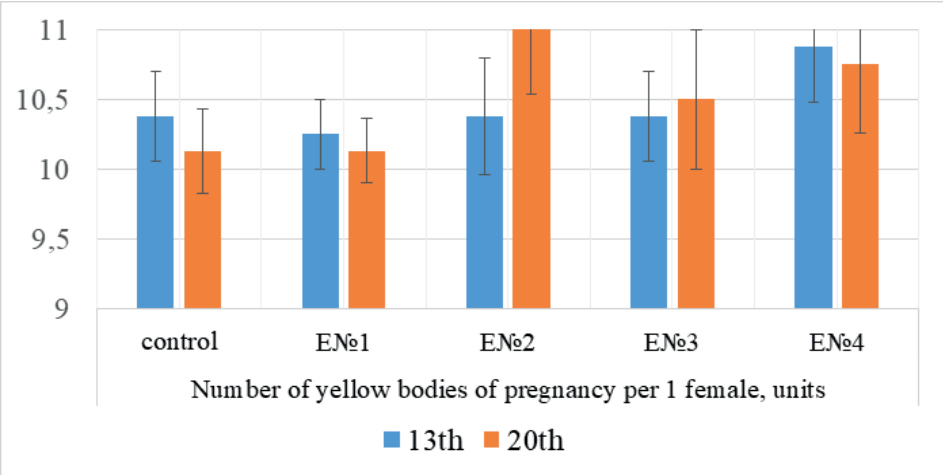


Fig. 3 - The number of yellow bodies in the ovaries of control and test rats

Indicators of embryotoxicity are generally accepted criteria: preimplantation (preimplantation, PMU) and postimplantation embryonic mortality (PEU), total embryonic mortality (TEM), morphological (anatomical) malformations, as well as the

overall delay in the development of fruits, which were calculated according to well-known formulas

The obtained results were processed by the method of variational statistics, their reliability was assessed using the Student's t test (t). The obtained data were considered to be significant at p <0.05.

Analysis of the results of the experimental study revealed a negative effect of cadmium compounds on the embryotoxicity indicators and the number of alive fetuses in the females at the 13th and the 20th days of pregnancy ((Table 1, Fig. 4).

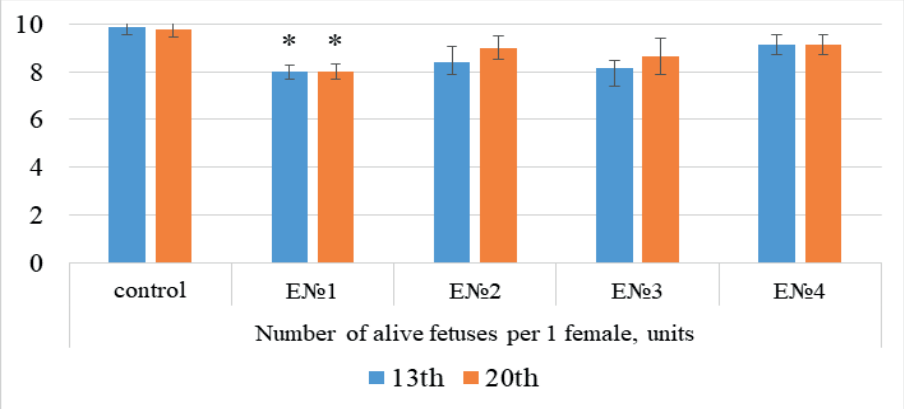


Fig. 4– Number of alive fetuses per 1 female, units

Table 1

Embryotoxicity indicators of control and experimental groups on 13th and 20th days of embryogenesis, (M ± m)

Indicator	Day	control	Study groups			
			E№1	E№2	E№3	E№4
Total embryonic mortality, % (TEM)	13	6,02 ± 1,71	26,83 ± 2,25***	17,86 ± 3,61**	20,48 ± 2,62***	17,24 ± 3,49*
	20	4,94 ± 1,81	20,24 ± 4,77**	15,60 ± 3,24**	18,22 ± 4,73*	14,82 ± 2,72**
Preimplant (preimplantation) mortality, unit (PMU)	13	0,02 ± 0,01	0,20 ± 0,03***	0,12 ± 0,03	0,13 ± 0,02**	0,12 ± 0,04*
	20	0,02 ± 0,01	0,14 ± 0,04*	0,11 ± 0,03*	0,12 ± 0,04*	0,10 ± 0,02**
Post-implantation mortality, units (PEU)	13	0,04 ± 0,02	0,09 ± 0,38	0,07 ± 0,31	0,08 ± 0,44	0,05 ± 0,33
	20	0,03 ± 0,38	0,07 ± 0,25	0,05 ± 0,29	0,07 ± 0,30	0,05 ± 0,32
Note. * - p <0.05, ** - p <0.01; *** - p <0.001 compare to the control group						

The number of alive fetuses per 1 female on the 13th day of pregnancy under the influence of cadmium chloride (E№1) decreased by 23.1% (p <0.001), and on the 20th day by 13.0% (p> 0, 05) compared to the control group. (Fig. 4).

At the same time, indicators of TEM , PMU, and PEU increased relative to the control group on the day 13: TEM 4.5 times (p <0.001), PEU 10 times (p <0.001), PIS 2.3 times (p> 0 , 05) and on the 20th day of fruit development we observed increase of TEM indicators by 4.1 times (p <0.01), PMU by 7.0 times (p <0.05), PEU by 2.3 times (p > 0.05) compared to the control group (p <0.05).

In the experimental group E№2, isolated effects of cadmium chloride on the 13th day of embryogenesis relative to the control group, the indices of the number of living fruits per female decreased by 11.5% (p> 0.05), while the TEM indexes increased by 3.0 times (p <0.01), PMU 6 times (p> 0.05), PEU 1.8 times (p> 0.05).

On the 20th day of fetuses development, there was a decrease in the number of alive fetuses per female by 4.0% (p> 0.05), but the TEM indexes increased 3.2 times (p <0.01), the PMU in 5, 5 times (p <0.05), PEU 1.7 times (p> 0.05) compared to the control group (p <0.05).

Under the combined influence of cadmium chloride with cerium citrate (E№3), the number of living fetuses per female decreased on the 13th (by 15.4% (p> 0.05)) and by the 20th day of embryogenesis (by 10.4% (p> 0.05)) compared to the control group.

Also, mortality rates increased by the 13th: TEM 3.4 times (p <0.001), PMU 6.5 times (p <0.01), PEU 2.0 times (p> 0.05), and by the 20th day of prenatal development: TEM 3.7 times (p <0.05), PMU 6.0 times (p <0.05), PEU 2.3 times (p> 0, 05) compared to the control group.

During analysis of the indexes of embryotoxicity in the experimental group No. 4 combined introduction of cadmium citrate with cerium citrate compared with the control group found a decrease in the number of alive fetuses per female on the 13th day (by 7.7% (p> 0,05)) and 20th day of embryogenesis (5.2% (p> 0.05)).

On the contrary, embryo-mortality rates increased as at the 13th day of gestation: TEM 2.9 times (p <0.05), PMU 6.0 times (p <0.05), PEU 1.3 times (p > 0.05 and on the 20th day of prenatal development: TEM 3.0 times (p <0.01), PMU 5.0 times (p <0.01), PEU 1.7 times (p> 0.05) compared to the control group.

Conclusions. The analysis of the obtained results indicates a pronounced embryotoxic effect of cadmium compounds on the processes of embryogenesis, which is a significant increase in total embryonic mortality compared with the control group in both embryogenesis timeframes, especially in the experimental groups of isolated administration of cadmium compounds: chloride E№1 - 13th day (+ 345,7%) and 20th day (+ 309,7%)) and citrate E№3 (13th day (+ 309.7%) and the 20th day (+268.8%)), especially due to an increase in pre-implantation mortality in E№1 (10.0 times on the 13th day and 7.0 times on the 20- and day 3) and in E№3 (6.5 times on the 13th day and 6.0 times on the 20th day).

At the same time, the number of alive fetuses per 1 female in the isolated cadmium chloride (E№1) and cadmium citrate (E№3) groups decreased by 23.1% at the 13th

day of embryogenesis and by 15.4% at the 20th day (E№1) and 13.0% and 10.4% respectively (E№3) compared to the control group.

More promounced embryotoxic effect was found in the cadmium chloride isolated action group.

At the same time, the group of cadmium chloride combined with cerium citrate showed improvements in all indicators of embryonic development relative to the cadmium chloride isolated effect group.

Thus, PMU indices were painted by 23.7%, by the 13th day - by 10.0%, by the 20th day, by 35% and by 14.3%

Similar changes in the studied parameters occurred in the group of combined effects of cadmium citrate with cerium citrate, indicating the modifying effect of cerium citrate on the toxicity of cadmium compounds.

In our opinion, it is promising to study the effect of cadmium compounds with metal citrate on organogenesis at histological level.

References:

1. Kolosova II, Rudenko KM, Shatorna VF. Cadmium - a threat to living organisms (literature review) Perspectives of world science and education The 5th International scientific and practical conference “Perspectives of world science and education” (January 29-31, 2020) CPN Publishing Group, Osaka, Japan. 2020. 884 p. Ukrainian

2. Mechanisms of toxicity of heavy non-ferrous metals in experiment and clinic / F.S. Dzugkoeva, IV Mozheeva., S.G. Dzugkoev [and others] // Fundamental and applied research in the modern world. - 2015. - № 10 (4). - P.117-120. Russian.

3. Non-renal effects and the risk assessment of environmental cadmium exposure / Åkesson A., Barregard L., Bergdahl I.A. [et al.] // Environmental Health Perspect. – 2014. – Vol. 122, № 5. – P. 431-438.

4. Trachtenberg IM On the problem of combined gonadotoxic action of heavy metals (lead and cadmium) and ionizing radiation / I.M. Trachtenberg, IN Andrusishina // Labor hygiene. –2000. – № 31. –P.101-110.

5.The toxicity of cadmium and resulting hazards for human health / Godt J., Scheidig F., Grosse-Siestrup C. [et al.] // J. Occupational Med. Toxicol. – 2006. – № 1. – P. 22-28.

6. Skalny AV. Assessment and correction of the elemental status of the population is a promising area of domestic health care and environmental monitoring. Microelements in medicine. 2018;19 (1): 5−13. Russian.

7. Apykhtina OL. Changes in the biochemical parameters of the blood serum of experimental animals after exposure to cadmium chloride and cadmium sulfide nanoparticles of different sizes. Biomedical and Biosocial Anthropology. 2017; 1: 47-51. Russian.

8.Cadmium toxicokinetics in the freshwater turtle, Chinemys reevesii / Huo J., Dong A., Yan J. [et al.] // Chemosphere. – 2017. – Vol. 182 – P. 392–398.

9. Effects of subchronic digestive exposure to organic or inorganic cadmium on

biomarkers in rat tissues / Hispard F., de Vaufleury A., Martin H. [et al.] // Ecotoxicol. Environ. Saf. – 2008. – Vol. 70, № 3. – P. 490–498.

10. Selenium source impacts protection of porcine jejunal epi-thelial cells from cadmium-induced DNA damage, with maximum protection exhibited with yeast-derived selenium compounds / Lynch S.J., Horgan K.A., White B., Walls D.// Biol. Trace Elem. Res. – 2017. – Vol. 176, № 2. –P. 311–320.

11. Dietary deficiency of cal-cium and/or iron, an age-related risk factor for renal accumulation of cadmium in mice / Min K.S., Sano E., Ueda H. [et al.] // Biol. Pharm. Bull. –2015. – Vol. 38, № 10. – P. 1557–1563.

12. Genotoxicity and Cytotoxicity of Cadmium Sulfide Nanomaterials to Mice: Comparison Between Nanorods and Nanodots / L. Liu, M. Sun, Q. Li [et al.] // Environmental Engineering Science. – 2014. – Vol. 31, N 7. –P. 373-380.

13. Thévenod F. Toxicology of cadmium and its damage to mammalian organs / F. Thévenod, W.K. Lee // Metal Ions in Life Sciences. – 2013. – Vol. 11. – P. 415-490.

14. Wang B. Cadmium and its neurotoxic effects / B. Wang, Y. Du // Oxidative Med. Cell. Longevity. –2013. – 898034.

AGRICULTURAL SCIENCES

THE ENERGY AUDIT OF GRANULATION TECHNOLOGY THE PRODUCTION COMPOUND FEEDS IN THE FORM BLEND CRUMBS

Bogdan Yegorov,
Doctor of Technical Sciences, Professor,
Natalya Batievskaya,
postgraduate student,
Odessa National Academy of Food Technologies

Annotation. *The generalization of the conducted analytical and experimental studies allowed develop the advanced of technology granulation in the form blend crumbs, which will increase the output of finished products. It was conducted energy audit of the basic (traditional) technology and new technology the production compound feed in the form blend of crumbs. The aim of the work was to substantiate obvious shortcomings in the traditional granulation technology and reduce reduces energy consumption for the production compound feed in the form blend of crumbs.*

Key words: *mixed fodder industry, technology of granulation, reduces energy consumption, granules, granulated crumb, expanded crumb, compound feed in the form blend of crumbs, an energy audit.*

Introduction. At the present stage of development of the agro-industrial complex of Ukraine, the problems of reducing the specific energy consumption in the production of compound feed products are important, not inferior to its quality. Problems finding ways or technologies that would satisfy the reduction of specific electricity consumption at all stages of the manufacture of compound feed products are relevant. [1]

As the development of the feed industry is characterized by the intensification of technological processes aimed primarily at improving sanitary quality, the methods of preliminary wet-heat preparation of mixed fodder, in particular, the application of expansion to the granulation process, have been presented as the basis for further development of the advanced granulation technology.

The process of granulation of compound feed products, it is one of the most energy-intensive and expendable processes along with the technological process of grinding. The article has been reviewed the problem of high specific electricity consumption in the production of granulated animal compound feeds.

Formulation of the problem. Granulation allows you to provide stable uniformity, improve sanitary and hygienic parameters, increase nutritional value, increase shelf life, and improve the physical properties of the components of the compound feed. However, despite all the advantages, the granulation lines that exist have relatively high performance and, at the same time, high unit costs of electricity. On the basis of the

conducted literature and patent examinations should be said that the development of technology to improve the granulation process will not only improve the nutritional and sanitary quality of compound feed products, but will also increase the productive effect of compound feeds and reduce the specific energy consumption. [1, 2]

In this way, it became necessary to search for a new, effective concept of change in the structure of the existing granulation technology of compound feeds for its comprehensive improvement, to solve problems that are considered.

The practical application of the pre-expanding before granulation has established itself thanks to positive indicators. Such technology assumes that loose feed is initially moistened and acquires more structural and mechanical properties. There is partial denaturation of the protein, which entails an increase in protein digestibility, as well as gelatinization of starch and destruction of the pulp and lignin complexes, which significantly increases the nutritional value and assimilation of nutrients. In the expander under the influence of high pressure and temperature occur structural and mechanical and chemical changes of the product, partial destruction of fungal and bacterial microflora is carried out sanitary and hygienic properties are improved. With this processing of compound feed in the expander, the performance granulator increases significantly.

According to the company Amandus KAHL (Germany), the use of expanders allows you to get compound feeds of high sanitary quality. Today, modern, large-scale companies for the production of high-quality technological equipment for the feed industry ("Andritz group", Austria) let out expanders, allowing to get expanded compound feed, which is ready for feeding in the form solid expandate, without the use of a further granulation process. This technological solution opens up new opportunities. This was the impetus for new developments and research in the technology of granulation of compound feeds. [3].

The constant rise in electricity, fuel, gas prices force population and producers to resort energy-saving activities. The development and implementation of energy-efficient technologies seems relevant, which would reduce their total energy intensity without reducing production volumes in all sectors of the agro-industrial complex of Ukraine, in particular in feed production.

The purpose the work is to reduce energy consumption, in the production compound feed in the form blend of crumbs.

To achieve this aim, the research objectives have been defined:

– to determine the internal energy efficiency potential the production animal compound feed in the form blend of crumbs.

– to determine the dependence of specific electricity consumption for the granulation process on other factors, conduct the necessary experiments;

– to make a selection and the calculation of the necessary technological equipment;

– to calculate an energy audit the basic (traditional) and new technology the production compound feed in the form blend of crumbs.

Research materials and methods. Experimental studies were conducted at the Odessa National Academy of Food Technologies.

1. To development improve granulation technology for production of compound feeds in the form granulated crumb and expanded crumb. A number of studies were conducted at the department of technology of animal feed and biofuel ONAFT, and the following technological solution was proposed. Traditional granulation technology includes, all 100% of the recipe for loose compound feed, it is moistened, expanded and granulated to obtain only crumbs from granules. (fig. 1, scheme A).

Our advanced granulation technology differs from the traditional one, because we get a separate product, an expandate, this reduces the load on the granulator, it is not 100% loaded, getting expanded crumb and mixing with granulated crumb. (fig. 1, scheme B).

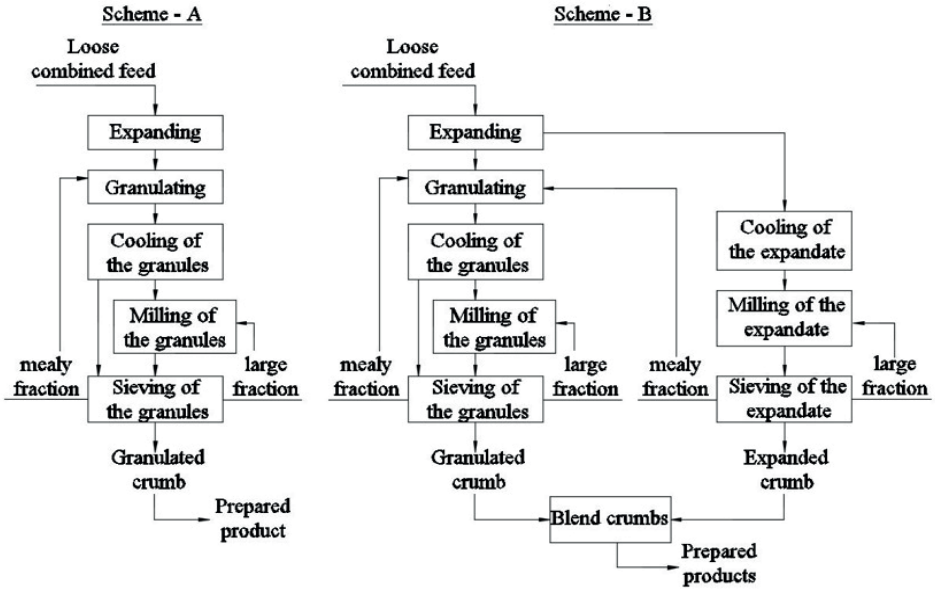


Fig. 1. Scheme A - Basic (traditional) technology production compound feed in the form granulated crumb.
Scheme B - Advanced technology production compound feed in the form blend of crumbs.

The developed technology production granulated compound feed in the form blend granulated crumb and expanded crumb provides: expansion raw materials, separate granulation prepared raw materials, getting granule, getting granulated crumb, getting expandate, getting expanded crumb and mixing crumb getting a blend granulated crumb and expanded crumb [4, 5].

The finished loose compound feed is processed in moisturizer, where it is heated to a temperature of + 50 °C to + 85 °C for 5–10 seconds and moistened content of 18–22%. Exercise of such processing provides compound feed thermo-plastic properties. The next stage of processing is carried out using expander. Moisture compound feed in expander is 16-22%, temperature of + 110 °C to + 120°C. The resulting product - the

expandate has a moisture content of 13-14%, its temperature is approximately 85-95 °C. Expandate has the form of pieces, sizes from 20-50 mm. Part of the expandate is cooled, crushed and sieved, to obtain expanded crumb, and part granulated in a granulator under standard processing conditions.

In the granulator under the influence of high pressure and temperature occur structural-mechanical and chemical transformations of the product, increases the degree of absorption of animal nutrients. The compound feed treated with steam has a moisture content of 15–18% and a temperature of 60–90 °C, steam pressure, as a rule, is 0.2–0.5 MPa, steam consumption is 50–80 kg/ton.

The granules obtained after granulation have a temperature of 60-80 °C, they are sent to the cooling stage. After this stage, chilled products are obtained in the form of granulated compound feed, which are crushed. Next, the grinding products (granulated crumb and expanded crumb) are sifted onto separate screeners to control the amount of products. The grinding products are sent to a separator, in which two sieves are installed: upper is №30. Descent from upper sieve sent for re-grinding. The bottom sieve in the separator set №10. The passage of this sieve is received mealy fraction, which is sent to re-granulation. The passage upper sieve and descent sieve getting crumb. [1, 5, 6].

2. Calculation energy audit of the basic (traditional) technology and advanced technology production compound feed in the form blend of crumbs. The determination of energy efficiency potential was carried out by comparative energy audit technology improved and basic technology. It consists in calculating the amount of energy consumed, the energy balance and the values obtained in research comparisons new technology improved and basic technology. Based on the basic technological scheme production compound feed in the form blend of crumbs, carried out the selection and calculation of the necessary technological equipment in accordance with the methods.

At manufacturing companies, energy metering consumption is carried out by fixing the amount of energy received. Therefore, when conducting an energy audit were used equipment passport data, and in case improved technology were used data from experimental studies. The technological process of extrusion of feed was carried out in ONAHT at the department of "Technology of feed and biofuel" through extruder of the EZ-150 brand (Bronto). Extruder productivity was determined by weighing the mass, which came out of the outlet screw part of the extruder for 20 minutes. The result is multiplied by 3, which characterizes the hourly productivity of the installation. The performance of the installation was determined provided that the current load of the main motor is 100%, the quality of the extruded product is satisfactory, and the temperature corresponds to the set. Before starting work, connections were made to an ammeter and a wattmeter to determine power characteristics. After starting, the press was set to a mode, at which its performance, process temperature and current load of the electric motor must comply with the nominal indicators. The power that was consumed by the extruder motor, was determined with a frequency of 2 to 5 minutes by measuring the voltage in the network, current consumption and power factor. The measurement of these values was carried out using a voltmeter, ammeter. Power was calculated by the formula [1]

$$N = U x I x \cos \varphi,$$

where, U – mains voltage, B;

I – mains current that has been consumed, A;

cos φ – power factor.

The total installed capacity was calculated as the product of the power of the technological equipment electric motor by its quantity. A similar calculation was carried out for each of the production lines and its results were used to calculate specific electricity consumption, in energy terms on each of the technological lines. Specific energy consumption in energy terms was determined by the formula [1]:

$$N\text{пит} = \frac{\Sigma N}{Q},$$

where, Σ N – total power consumption of equipment electric motors, which performs this operation, kW;

Q – productivity of equipment (line), kg / hour.

Specific electricity consumption in estimated terms was calculated by multiplication of specific energy consumption in energy terms the industrial power tariff. Next, we calculated the total cost of electricity for the entire technology (basic technology and advanced technology).

Based on the data obtained, we determine the specific consumption of electricity in energy terms (table 1).

Table 1

An energy audit the basic (traditional) technology and new technology the production compound feed in the form blend of crumbs

Technological process		Specific electricity consumption, kW·h / t
Basic (traditional) technology production compound feed in the form granulated crumb (line productivity is 10 tons per hour)		
1	The expansion	15,0
2	The granulation	29,3
3	The cooling	3,6
4	The milling	5,2
5	The sieving	1,5
Total, N пит., kW / h		54,6
Finished product yield – granulated crumb, % or tons		**70 / 7**
Total across lines, N total, kW·h / t		**78**

Advanced technology production compound feed in the form blend of crumbs. (line productivity is 10 tons per hour)		
1	The expansion	15,0
Total, N пит., kW / h		15,0
Finished product yield – expanded, % or tons		100 / 10
Total on the process, N.№1, kW·h / t		150
2	The cooling	3,6
3	The milling	3,6
4	The sieving	1,5
Total, N пит., kW / h		8,7
Finished product yield – expanded crumb, % or tons		40/4
Total on the process, N.№2, kW·h / t		34,8
2	The granulation	22,4
3	The cooling	3,6
4	The milling	5,2
5	The sieving	1,5
Total, N пит., kW / h		47,7
Finished product yield – granulated crumb, % or tons		60/6
Total on the process, N.№3, kW·h / t		286,2
Finished product yield – compound feed in the form blend granulated crumb and expanded crumb, % or tons		**82/ 8,2**
Total across lines, N total, kW·h / t N total, = (N №1 + N №2 + N. №3) / product yield in tons		**57,4**

From the table 1, can conclude. In both new technology and traditional technology, the most energy-intensive is the granulation process. Since granulation process consumes energy in the amount of 29.3 kW·h/t according to the traditional scheme, according to the advanced scheme 22.4 kW·h/t.

Conclusions. Calculated energy audit of the basic (traditional) technology and advanced technology production compound feed in the form blend of crumbs, shows that the new, improved technology is energy-efficient compared to traditional technology. This means that it is economically feasible, since there is a general saving of energy resources of 20.6 kW·h / t, or 26.4%. This energy efficiency is not a constant, as may vary depending on features of the construction of the technological process at a particular enterprise.

The new technology is environmentally friendly, since the use of diesel fuel is completely eliminated, that is, carbon dioxide emissions into the environment are avoided. The resulting feed is free of carcinogens, this will make livestock products safe for humans. The difficulties in introducing a new technology are in constantly rising electricity prices and many other factors. [7]

References:

1. Egorov B.V. Compound feed production technology: a textbook for students of higher educational institutions. Odessa, 2011. page 448.

2. Process technologies, equipment, plants, and systems // ANDRITZ: [Website]. 2020. URL: https://www.andritz.com/group-en (viewed on:10.01.2020).

3. Jorgensen L.L., Jensen B.A., Poulsen H.O. Effects of expanding, pellet and grinding on Salmonella typhimurium infection, growth performance and gastro-intestinal ecosystem in slaughter in pigs (in Danish). The National Committee for Pig Production, Copenhagen, Denmark; 2010.

4. Danish Agriculture and Food Council // Agriculture and Food. 2010. V. 2. No1. page 174.

5. Yegorov B.V., Batievskaya N.O. Application of granulation technology in various industries // Grain Products and Mixed Fodder's. 2017. volume. 17, issue. 3. page 33-38. http://orcid.org/0000-0002-9380-28916.

6. Rules for the organization and conduct of the technological process compound feed production. MAKA, Kiev Institute of Bread Products, 1998. page 220.

7. Gabriel I.M,. Mallet S.H., Leconte M.J. Differences in the digestive tract characteristics of broiler chickens fed on complete pelleted diet or on whole wheat added to pelleted protein concentrate. British Poultry Science; 2003.

HISTORY

THE READING INTERESTS OF UKRAINIAN CHURCH ELITE OF THE XVIII CENTURY

Svitlana Kagamlyk,
Ph.D. in History, Senior Researcher,
Taras Shevchenko National University of Kyiv, Ukraine

Annotation. *The composition of libraries of Ukrainian church elite of the XVIII century, as so as their character and peculiarities, are analyzed in this article. Author established that the formation of private book collections was largely predefined by European cultural influences. The composition of libraries reflected the creative interests and needs of their owners, primarily as writers and translators. The contents of libraries reflected an active integration of Ukrainian church elite into the all-European cultural process.*

Key words: *Orthodox Church, Church Hierarchy, Ukrainian church elite, Book collection, European influences, Russian Empire.*

In the early modern era of its history Ukraine due to its geopolitical location served as a mediator between the East and West Europe, and Ukrainian culture of this period was reasonably defined as syncretic, justifying it by the interaction of medieval heritage and baroque education. Also, the advent of the Enlightenment elements influenced the decision a lot [4, c. 130]. Its creators were primarily representatives of the higher clergy, who established cultural institutions, supplied literary production, formed the educational process.

One of the most representative manifestations of the Ukrainian Orthodox Church hierarchs' intellectual potential was the size and the contents of their private book collections. In this context it is important to follow the reading interests of higher Ukrainian clergy by the use of a wide variety of sources, including catalogues of clerics' library collections, book donations, bookplates on books and so on.

This problem was reflected in the historical literature only partially, at the level of separate, most famous personalities [7; 9; 10; 16; 18]. In particular, the analysis of Stephan Yavorskyi library that was thoroughly analyzed by S.Maslov should be mentioned [10]. The famous explorer of Ukrainian publishing J. Isayevych traced the private libraries catalogues of a number of secular and clerical persons, including Petro Mohyla [5, p. 362 - 368]. As for the scholars from diaspora, some research studies on the subject belong to D. Chyzhevskyi who, in particular, studied the library of Theophanes Prokopovych [18].

The contents and further fate of the libraries owned by clerics were studied by Russian scientists. In particular, S. Luppov in his monograph on the history of book after the reign of Petro I [8] focused on bishops who owned extensive libraries; among Ukrainians - Theophanes Prokopovych, Theophylact Lopatynskyi, Lavrentii Horka.

Investigations in the field of book studies continued by V. Hotieiev - he provided some data on the analysis of libraries of Symon Todorskyi, Joasaph Horlenko, Barlaam Vanatovych, Platon Malynowskyi [17]. However, Russian scientists did not differentiate between Russian clerics and Ukrainian clergy, analysing them together with native Russians among the church leaders who occupied the leading position in the synodal hierarchy of Russian Empire.

In the investigation process of the contents of the libraries owned by Ukrainian bishops, crucial role was devoted to the study of book registries that allow the possibility to explore and analyze the contents of Ukrainian church leaders private libraries. Low storage quality of the eighteenth century sources does not give a complete picture of the contents of Ukrainian bishops libraries now. Nevertheless, some information on their possession of separate books based on proprietary records for printed books was saved till our time.

Particularly, Petro Mohyla owned a considerable collection of Latin and Polish books. The fact was reflected in the registry of books purchased by him in Warsaw and Krakow in 1632-1633 years. The list (74 items) contained books on historical, philosophical and mathematical studies [1, c. 186-189].

Much better picture of literature preservation can be seen from the catalogues of libraries owned by church leaders of the eighteenth century. However, their research and identification is often complicated by uncertainties in writing titles of the books. It primarily relates to foreign publications, that are often cited in the inventories not in the source language but as an inaccurate, simplified translation (sometimes without specifying the target language) or in the form of Russian transcription of foreign words.

Catalogs of books wich belonged to Ukrainian bishops in the 18th century provide strong evidence that despite the presence of liturgical books in Slavonic language, which were needed for religious rites and church administration and management activities, considerable number of the books were the works by Catholic authors from Western Europe and Poland written in Latin or Polish. Sometimes there were books in Greek or French, that can be explained by the appropriate level of education in the Kyiv-Mohyla Academy.

Especially impressive, as far as the number of books in Latin is concerned, were collections of the hierarchs of Ukrainian origin who were conducting their ecclesiastical activities in Russia: Feofan Prokopovych, Feofilact Lopatynskyi, Symon Todorskyi, Stefan Yavorskyi, Kyrylo Liashevetskyi, Lavrentii Gorka and others.

The important value for the study of the range of education and church leaders' interests, who received their education at Kyiv Academy, was the library description of one of the highest church dignitaries, vice-president of the Synod, archbishop of Novgorod and Velykolutsk Theophanes Prokopovich, that at the end of his life outnumbered three thousand volumes. By language criterion, the library contained mostly works in Latin, the number of books in other languages was only about 140 [15, p. 373-417; 8, pp. 257 - 265].

The library of Theophylact Lopatynskyi, the archbishop of Tver and Kashin was the second by the number of publications and significance after the one owned by Theophanes

Prokopovych - it contained 1416 books. The majority of books were in Latin, books in Slavic languages numbered to 110, apart from them the library contained about 50 books in Greek (including Latin-Greek) and about 50 volumes in Polish. Overall, the library of Theophylact Lopatynskyi reflected his artistic preferences and needs as a writer and translator [8, p. 268 - 274].

One of the most important libraries was also the one owned by Simon Todorskyi, archbishop of Pskov, Izborsk and Navsk, consisting of 800 volumes. Among the works on Oriental studies in German, Latin, Greek, Hebrew there was a great number of manuscripts written in Indian dialects, in Sanskrit, Tatar, Arabic, Ethiopian and other languages, demonstrating the high culture, broad-mindedness and the wide scale of interests of the scholar [13, p. 28].

According to S. Maslow, the library of Stefan Jaworskyi, metropolitan of Riazan and Murom, the locum tenens of the Moscow patriarchal throne, contained 609 books, including 28 manuscripts. Among them there were 443 book in Latin, 88 in Slavic, 75 in Polish and 1 manuscript in French [10, p. 122].

Ambrose Yushkevych, the archbishop of Novgorod and Velykolutsk owned a significant collection of European books: it contained 601 volume, 48 (8%) of which were in Slavic, the rest was written mainly in Latin. As for the subject, the majority had relation to religion, especially to theology [8, p. 283 - 284].

Kyrylo Liashevetskyi, the bishop of Voronezh and Yelets, Chernigiv and Novgorod-Siversky was a well-known bibliophile. His library contained around 400 books mainly in Latin, German and Polish languages. Theological and philosophical literature prevailed over other volumes. In particular, it contained some works by German pietists: J. Budde, A. Michaelis, philosophers Ch. Wolph, Ch. Baumeyster. There were also Russian translations of M.Montaigne, S. Puffendorf, J. Locke [6, p. 337].

The library of Lavrentiy Horka, the bishop of Vyatka and Great Perm contained 355 books, including the works by Tommaso Campanella, "On the Nature of Things" by Lucretius Kar, Venetian edition of "The Divine Comedy" by Dante (1536), the treatises by G.Horace, works by J.Lipsius, K. Curtius, G. Suetonius and others. [6, p. 147; 8, pp. 274 - 281].

Gavryil Buzhynskyi, the bishop of Ryazan and Murom, also had a significant library - 365 books half of which were of secular character. They were books on the history of law (H. Grotius, N. Machiavelli, S. Puffendorf), philosophy (Aristotle, Seneca), history (T. Livius, Thucydides, J. Caesar K. Curtius), as well as on military service, mathematics, medicine (Homer, Virgil, Horace, Ovid) and others. The book collection of Gavryil Buzhinskyi together with the one owned by Lavrentiy Horka became a base for the library of Moscow Slavic-Greek-Latin Academy [6, p. 91].

As it can be seen from the above-mentioned, the representatives of the highest ecclesiastical order owned mainly the book of western origin, especially in Latin. The majority was constituted from books on dogmatic theology mainly by Western European and Polish catholic writers, pastoral theological literature by Polish divines, some works by German pietists, books by Protestant authors. It was due to high level of education at the Kyiv Academy.

A significant number of Latin-Polish books in private libraries of church leaders indicates that Ukrainian national elite represented by the clergy and nobility of medieval times was closely related to Polish culture. In particular, it was influenced by the corresponding education – special attention at the Kyiv Mohyla Academy was given to Latin language, studies at Western education institutions and contacts with them, an important role played the possibility for Ukrainian bishops to buy the books abroad etc. According to I. Shevchenko, cultural orientation of Ukrainian nobility on Poland lasted until the middle of the eighteenth century [19, p. 129].

German literature, popular throughout the Europe, took an important place in the catalogues of Ukrainian church leaders private libraries. Such a tendency was facilitated by a high level of education and book publishing in German lands, diverse repertoire of German publications and a wide range of personal communication among the ecclesiastical and secular elites of both nations. According to a research conducted by V. Nichyk and O. Dziuba, the bulk of German books found in the libraries was published in German printing houses mainly in German on theological, philosophical, classical literature; were also present own works pf German authors on philosophy, theology, law along with dictionaries and geographical descriptions [2; 13]. In particular, the works of the Protestant author, Martin Liuther, were listed in the description of libraries owned by Theophanes Prokopovych, Simon Todorskyi, Theophilact Lopatynskyi and Philotheus Leszczynskyi, the metropolitan of Tobolsk and Siberia, and Stefan Kalinovskyi the archbishop of Novgorod and Velykolutsk [2, p. 310]. Theophanes library contained complete works by chief ideologist of the pietists J.Budde, from the University of Galle, some of his works were listed in the libraries of Theophylact Lopatynskyi, Kyrylo Liashevetskyi, Ambrose Yushkevych, Stefan Kalinowskyi, as well as in the libraries of metropolitans - Arseniy Mohylianskyi, the metropolitan of Kyiv and Halych, Gideon Vyshnevskyi, the metropolitan of Smolensk and Dorohobuzk [2, p. 311 - 312].

A peculiar feature of libraries owned by Ukrainian church elites of an early modern time was their possession of a significant number of works created by ancient philosophers and historians - Quintus Curtius, Horace, Juvenal, Cornelius Nepos, Cicero, Virgil, Herodotus and others. Senece, famous Roman philosopher, was one of the most popular ancient thinkers admired by Kyiv-Mohyla Academy former students among the church leaders. According to J. Zakhara, almost Ceneca's works known at that time were preserved in the academic library and in the personal libraries owned by famous religious and cultural leaders. In particular, Stephan Yavorsky and Theophanes Prokopovych widely used his ideas in the courses of ethics, logic and natural philosophy, and highly evaluated his erudition [3].

The analysis of library collections owned by Ukrainian church elites indicates that the Kiev Academy was the only ideological, philosophical and cultural school, whose members were actively interested in Italian literature and science. It is known that Theophanes Prokopovych library contained the highest number of books by Italian authors. In particular, there were two works by Galileo Galilei - "Dialogues on the system of the world" (1641) and "On the System of the World" (1700) [11, p. 94], as well

as two works by Niccolo Machiavelli - "Discourse on the state or the holder of power" and "Reflections on the State, discourse on which includes three books." Machiavelli's works were also in libraries of Stefan Jaworskyi, Theophilact Lopatinskyi and Simon Todorskyi. A. Bychko in the introduction to the works of Niccolo Machiavelli, noticed that Ukrainian thinkers give paramount importance to the fact that he was a "genius, who was the first to formulate the idea of national statehood and show management mechanism" [11, p. 94].

Modern researcher O. Pachlowska stated that a new significant phenomenon appeared at the time of contacts intersection of Italian and other Western cultures with Ukrainian one - Neolatin Ukrainian literature that, according to the researcher, enabled Ukrainian literature freely operate in the European cultural context and at the same time resist the attempts for denationalization [14].

Book collections of the Ukrainian church elite included a large number of works, which were secular by nature, in particular, works by ancient historians and Italian humanist thinkers.

Conclusions. Thus, analysis of the libraries owned by representatives of Ukrainian church elite in the early modern time points out the presence of a significant number of Western editions, reflecting the artistic preferenses and needs of their owners, as well as writers and translators. The main part consisted of books in Polish and Latin mainly by Western European and Polish Catholic authors, pastoral literature of Polish theologians, works of German pietists, books by Protestant authors, that was explained by the appropriate level of education at the Kyiv Mohyla Academy. German literature works held an important part in the private libraries of Ukrainian church leaders, favoured by a diverse repertoire of German publications and a wide range of personal relations.

A significant number of works by ancient historians and Italian philosophers-humanists on ecclesiastical and political subjects was a peculiar feature of libraries owned by Ukrainian ecclesiastical elites. The composition of libraries reflected the creative interests and needs of their owners, primarily as writers and translators.

Consequently, the contents of Ukrainian bishops private book collections reflected an active integration of Ukrainian church elites into the all-European cultural process.

References:

1. Arhiv Ugo-Zapadnoy Rossii (1887) [Archive of Southwest Russia]. Ch. 1. T. 7. Kiev. 816 s.

2. Dziuba O.M. (2004). Nimecka knygha v bibliotekakh Ukrainy (XVIII st.) [German book in libraries of Ukraine (XVIII cent.)]. Ukraina v Centralno-Skhidnii Yevropi (z naidavnishykh chasiv do kincia 18 st.). No 4, 307–319.

3. Zakhara I.S. (1991). Filosofskoe nasledie Seneki v Kievo-Mogilyanskoy akademii [Seneca's philosophical heritage at the Kiev-Mohyla Academy]. Otechestvennaya filosofskaya mysl 16-17 vv. i grecheskaya kultura. Kyiv, 266-273.

4. Isaievych Ya. (1994). Osvitnii rukh v Ukraini 17 st.: skhidna tradyciia i zakhidni

Vplyvy [Educational Movement in Ukraine: Eastern Tradition and Western Influences]. Ukraina 17 st. mizh Zakhodom ta Skhodom Yevropy. Materialy 1-gho ukrainsko-italiiskogho sympoziumu 13–16 veresnia 1994 r. Kyiv; Veneciia, 114 – 135.

5. Isaievych Ya. (2002). Ukrainske knyghovydannia: vytoky, rozvytok, problemy [Ukrainian book publishing: origins, development, problems]. Lviv. 520 s.

6. Khyzhniak Z., ed. (2001). Kyievo-Moghylianska akademiia v imenakh. 17-18 st.: Encyklopedychne vydannja [Kyiv-Mohyla Academy in Names, XVII – XVIII centuries: Encyclopedic Edition]. Kyiv. 736 s.

7. Losiievskyi I. (1992). Biblioteka Meletiia Smotryckogho [Meletia Smotrytsky's Library]. Kyivska starovyna. No 5, 59-65.

8. Luppov S.P. (1976). Knigha v Rossii v poslepetrovskoe vremya 1725–1740 [The book in Russia in the post-Petrine time 1725-1740]. Leninghrad. 380 s.

9. Luckaya F.Y., Mazmanyanc V.K. (1995). Sudba biblioteky Stefana Yavorskogho [The fate of the library of Stefan Yavorsky]. Knigha. Issledovaniya i materialy. Sbornik 70, 194-199.

10. Maslov S.Y. (1914). Biblioteka Stefana Yavorskogho [The library of Stefan Yavorsky]. Kiev. 102 s.

11. Nichyk V. (2002). Vid renesansnoi Italii do reformaciinoi Nimechchyny [From Renaissance Italy to Reformation Germany]. Relighiino-filosofska dumka v Kyevo-Moghylianskii akademii: yevropeiskyi kontekst. Kyiv, 77–98.

12. Nichyk V.M. (2001). Kyievo-Moghylianska akademiia i nimecka kuljtura [Kyiv Mohyla Academy and German Culture]. Kyiv, 252 s.

13. Nichyk V.M. (2001). Symon Todorskyi i ghebraistyka v Kyievo-Moghylianskii Akademii [Simon Todorsky and Hebrew Studies at the Kyiv-Mohyla Academy]. Kyiv, 48 s.

14. Pakhlovska O. (1990). Ukrainsko-italiiski literaturni zviazky 15–20 stolittia [Ukrainian-Italian literary relations of the 15th-20th centuries]. Kyiv, 215 s.

15. Prokopovych Feofan (1981). Filosofski tvory. V 3 tomakh [Philosophical works in three volumes]. T. 3. Kyiv.

16. Romanova N.Y. (2006). Knizhnoe sobranie svyatitelya Gheorghiya Konisskogho kak chast istoryko-kulturnogho naslediya Ukrainy i Belarusi [Book collection of St. George Konissky as part of the historical and cultural heritage of Ukraine and Belarus]. Moghylianski chytannia. 2005, 459–465.

17. Khoteev P.Y. (1989). Knigha v Rossii v seredine 18 veka. Chastnye knizhnye Sobraniya [Book in Russia in the middle of the XVIII century. Private book collections]. Leninghrad, 142 s.

18. Chyzhevskyi D. (1953). Biblioteka Teofana Prokopovycha [Theophanes Prokopovich Library]. Naukovyi zbirnyk. Niu York, 127-136.

19. Shevchenko I. (2001). Ukraina mizh Skhodom I Zakhodom. Narysy z istorii kultury do pochatku 18 st. [Ukraine between East and West. Essays on the history of culture to the beginning of XVIII century]. Lviv, 250 s.

Modern Science — Moderní věda
№ 2 — 2020

scientific journal / vědecký časopis

Východoevropské centrum základního výzkumu oznamuje možnost publikování v českém vědeckém časopise «Modern Science — Moderní věda» vědeckých článků (výsledků vědeckého výzkumu). Časopis má oficiální potvrzení o evidenci periodického tisku v České republice, evidenční číslo MK ČR E 21453. Časopis je na seznamu Východoevropského centra základního výzkumu EECFR jako vědecký časopis. Časopisy se rozesílají základním evropským univerzitám a výzkumným institucím a do Nobelové nadace (Švédsko).

Časopis je vytvořen pro zveřejnění vědeckých děl, provedených vědci ze střední a východní Evropy. Publikace vědeckých článků je v angličtině, češtině a ruštině.

Zakladatelé časopisu: Východoevropské centrum základního výzkumu (Praha, Česká republika), Inovační park — společnost «Nemoros» (Praha, Česká republika). Oficiální zástupce časopisu v Ukrajině je Výzkumný ústav sociálně-ekonomického rozvoje (web-stranka: http:// sried.in.ua).

Prioritní témata časopisu:

1. Výsledky základního výzkumu.
2. Stabilní rozvoj, moderní technologie a ekologie.
3. Průmyslové a manažerské inovace.
4. Ekonomie, sociologie, politologie, veřejná komunikace.
5. Mezinárodní vztahy, státní správa a právo.
6. Filozofie, historie, psychologie, pedagogika, lingvistika.
7. Design, umění a architektury.
8. Fyzika, astronomie, matematika, informatika.
9. Chemie, biologie, fyziologie, medicína, zemědělství.
10. Doprava, spoje, stavebnictví, komunální služby.

edice 350 kopií