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Circular economy of the region: theoretical aspect

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Abstract. The economy of Ukraine's regions is based on a linear model of production and consumption. This does not allow saving resource potential. The socio-economic paradigm of the use of resources in the state, developed for their preservation and mutual renewal, is the circular economy. Currently, a lot of attention is focused around the circular economy, as a new socio-economic doctrine of increasing the efficiency of resource use. The purpose of the article is to study the tools for the implementation of the circular economy, to determine the requirements for the transformation of the current economic system to adapt the cyclical reuse of raw materials. The method of theoretical knowledge, generalization, analysis, synthesis, modeling was used in the research process. The article reveals the essence of the concept of "circular economy" and offers its own definition of this concept as a way of economic development, where the value of products, materials and resources is preserved as long as possible, and waste is significantly reduced or even eliminated. The implementation of the circular economy model, which is based on the R-principles of its implementation, is considered. Therefore, the regional circular economy puts forward a more rational approach in the context of resource management. However, it also requires mass systemic transformations in the regions. Important for the implementation of the circular economy is the creation of urgent management conditions, as well as economic factors. It is substantiated that the main areas of development of the circular economy of the region are construction, mobility and transportation, food, products and services. The advantages of implementing the circular economy of the region are outlined. The scientific value of the work lies in the improvement of the concept of circular economy by the method of its implementation in the economic structure of a specific industry

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INTRODUCTION

The circular economy is receiving more and more attention as a new socio-economic paradigm for optimizing the use of resources in the country. Today, cities, where people live, work, consume and dispose, play a fundamental role in the country's transition to a circular economy, as they are at the center of key decisions that determine economic growth, social well-being and environmental benefits. It is worth noting that it is based not only on the diverse management of resources and the introduction of innovative technologies in production, but also on the rational management of waste. At the same time, the economies of the regions are now locked in a system that favors a linear model of production and consumption. However, this fixation is weakening under the pressure of several powerful disruptive trends. We must take advantage of this favorable alignment of economic, technological and social factors to accelerate the transition to a circular economy. That is why the question of researching the essence of the "circular economy", defining its tools and models for the national economy is gaining relevance.

The study of the problems of implementing the basics of circular economy within the borders of the country, region, and city is of interest to both foreign and Ukrainian scientists. Thus, general theoretical issues of circular economy implementation within the country were studied by N. Avramenko, A. Tovstenko [1], A. Zuev [2], I. Zvarych [3], V. Loiko [4], D. Pierce, R. Turner [5] and others. In their works, M. Varfolomeev [6], A. Babak [7], M. Heisdorfer [8], O. Lozo [9], O. Churikanova [10] pay special attention to the legal regulation of relations regarding waste management, and together with this – the problems of their disposal and the expansion of the producer's responsibility for waste. Scientists such as N. Boken [11], P. Ghisellini [12], M. Guryev [13], O. Dronova [14] contributed to the study of approaches to the implementation of the circular economy at the state level and the determination of its development prospects., I. Kulchytska [15], I. Tymoshenko [30] and others. Socio-economic consequences, problems and prospects of introducing a circular economy in regions and cities are revealed in the works of N. Gakhovich, L. Shinkaruk [16],

S. Miroshnychenko [17], S. Sove, S. Bernard, P. Sloan [18], M. Pilyugin [19], K. Fletcher and others. The topic of research in the direction of substantiating the applied aspects of the concept of circular economy development is revealed in the works of K. Barytska [20], T. Kvasha, O. Paladchenko [21], J. Kircherr, D. Reike, M. Heckert [22], M. Zlotnik, O. Melnyk [23] and others. The scientific works of T. Berger and K. Frey [24] are devoted to the peculiarities of the implementation of the circular economy in industries at the regional level, especially in those where there is sufficient human capital. However, the issue of circular economy implementation at the regional level remains little researched and requires in-depth study.

The purpose of the article is to study the theoretical foundations of the concept of "circular economy", define its models, outline the main advantages of the circular economy at the regional level.

Circular economy as a socio-economic paradigm of resource use

Regions should play a key role as stimulators, mediators and contributors to the development of the circular economy. In contrast to the traditional economy, the circular economy is the most successful way to save resources and materials, and therefore – the way to constant economic growth.

There are many definitions of the circular economy. The circular economy is an economic model that was first proposed in the mid-1960s as a means of ensuring that the resources that enter the economy can remain part of it for as long as possible.

In economic literature, the concept of "circular economy" was first proposed in 1990 by scientists D. Pearce & R. Turner, who noted that the Earth is a closed economic system in which the economy and the environment are not characterized by linear relationships, but by circular relationships. In order to achieve a win-win situation for the economy and the environment, scientists proposed a closed cycle of materials in the economy [5].

To begin with, we note that circularity means the effective reuse and recycling of resources, materials

and products in closed cycles. In other words, circularity is an economic model that represents sustainable development as a transition from a linear model based on consumption and disposal to a model in which the lifetime of products is maximized and materials and waste are minimized. There are three different cycles of circularity, which gradually become wider [25]:

- 1) closure of resource cycles, which is determined relative to the traditional economic system;
- 2) slowing resource cycles and material flows due to continued and increased use of products to maintain their value over time;
- 3) narrowing of resource cycles, which involves more efficient use of materials, natural resources and products in a linear system.

The circular economy can be implemented holistically, but at the same time, the features of the circular economy are at the core of every urban system [26].

According to Ukrainian scientists, in particular V.V. Loiko, the circular economy involves more careful use of both natural resources and things that have already been created and are used in people's daily lives. The author believes that the transition to a circular economy should be based on a change in production technologies, improved use of natural resources, and a change in the general attitude of consumers [4].

The collective of authors J. Kirchherr, D. Reike, & M. Heckert considers the concept of "circular economy" as an economic system based on business models that provide for alternative reuse in order to achieve sustainable development, environmental protection, economic growth and social justice in the interests of present and future generations [22].

I. Kulchytska defines the circular economy as such, which involves the reuse of raw materials and products, which as a result will remain in circulation as long as possible, and their value will be maximum. Thus, the author draws our attention to the fact that the transition to a circular economy will ensure a reduction in the extraction of natural resources, a reduction in production waste and the reuse of those that have already been created [15].

M. Heisdorfer [8] believes that the circular economy is a regenerating system in which resource consumption,

emissions and energy losses are minimized by closing and reducing material and energy cycles.

It is agreed that the definition of W. Haas, F. Krausmann, D. Wiedenhofer, M. Heinz, who consider the circular economy a simple but convincing strategy aimed at reducing both the consumption of raw materials and the release of waste by closing the economic and ecological loop resource flows [27].

The analysis of scientific works on the circular economy [1;11;24;25;27] gave us the opportunity to form our own vision of this concept, which is that the circular economy is a way of economic development where the value of products, materials and resources is preserved as much as possible longer, and waste is significantly reduced or even eliminated. The main purpose of which is to create new alternative economic approaches, the task of which is to minimize the negative human impact on the environment. It offers an alternative model where the value of products, materials and resources is preserved as long as possible, and waste is significantly reduced or even eliminated. Focused on "closing the loop," the circular economy is a practical solution to living within our planetary boundaries. Simply put, a circular economy is an economy in which our consumption of resources and materials is circular, we reuse our resources and put them back into the economy instead of throwing them away.

In the minds of the fourth industrial revolution (Revolution 4.0, Industry 4.0) there is a clear connection with the circular economy, which is based on the reduction of negative human impact on the environment (climate changes, accumulation of huge amounts of waste, depletion of natural resources, environmental degradation, etc. d.) [29].

Circular economy is based on 3R principles:

1. Reduce – reducing the use of natural resources, increasing production efficiency;
2. Reuse – reuse of the product for its main purpose;
3. Recycle – processing of materials to obtain products of the same or lower quality.

Along with this, in 2018, the principles of the circular economy were significantly expanded by the World Economic Forum, and now we have the 10R model, which clearly follows the continuity of the "3R

model”, which is expressed in the preservation of the key elements of the system (Fig. 1.) [14; 31].

4. Refuse – refusal to produce a product for “ecologically dirty” technology, offering another product;

5. Rethink – rethinking the ways of using the product, its exchange or joint use;

6. Repair – repair and maintenance of a defective product with its further use;

7. Refurbish – restoration of an old product for its further consumption;

8. Remanufacture – reprocessing and application of a part of an old product in a new product;

9. Repurpose – reorientation of a part of an old product in a new product for a different purpose;

10. Recover – burning of materials with recovery of energy lost in their production.

Therefore, most choose a simplified version of the circular economy based on the 3-R principles, since not every “R” is suitable for every business process and is more manageable. Thus, the 10-R model works as follows; the higher the R-ladder, the less resource usage.

The transition from the 3-R model to the 10-R model forces us to consciously think about the raw materials we use in the design process.

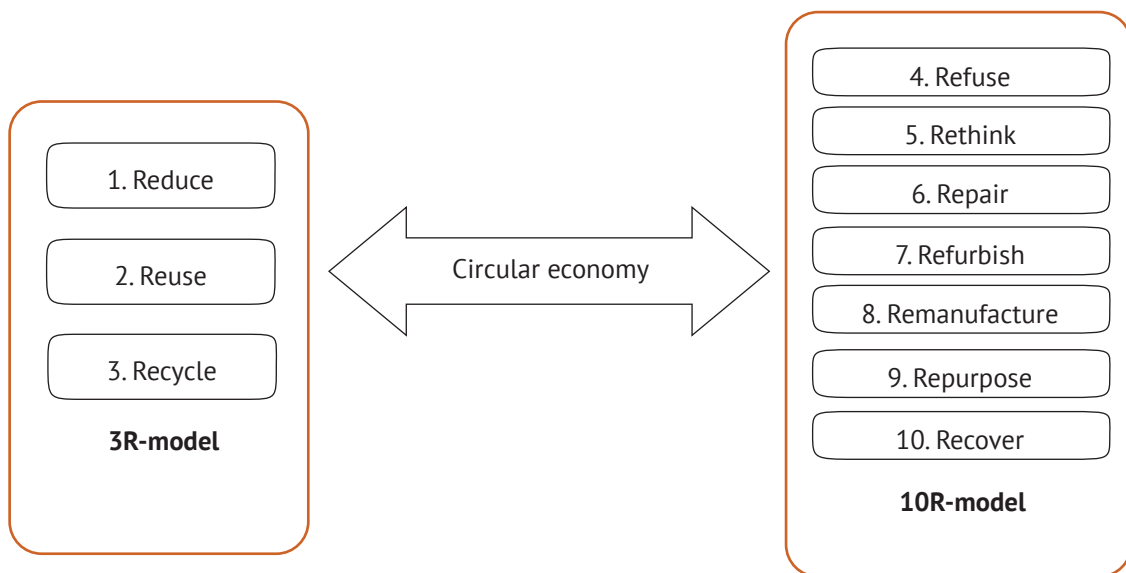


Figure 1. Model 10R – principles of circular economy

The circular economy is transformative, systemic and functional. First, it involves a change in behavior and culture towards different ways of production and consumption, new business models and governance under shared responsibility between levels of government and stakeholders (people). Second, it enables the complementarity of water resources, waste, energy, transport, housing and land use (policy). Thirdly, information and outflows of materials, resources and products require a reflection of the appropriate scale in which the circular economy is applied, as well as functional connections between urban and rural areas (places) [31].

Peculiarities and features of the regional circular economy

Note that the transition to a circular economy affects various policy areas and levels of governance in the region, ranging from mobility, agriculture, land use and waste management, to business development and consumer education, affecting participants in all sectors of the region. After examining the academic sources, we concluded that the circular economy of the region is not something that any institution or company can do alone, by its very nature, the circular economy facilitates connections between individual stakeholders and sectors of the region. Thus, we draw attention to the fact that an effective circular economy of the

region will be achieved through the meeting between bottom-up initiatives (concrete activities involving local organizations that seek synergies with partners at the same level or that wish to expand or diversify their activities) and top-down approaches downward (coordination and planning to facilitate connections between actors at lower levels).

Before spreading to the national and international level, the circular economy must be combined with the development of the regional economy. Only in the case when starting from one settlement, and then spreading to the entire territorial community, then to the region, and on the condition that the regions take responsibility for the rational and efficient use of their own resources, the circular economy will develop properly. It is the development of the circular economy that aims to strengthen the sustainability of the region by limiting its dependence on the influx of resources. Circularity of resources in the region will make it possible to optimize the use of materials and energy for the benefit of the regional economy. The development of the circular economy will allow the region to move towards a more sustainable, inclusive and low-carbon development model.

The European Union produces more than 2.5 billion tons of waste every year. It is currently updating its waste management legislation to facilitate the transition to a more sustainable model known as the circular economy. The European Commission's 2016 study "Circular Economy in Europe" identified the following benefits of promoting the circular economy for EU countries:

- improved security of resources and reduced dependence on imports will lead to a decrease in demand for primary raw materials;
- reducing the impact on the environment, including a sharp reduction in greenhouse gas emissions;
- economic benefits, including new opportunities for growth and innovation, as well as savings related to increased resource efficiency;
- social benefits – from the creation of new jobs at all skill levels to changes in consumer behavior leading to better health and safety outcomes [32].

Regions play an important role in the circular

transition. First, they have core responsibilities in key sectors of the circular economy, such as transport and solid waste. Secondly, they are laboratories for innovation and experimentation. Third, cities in regions can be promoters, facilitators and facilitators of the development of the circular economy, while bearing a shared responsibility with national governments and stakeholders.

In the regions, the circular economy involves a systemic shift in which: services are provided for the effective use of natural resources as primary materials and optimization of their reuse; economic activities are planned and carried out in such a way as to slowly narrow and close the loops in value chains; the infrastructure is designed and built to avoid linear blocking and material waste. The main areas of development of the circular economy of the region are construction, mobility and transportation, food, products and services. This shows that the circular economy of the region is possible.

Considering the huge systemic effort, the implementation of the circular economy of the region should have great advantages in order to pay for itself.

Financial support in the implementation of the circular economy of the region can take different forms, such as grants, loans, tax incentives or investment guarantees, offered directly by the public sector or provided through other actors (for example, business associations or business development agencies).

By exchanging knowledge, organizing events or creating exchange platforms, regions can initiate and promote the activities of other local and regional actors, such as businesses and utilities, universities and research centers, civil organizations in the implementation of the circular economy.

In the process of research, we determined the advantages of the circular economy of the region:

- reduces the use of non-renewable resources, sees that the practice of reusing resources and restoring old products (rather than throwing them away) is the norm. This ensures that we use fewer non-renewable resources;
- reduces carbon emissions – the introduction of material management in the circular economy (for example, production and disposal of materials) contributes

to the reduction of up to two-thirds of greenhouse gas emissions;

- strives for zero waste – reuse of resources and products, leads to a zero-waste model, which in turn benefits everyone. Zero waste means less plastic in the ocean, less trash in our oceans and less landfill. It also means that there is less need to mine limited resources; instead, we reuse them;

- provides benefits to the consumer – by reusing materials, it prevents practices such as planned obsolescence, meaning your products will last longer. Many new industry types will also appear. This means that there will be many new jobs;

- opens up new opportunities for business development – with greater availability of work comes more opportunities for business (eg repairing old things, collecting used resources such as clothes or electronics, etc.).

The circular economy also creates social benefits, especially in low-income countries, as the integration of informal waste pickers into formal waste collection provides job security and fair wages.

At the same time, it has become a well-known and recognized model among companies, regions, cities and non-governmental organizations around the world – from China and Latin America to the EU and the USA. However, it is no less discussed that the concept of circular economy has been heavily criticized by both practitioners and researchers [18]. In this regard, researchers [11;18;23;27;29] identified the following shortcomings (remarks) regarding the implementation of the concept of circular economy in the region:

- due to the widespread nature of this concept, it is impossible to measure its impact on all areas of the region's economy, namely: it includes everything from recycling systems, rental, replacement of products, services to the development of applications for the sharing economy, etc.;

- ignoring, as a rule, previously accumulated materials and resources in the region. In particular, the circular economy boils down to the question of choosing between linear and circular products and ignores physical laws regarding the physical limitations of materials and the complexity of waste;

- enterprises develop circular activities only for a

part of their operational activities. First, this may be due to the difficulty of scaling up pilot projects. Secondly, it is often only a small part of the enterprise's activity that is based on the principles of the circular economy, while the main activity continues as usual;

- weak knowledge about the impact of the circular economy on the environment complicates the process of measuring this impact, especially in the long term and on a larger geographical scale. That is why it is believed that the circular economy only delays, and does not eliminate, the negative impact of the linear economy on the environment;

- this concept has mainly a debatable nature of the problem of resource consumption because there is no connection with how this concept will lead to greater social justice;

- the circular economy depoliticizes industrial and environmental policy while strengthening market and business power. It's an attractive concept that promises to be a win-win for everyone. This enables discussions of synergies, win-wins and opportunities rather than trade-offs, challenges and limitations.

In essence, the circular economy aims to design the process of waste processing. In fact, the idea of a circular economy tells us that there is no such thing as waste. To achieve this in the production of products, it is necessary to use durable, high-quality materials that will be optimized for the cycle of disassembly and reuse, which will simplify their processing, transformation or renewal in the future [14].

Therefore, the concept of the circular economy of the region, in our opinion, should not be limited exclusively to the processing of waste at the end (recycling). On the contrary, it must be constantly expanded due to the proposed innovations at all stages of the life cycle of goods and services in combination with the interaction between all stakeholders. At the same time, the concept recognizes the importance of the region's economy working efficiently at all scales – for businesses large and small, for organizations and individuals, while creating and restoring the overall health of the region's ecosystem.

At its core, the circular economy draws inspiration from natural systems.

For the transition and development of the circular economy in the regions, it is necessary to implement seven principles of transition, which are shown in Fig. 2.

In general, the circular economy is driven by a natural system that seems to have been working effectively for thousands of years. These principles are simple, but require a deep understanding of all parties – governments, companies, individuals, they must work together to make the circular economy a reality. Along with this, the transition to circular principles calls for regional authorities to introduce new business models, new modes of consumer behavior and new decisions to transform waste into resources. If we can reduce congestion, eliminate waste and lower costs, higher economic productivity and new growth will allow cities to thrive. New business opportunities will boost skills

and jobs. Thus, the result of the circular economy of the region will be the creation of ecocities, an ecosociety, and in particular an ecoregion.

The transition to a circular economy requires massive systemic changes in the region. Bringing a true circular economy to the region will require a great deal of effort from individuals, businesses and governments. At the regional level, the transition to a circular economy should begin with legislative regulation, the introduction of technologies and innovations, financing and maintenance of new standards, to the formation of the readiness of society in general to change its habits in the direction of the wide use of circular products, the creation of new platforms and schemes for the interaction of producers and consumers of circular goods [11].

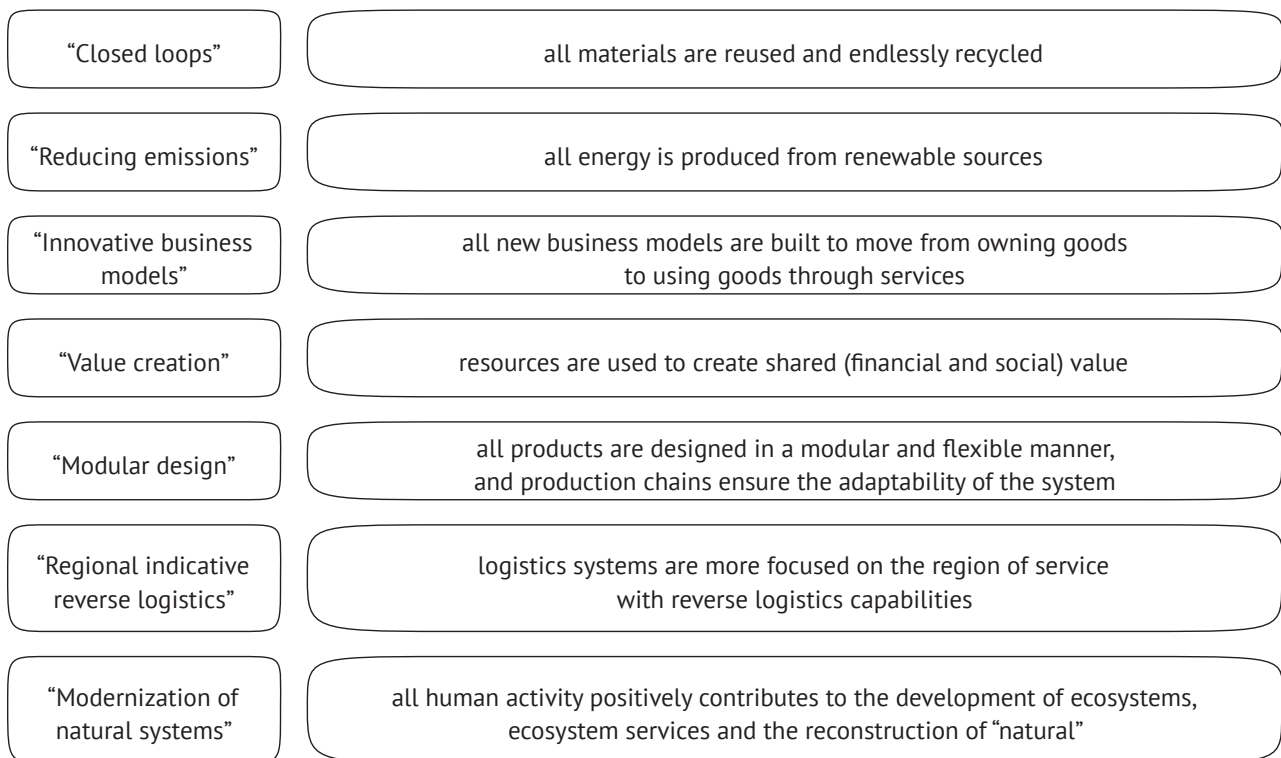


Figure 2. Principles of the region's transition to a circular economy

Along with this, regional authorities play an important role in launching and accelerating the transition to a circular economy by leading by example, setting clear framework conditions or directly supporting local

and regional stakeholders in a greener economy. Without a doubt, the circular model is the most successful way to save resources and materials, and therefore the way to permanent economic growth of the region.

CONCLUSIONS

The circular economy of the region offers a new, more rational approach to handling resources, including waste. A closed-loop economy promotes sustainable management of natural resources and helps shape a more sustainable, prosperous and sustainable future for all. In order to implement the circular economy of the region, it is necessary to ensure the necessary management conditions and existing economic conditions, namely: updating the regulatory and legal framework; agreed policies, informed and engaged stakeholders;

monitoring and evaluating progress and results; clear and reliable business incubators have been created. Now is the time to take full advantage of the region's many opportunities to create a system that can work for the economy, society and environment in the long term.

In the perspective of further research, there are fundamental changes that go beyond the simple "correction" of the environmental consequences of economic activity, to a deep rethinking of the ways of production and consumption by society.

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Циркулярна економіка регіону: теоретичний аспект

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Анотація. У статті розкрито сутність поняття «циркулярна економіка» та запропоновано власне визначення цього поняття, як спосіб економічного розвитку, де цінність продуктів, матеріалів і ресурсів зберігається якомога довше, а відходи значно зменшуються або навіть виключаються. Розглянуто реалізацію моделі циркулярної економіки, в основі якої лежать R-принципи її реалізації. Обґрунтовано, що основними сферами розвитку циркулярної економіки регіону є будівництво, мобільність і транспортування, їжа, продукти та послуги. Окреслено переваги від реалізації циркулярної економіки регіону

Ключові слова: циклічність, циркулярна економіка, регіон, модель циркулярної економіки, переваги

Efficiency of seed production in the context of development of the southern region of Ukraine

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Abstract. The article presents the results of the analysis of the need to establish and operate the Center for the production of basic and certified seeds of new varieties of basic cereals in conditions of natural and artificial moisture on the basis of the Training-Scientific-Practical Center of MNAU. The implementation of the project will promote the development of domestic seed production, providing agricultural producers with high-quality sowing material of new varieties, as well as improving the quality of education during the training of specialists in agronomy

Keywords: seed production, grain crops, varieties, irrigation, economic efficiency, project

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INTRODUCTION

The southern region, with significant areas of fertile black soils, remains in last place in terms of yield of wheat and barley – the main cereals. Thus, according to the State Statistics of Ukraine in 2020, the average yield of wheat grain in Mykolayiv region was 2.70 t/ha, barley – 2.75 t/ha, while in Vinnytsia – 4.26 and 3.91 t/ha ; Kyiv – 4.28 and 3.79 t/ha; Poltava – 4.48 and 3.60 t/ha; Kharkiv – 5.05 and 4.02 t/ha;

Sumy – 5.23 and 4.15 t/ha, respectively [1]. The main reason for this is the lack of attention to seed development. At the same time, one of the most effective methods of increasing yields, resistance to abiotic and biotic environmental factors and increasing the production of high quality grain of major cereals in climate change is the selection of varieties and irrigation, which is especially needed in the Southern Steppe [2-5]. Timely variety replacement and renewal allows to ensure yield growth from 0.2 to 1.0 t/ha [6].

In addition, the maximum realization of the genetic potential of the variety is possible with strict compliance with the technological requirements of its cultivation. Productive varieties and conditioned seeds of cereals are one of the key and indispensable factors influencing the intensification and expansion of the grain production process. Achievements in breeding cannot be realized without well-established seed production, the main role of which is the accelerated reproduction of varietal seeds, introduction into production of new varieties, preservation of their valuable traits and properties and genetic identity [7, 8].

Therefore, a diverse study of the adaptive characteristics of new plant varieties and their seed propagation is the basis for increasing production, improving the quality of crop products, its competitiveness in domestic and foreign markets. However, the presence in the production of seeds in the southern region of more than 140 varieties of cereals leads to complications in seed production and is a consequence of improper implementation of special and mandatory measures [7, 9]. It is the post-registration study of varieties at the regional level that will help producers of seed material and commercial grain to choose the most adapted to different agri-environmental conditions varieties and

receive scientific and methodological support on the technology of growing seeds of studied varieties. This is the close cooperation of all parties interested in the selection, use of varieties and processing of their own seeds [10-12].

The Law of Ukraine “On Higher Education” provides ensuring an organic combination in the educational process of educational, scientific and innovative activities, the main task of which is to acquire knowledge through research and development and their focus on creating and implementing new competitive technologies, innovative development of society and training of specialists of innovative type. Therefore, the urgent direction is the study and implementation of the most effective innovative methods of training in the agricultural sector [13, 14].

Selection and reproduction of the highly productive grades of the grain crops adapted to conditions of the southern zone, their reproduction and creation of modern seed plant on production and finishing of seeds of modern grades of wheat and barley of winter and spring forms on the basis of the Mykolayiv NAU will completely provide commodity producers. highly qualified personnel in the field of seed production and varietal science.

Analysis of recent research and publications

Polish researcher E. Gatsek and domestic scientists E. Radomska and N. Jakubenko [15] analyzed the post-registration study of plant varieties in the Republic of Poland and substantiated further prospects for its effective implementation in Ukraine.

O.V. Zakharchuk [16] developed scientifically sound proposals for the formation of a full-fledged market of plant varieties and improve the varietal and seed supply of the crop industry of agricultural enterprises.

A group of scientists from the Institute of Plant Breeding. V. Yuriev NAAS of Ukraine proved that the introduction of innovative breeding developments will increase the special fund for the development of science, seed and grain industries, and the rational use of existing scientific potential, material and technical base will give impetus to commercialization of

research, their effective introduction in domestic and foreign markets [17].

According to research by G. Chugriy et al. [18] identified the most adaptable to the conditions of the Northern Steppe of Ukraine varieties of winter wheat from different breeding centers of Ukraine. It was found that only the complex adaptive ability of the variety to resist negative factors in the critical phases of crop development helps to ensure the formation of high indicators of yield structure.

R. Lonescu et al. [19] proposed a new model of management decision, which is based on the principles of sustainable economics and offers managers the opportunity to make smart decisions in socio-economic conditions caused by climate change and the global health crisis.

Paying tribute to the scientific and practical significance of the works of these authors on the seed production of a new generation of varieties of cereals in Ukraine and abroad, a number of issues are still insufficiently studied.

An extremely effective measure to promote and implement the achievements of science in production is the formation of scientific and technological landfills of modern varieties of innovation, adapted to environmental conditions, and modern varietal technologies for the production of high quality seeds. In this regard, the development of technology for growing seeds of major cereals (soft winter wheat, winter barley and spring barley), which will be based on improved basic technological (sowing dates and seeding rates) and agri-environmental, ecological plasticity of the variety, foliar nutrition, growth stimulants, etc.) elements are of regional importance.

The aim of the article is to solve the scientific problem of seed production in the main area of grain production – the southern region, improving the system of agricultural education, in particular in training specialists in “Seed Production”, which consists in research and development and their focus on creating and implementing new competitive technologies for growing seed material of cereals and the introduction of the most effective innovative methods of teaching disciplines “Breeding and Seed Production”, “Seed Science” on the basis of the Mykolaiv National Agrarian University (MNAU).

TASKS AND METHODS OF RESEARCH

To achieve this goal it is necessary to analyze the need to establish and operate a Center for the production of basic and certified seeds of new varieties of basic cereals in natural and artificial humidification of southern Ukraine on the basis of the Training and Research Center of MNAU with the participation of research institutions of the National Academy of Agrarian Sciences of Ukraine, industrial enterprises of Ukraine, members of the Training-Research-Production Consortium (TRPC) “Southern”, the Southern

Interregional Research Center of NAAS and providing quality seeds to agricultural producers. Such integration of science, education and production will help improve the quality of education in the training of specialists in “Seed Production” in “Agronomy”, providing producers with high quality seeds of new varieties recommended for distribution in the Southern region and providing them with scientific and practical recommendations on new seed technologies. .

RESEARCH RESULTS

Mykolaiv National Agrarian University, with 400 hectares of modern irrigation using the latest Zimmatic sprinklers, has created stable conditions for growing cereal seeds and a scientific basis for studying the adaptive characteristics of promising varieties for irrigated lands.

To ensure the work of the Center for Seed Production of the newest domestic varieties of grain crops in the conditions of natural and artificial moisture in the South of Ukraine, Mykolaiv NAU has created the appropriate scientific infrastructure: Research and Training Consortium “South” institutions of higher education and 22 industrial enterprises of Ukraine; Southern Interregional Research Center of NAAS, consisting of 6 institutions of higher education, 8 research institutions and 6 research farms of the southern region and Science Park “Agroperspective”.

Long-term cooperation of the university with breeding centers of Ukraine, growing demand among farmers for quality seeds will ensure the success of the project to establish a Center for Seed Production and Circulation of the latest domestic varieties of cereals in natural and artificial moisture in southern Ukraine.

Since 2014, the University has been carrying out tests on more than 200 varieties of cereals of all breeding centers of Ukraine and foreign originators, holding international and all Ukrainian Field Days with the obligatory invitation of agricultural producers in the region. According to the results of research, the Catalog of Varieties is published annually. Recommended varieties with high productivity potential will be fully realized when grown under artificial and natural moisture in the southern region.

Preparatory work on the purchase and commissioning of a mobile universal cleaning machine SSC 60/10 based on Petcus P-12 for presowing preparation of cereal seeds. The specified equipment has high manufacturability:

- represented by a well-known German brand (high quality and reliability);
- the sorting machine allows to receive seeds of high quality (DSTU 2240-93);
- integrated pickling machine in the equipment;
- high productivity of the equipment – 25 t/h. primary seed cleaning and 6 t/h. finishing cleaning;
- mobility (equipment mounted on a cargo trailer);
- equipment does not require design work, permits, fixed connection to communications.

All this will contribute to the creation of the Center for Seed Production of the newest domestic regional varieties of grain crops in natural and artificial moisture in southern Ukraine, which aims to create an innovative environment and conditions for intensifying innovation processes in agricultural production under irrigation and natural moisture, growing new varieties of cereals such lands and their rapid promotion to agricultural producers, the spread and improvement of innovative technologies in the agricultural sector of the Southern region.

The overall goal of the project is to develop innovation infrastructure, create a favorable innovation environment, conditions for intensifying innovation processes, rapid promotion of new breeding achievements in production, modernization of the agricultural sector through the introduction of new advanced seed production technologies in artificial and natural moisture, increase production, sowing material of modern

varieties of grain crops adapted to cultivation in the conditions of climate change to meet the needs of the region, which fully meets the objectives of the State Development Strategy of Mykolaiv region for the period up to 2027 from 23.12.2020 by the decision of Mykolaiv regional council № 2.

Much attention in the activities of the Center will be paid to information and advisory support of the created innovation. The results of post-registration testing of newly registered varieties of soft winter wheat, winter barley and spring barley, which differ in ecological and genetic origin, will be of great scientific importance; establishing the regularity of improving their sowing qualities and yield properties of seeds by optimizing the sowing period, seeding rate and nutrients.

As a result of this project, new experimental data will be obtained, which will significantly increase grain yield, quality seed yield and profitability compared to conventional technologies, as well as provide farmers in the Southern region with high quality seeds of newly registered varieties for varieties and quantities.

The main activities of the project are the creation of the Innovation Landfill – a base for research to study the adaptive characteristics of cereals and testing of new varieties of breeding centers, establishing demonstration sites, development and implementation of innovative technologies for seed propagation under irrigation and natural hydration.

1. The list of expected results of the project includes:
2. Creation on the basis of Mykolayiv NAU Innovative landfill for production and circulation of seeds of modern varieties of grain crops for irrigated and non-irrigated lands of the South of Ukraine.
3. Development and implementation of innovative technology for propagation of seeds of winter and spring cereals in the conditions of artificial and natural humidification of the South of Ukraine.
4. Holding Field Days and scientific-practical conferences, publishing scientific-practical materials, Catalog of grain varieties recommended for the conditions of the Southern Steppe of Ukraine, providing recommendations to agricultural producers.
5. Commissioning of an innovative line for finishing seeds of newly registered varieties of grain crops to

high sowing conditions in the research and production department of the University.

6. Development of recommendations on the system of nutrition protection of seed crops of wheat and barley of winter forms and spring barley.

7. Preparation of practical recommendations and standards for the use of mobile universal cleaning machine SSC 60/10.

8. Development of economic and mathematical model of the transition from conventional commodity farming to seed production with specialization in seed propagation of new varieties of cereals; publication of research results in scientific journals.

The target groups of the project are agricultural

producers of the South of Ukraine, research institutions of NAAS, breeding centers of Ukraine, members of TRPC "Southern", members of the Southern Interregional Research Center of NAAS, producers of agrochemicals and biologicals of agricultural machinery, Science Park "AgroUspective". The territory covered by the project results is Mykolayiv, Kherson and Odesa oblasts.

The total estimated cost of the project for three years of implementation is UAH 14,131.4 thousand. The main source of project funding is UAH 12,000.0 thousand – state budget funds received from the European Union, additional source of funding UAH 2,131.4 thousand – funds of the Mykolayiv National Agrarian University (Table 1).

Table 1. Economic efficiency of the project on creation of the center of seed-growing of the newest domestic regionalized grades of grain crops

Indexes	2021 p.	2022 p.	2023 p.	Together
1	2	3	4	5
<i>Operational activity</i>				
Area of winter wheat sowing, ha	200.0	200.0	200.0	X
winter barley, ha	77.0	77.0	77.0	X
Yield of winter wheat, t/ha		10.0	10.0	X
winter barley, ha		8.5	8.5	X
Gross harvest of winter wheat, t		2000,0	2000,0	4000,0
Gross harvest of winter barley, t		654.5	654.5	1309,0
Produced seeds of winter wheat, t (85%)		1700,0	1700,0	3400,0
Produced seeds of winter barley, t (85%)		556.3	556.3	1112,7
Used own seed material of winter wheat, t		45.0	0.0	
Used own seed material of winter barley, t		15.4	0.0	
Yield of grain waste, t (13% of total gross harvest)		345.1	345.1	690.2
Additional grain of entrepreneurs to be cleaned and calibrated, t		1000,0	1100,0	2100,0
Cost of winter wheat seeds (elite) for sale, thousand UAH/t (20% VAT)		10.0	10.5	X
Cost of winter barley seeds (elite) for sale, thousand UAH/t (20% VAT)		9.8	10.0	X
Cost of grain waste of wheat and barley, thousand UAH/t		3.0	3.2	X
The cost of providing services for cleaning, calibration and treatment of grain for other producers, thousand UAH/t		0.7	0.7	X
Revenue from the sale of wheat seeds, thousand UAH		16550,0	17850,0	34400,0
Revenue from the sale of barley seeds, thousand UAH		5301,1	5563,3	10864,3
Revenue from sales of grain waste, thousand UAH		1035,3	1087,0	2122,3
Revenue from grain seed cleaning and calibration services, UAH thousand		700.0	770.0	1470,0

Table 1, Continued

Indexes	2021 p.	2022 p.	2023 p.	Together
1	2	3	4	5
Cost of commodity wheat grain, thousand UAH/t		5.1	5.1	X
Cost of commodity grain of barley, thousand UAH/t		4.5	4.5	X
Revenue from the sale of wheat seeds as comrade. grain, thousand UAH		10200,0	10200,0	X
Revenue from the sale of barley seeds as a trade grain, thousand UAH		2945,3	2945,3	X
Additional income from the sale of grain as an elite seed of winter wheat, thousand UAH		6350,0	7650,0	14000,0
Additional income from the sale of grain as an elite seed of winter barley, thousand UAH		2355,8	2618,0	4973,8
Additional income from the sale of grain as an elite seed – total, thousand UAH		8705,8	10268,0	18973,8
Income from services for cleaning and calibration of grain seeds and sale of grain waste, thousand UAH		1735,3	1857,0	3592,3
Total gross income from the operation of the seed plant, thousand UAH		10441,1	12125,0	22566,1
Production costs - total, thousand UAH	668.7	817.9	644.8	2131,4
Operating profit, thousand UAH	-668.7	9623,2	11480,2	20434,7
Discount rate (discount rate 11%)	1.00	0.90	0.81	-
<i>Discounted cash flow from operating activities, UAH thousand</i>	<i>-668.70</i>	<i>8669,51</i>	<i>9317,34</i>	<i>17318,2</i>
<i>Investment activity</i>				
Capital investments - total, thousand UAH	12 000,0	0.0	0.0	12000,0
including: - Petkus P-12 mobile universal cleaning machine	12000,0			12000,0
Total costs, thousand UAH	12668,7	817.9	644.8	14131,4
<i>Discounted cash flow from investing activities, UAH thousand</i>	<i>12000,00</i>	<i>0.00</i>	<i>0.00</i>	<i>12000,0</i>
<i>Discounted free cash flow, UAH thousand</i>	<i>-12668,70</i>	<i>8669,51</i>	<i>9317,34</i>	<i>5318,2</i>
Cumulative discounted free cash flow, UAH thousand	-12668,70	-3999,19	5318,16	X
Net present value (NPV), thousand UAH	5318,17		X	
Internal rate of return (IRR),%	40.5		X	
Return on investment (PI),%	144.32		X	
Discounted payback period of DPP, years	2.6		X	

Tax revenues to the budget for the years of project implementation will amount to UAH 3,958.5 thousand (Table 2).

The implementation of the project will contribute to a significant increase in economic, social and energy efficiency of agricultural production in the southern region; increasing the production of high quality seed material in conditions of natural and artificial moisture; increasing the manufacturability of production and productivity; meeting the needs of agricultural producers in the South of Ukraine, members of TRPC “Southern” and the Southern

Interregional Research Center NAAS in high-quality sowing material of domestic varieties of cereals and the needs for services for cleaning, calibration and pre-sowing treatment of seeds of their own production; establishment of a regional information and logistics seed center for cooperation between grain producers and scientific institutions.

Sustainability of the project results is ensured due to the functioning of the Seed Production Center for the production and circulation of the latest domestic varieties of grain crops for the South of Ukraine on the basis of the Mykolayiv National Agrarian University.

Table 2. Receipts to the state budget from the project implementation, thousand UAH

Indexes	2021 p.	2022 p.	2023 p.	Together
1	2	3	4	5
Cash proceeds, UAH thousand	0.0	10441,1	12125,0	22566,1
Tax liability, UAH thousand	0.0	1740,2	2020,8	3761,0
Total costs, including:	12668,7	817,9	644,8	14131,4
- investment costs (mobile universal cleaning machine SSC 60/10 based on Petcus P-12), thousand UAH	12000,0	-	-	12000,0
- project implementation costs	668,7	817,9	644,8	2131,4
including:				
- salary with accruals	335,8	359,9	384,7	1080,4
- material costs	309,3	409,3	211,4	930,0
- serves	10	40	40	90,0
Tax credit, thousand UAH	53,2	74,9	41,9	170,0
Receipt of VAT in the budget, thousand UAH	-53,2	1665,3	1978,9	3591,0
Personal income tax (18%), UAH thousand	49,5	53,1	56,8	159,4
Single social contribution (22%), UAH thousand	60,6	64,9	69,4	194,9
Military fee (1.5%), thousand UAH	4,1	4,4	4,7	13,2
Total payments, thousand UAH	61,0	1787,7	2109,8	3958,5
Budget efficiency,%				28,0

Introduction of modern irrigation on the lands of the University for varietal testing of promising varieties of grain crops created in NAAS institutions under conditions of risky agriculture will provide the region with high quality seeds adapted to the conditions of the South of Ukraine, introduce the latest technologies will provide an opportunity to increase grain yields to 30%, provide agricultural producers in southern Ukraine, members of TRPC "Southern" and the Southern Interregional Research Center with modern services for cleaning, calibration and presowing seed treatment in accordance with DSTU 2240-93.

The multiplier effect of the project is to increase the production of high quality sowing material of new promising varieties of cereals for irrigated and non-irrigated lands, will be provided by publishing scientific and methodological, informational materials, publications in scientific journals and a group of agricultural producers in the region. cultivation of seed crops of cereals under irrigation of the southern region. It is also planned to support the media and post information

about the project on the website of the project customer. The results of the project will be verified through questionnaires and disseminated among other interested agricultural producers, scientists and graduates.

Within the framework of the project implementation, monitoring of the achievement of goals is introduced by comparing the actually obtained values of indicators with their forecast values, which is conducted every year by the Ministry of Education and Science of Ukraine and Mykolayiv National Agrarian University.

Assessment of the achievement of project objectives is based on the results of the calendar plan for each stage of activity. A generalized evaluation of the effectiveness of the project is conducted by the Ministry of Education and Science of Ukraine one year after the completion of the project. The procedure for monitoring and evaluating the effectiveness of the project is determined by the Ministry of Education and Science of Ukraine.

The internal monitoring procedure will be carried out according to quantitative and qualitative indicators,

provides a detailed description of the project activities at its respective stage; identification of those responsible for the task; division of responsibilities between performers.

Information on monitoring and reporting on the status of the project will be reflected in the documents:

- Bulletin on indicators of the state of works (to be filled in by the customer).
- Minutes of meetings (to be filled in by the customer).
- Internal report on the status of the project (to be filled in by the customer).
- External report on the status of the project (to be filled in by the customer).

To ensure control in the project, the main monitoring and control procedures will be implemented:

- work plan control procedure;
- financial plan control procedure;
- quality control procedure;
- document control procedure.

The following project evaluation technologies have been introduced:

- control at the end of the work (method "0-100");
- control during 50% readiness of works (method "50-50");
- regular operational control (at regular intervals);
- expert assessment of the degree of execution of works and readiness of the project.

In case of occurrence of unforeseen or negative results or side effects during the project implementation, the procedure of corporate settlement is provided in the operative way.

A separate important criterion for the internal evaluation of the achievement of project results is the economic efficiency of the project.

Upon completion of the project, a survey of agricultural managers and specialists on the results of the introduction into production of innovative technologies obtained under this project for growing winter wheat and winter barley under irrigation and in conditions of natural moisture.

The following project evaluation technologies have been introduced:

- control at the end of the work (method "0-100");
- control during 50% readiness of works (method "50-50");
- regular operational control (at regular intervals);
- expert assessment of the degree of work implementation and project readiness.

CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The development of irrigation in the South of Ukraine is an important condition for the formation of a favorable innovation and investment environment in the region, the realization of the country's agricultural potential, increase agricultural production, exports and food security.

The project to establish the Center for Seed Production of the newest domestic regional varieties of grain crops in the conditions of natural and artificial moisture in the South of Ukraine is aimed at developing seed growing technology for each studied variety and innovation.

Implementation of the project on the area of 277 hectares for 2021-2023 will allow to obtain budget efficiency at the level of 28% and will stimulate the development of irrigation in Mykolayiv region, which is a guarantee of high yields of major crops, stability of revenues to the state budget and strengthening leadership the world.

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Ефективність насінництва в контексті розвитку Південного регіону України

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Анотація. У статті представлено результати аналізу необхідності створення та функціонування Центру з виробництва базового та сертифікованого насіння нових сортів основних зернових колосових культур в умовах природного та штучного зволоження на базі Навчально-науковопрактичного центру МНАУ. Реалізація проекту сприятиме розвитку вітчизняного насінництва, забезпечення агровиробників високоякісним посівним матеріалом нових сортів, а також підвищення якості освіти під час підготовки фахівців з агрономії

Ключові слова: насінництво, зернові культури, сорти, зрошення, економічна ефективність, проєкт

Effective personnel management tools in local self-government bodies

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Abstract. The toolkit of tools and mechanisms for personnel management in local self-government bodies of Ukraine is used at maximum capacity and is practically exhausted. In view of this, the expansion of the concept of personnel organization should take place with the involvement of innovative approaches, methods and concepts in personnel management processes. The aim of the study is to determine and justify modern, relevant approaches to improving the qualifications and effectiveness of the work of the team in local self-government bodies, to investigate the adaptability of innovative factors in the structure of the administrative apparatus. The work process was organized using the method of analysis, synthesis, generalization, comparison and modeling. The article examines the essence of personnel management, which consists in ensuring the optimal quantitative and qualitative composition, the organization of personnel training, and the achievement of a rational degree of personnel mobility in local self-government bodies. Peculiarities of personnel management in local self-government bodies are substantiated by summarizing theoretical foundations. Innovative methods and tools of personnel management, which are not directly stipulated by the legislation, but correspond to it, have been studied. It was determined that for the purpose of effective personnel management, it is worth paying attention to such an approach to managing the development of human resources as the formation of continuous corporate training systems. The practical value of the work lies in specifying the algorithm for increasing the efficiency of personnel management in state institutions and recommending effective mechanisms that will contribute to increasing the effectiveness of human resources management in local self-government bodies, which, as a result, will have a positive effect on the economic rise of the territorial community, in particular

Keywords: territorial communities, scientific management, work efficiency, E-learning system, economic growth

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INTRODUCTION

The current large-scale administrative and territorial reform and complex changes in the local self-government of Ukraine require scientific research and the development of a unified systemic vision of this process. Management is the basis of effective functioning of any organization, including local self-government bodies. Achieving high results of local self-government is impossible without the introduction of innovative approaches to personnel management processes. The potential of the used methods, methods and tools of personnel management is practically exhausted, therefore the search for ways to increase the efficiency of the use of human resources is shifting to the plane of development of innovative personnel technologies. Therefore, the issue of introducing innovative and effective personnel management tools for local self-government bodies is a very relevant topic.

There are many approaches to defining the concept of "personnel management". Thus, Ya. Krushelnytska & O. Kyrychenko define "personnel management" as a purposeful activity of managers and specialists regarding the formation and effective use of aggregate labor potential, which includes the development of concepts and strategies of personnel policy, principles and methods, the formation of a personnel management system to achieve goals organizations [14].

In turn, A. Mosumova [16] emphasizes that there are no special differences in the functional processes of personnel management in public organizations compared to the private sector. The scientist identified the following as the main and important personnel management processes in public organizations: analysis of personnel processes and their planning; recruitment and selection of personnel; personnel adaptation; evaluation and control of personnel actions, motivation and stimulation of personnel, development of personnel, improvement of their professional qualification level; labor relations, quality of life, working conditions; release of personnel.

According to T. Pokotylo [19], the effective formation and use of the labor potential of local self-government bodies depends on the effectiveness of the following principles of personnel management: system

management of all components of the organizational and economic mechanism of the organization's labor potential management; rational formation of labor potential; compliance of material and non-material incentives to the full disclosure of labor potential to the motives of employees; openness of information, etc. A number of scientists emphasize the importance of strategic personnel management. Thus, in his research, A. Rachynskyi developed an author's approach to strategic personnel management as a mechanism for implementing structural changes in the activities of state authorities under conditions of crisis, and also clarified the methodological principles of the formation of a strategic approach to personnel management in such bodies, criteria for the development and implementation of value strategies in the activities of their personnel. The taxonomy of personnel management in public bodies based on the profile of personnel managers was presented by scientists J. Herrera, & D.M. Miller [3]. The analysis focuses on the task environment of managers, defined by three main elements from strategic human resource management research. In particular, this research examines the level of participation of HR managers in policy-making processes at the strategic level, vertical and horizontal political integration, and the flexibility of human resource managers in interpreting and implementing key HR functions (i.e., recruitment, hiring, and compensation). The results of their research yield five different profiles that describe different approaches to human resource management. Klingner, D.E., Nalbandian, J., & Llorens, J. believe that government agencies are facing pressure to become more efficient by reducing costs and increasing productivity [4]. A critically important, but expensive element of every organization is the staff. In both the public and private sectors, human resource management is an area that often receives a lot of attention to improve efficiency and effectiveness. According to J. Serrano, & M. Barba [5], the results of their research show that local self-government bodies, which develop methods of recruitment and selection, training, evaluation and reward, taking into account the needs of specific workplaces, the potential of employees and their activities, improve their results.

The ability of local self-government bodies to manage human resources was studied by C. Vincent, & Stephen C. [6]. The impact of various internal and external factors on human resource management activities in local governments was investigated by G. Wilson [8], D. Alao, C. Ajike, & M. Ibrahim [1].

The authors [2] emphasize that state authorities face the challenges of demographic changes. Currently, there is a shortage of younger workers and qualified personnel. Therefore, the leap from rigid personnel management to active, modern human resource management is inevitable as a central key to the long-term success of companies. N. Havkalov is of the same opinion [9]. The scientist believes that the essence of personnel management in public organizations is to ensure the optimal quantitative and qualitative composition of personnel, the organization of personnel training, and the achievement of a rational degree of personnel mobility in public organizations. We are impressed by the opinion of scientists, because we are convinced that the recruitment of younger personnel through targeted training and personnel marketing, the use of modern communication channels, effective and sustainable development of personnel through further and continuous training and systematic management can be key factors in successfully increasing the level of attractiveness of an employer.

The literature emphasizes the key role that the workforce plays in the operations of companies. It is also emphasized that human resource management is a source of competitive advantages. However, although this topic has been widely studied in the private sector, little research has focused on public administration, particularly in local governments. To fill this gap, this study addresses a number of theoretical issues and practical recommendations regarding effective HR management tools in local governments. The purpose of the article is to substantiate the theoretical provisions and develop practical recommendations for effective personnel management tools in local self-government bodies.

Modern personnel management mechanisms as a guarantee of providing territorial communities with professional personnel

In conditions of decentralization, the problem of

providing united territorial communities with high-quality personnel becomes especially relevant, since their professional level is one of the prerequisites for the successful development of the community [13]. Moreover, according to the scientists of the National Institute of Strategic Studies, ensuring the sustainable development of communities and regions depends not only on the potential competitive advantages of the resource type (the presence of natural-resource potential for economic development, demo-economic potential), but also on the competitive advantages of the non-resource type, related, first of all, with the possibilities of implementing innovative development factors, improving human capital [12].

Personnel management in public organizations is not only an important area of management, but also an important tool for influencing their functioning, taking into account the goals and principles of the state personnel policy [14].

Local self-government bodies must always find the most effective ways to hire, encourage, reward, retain, develop and improve the skills of their employees. This is important for the efficient, rational and coordinated work of the local self-government body, which provides high-quality and citizen-oriented services. Peculiarities of personnel management in local self-government bodies are presented in Table. 1.

We believe that modern personnel management has a strategic perspective that recognizes that the organization's employees are a resource that enables the achievement of the organization's goals. At the heart of personnel management, it is taken into account how management decisions shape the effectiveness of the workforce in a planned way and in unexpected conditions. Based on this concept, we believe that the mechanism of personnel management is the orderly and consistent use by local self-government bodies of a set of methods, means and tools of influence based on certain principles, as a result of which the realization of goals in the field of personnel management is ensured. The mechanism of personnel management must correspond to the purpose, strategy and concept of management, which is reflected in its components: principles, functions, tools and methods of management.

Table 1. Peculiarities of personnel management in local self-government bodies

Current trends in personnel management in local self-government bodies	Actual and unresolved problems in personnel management in local self-government bodies
The lack of a single, clear system for assessing the quality and efficiency of personnel work, the certification and control of personnel are of a formal nature, it is mostly difficult to compare the results of specialists	A decrease in the level of personnel management, the appearance of disinterest of personnel in the results of their own activities, and the appearance of corruption at various levels of government.
Low prestige of the work and low salary, which does not correspond to the complexity of the work and emotional stress	Insufficient number of qualified specialists in local self-government bodies
The impossibility of using financial instruments (salary increases, bonuses) for material stimulation of personnel, which demotivates personnel and does not contribute to the quality of the work process.	Development of a differentiated system of personnel motivation by creating a bonus system that reflects the effectiveness of their activities, providing favorable conditions and guarantees for personnel.
Stereotypes and lack of purposeful work of state structures in the direction of forming a favorable image in public consciousness	Increasing the prestige of work in local self-government bodies, introducing effective and transparent incentive mechanisms, social protection and increasing the responsibility of personnel

The team of authors [24] notes that the subsystems and elements of the personnel management system of local self-government bodies include the subject of personnel management and regulatory subsystems (the Constitution of Ukraine, laws of Ukraine, decrees and orders of the President of Ukraine, resolutions and orders of the Cabinet of Ministers of Ukraine, orders of the National civil service, acts of other state bodies), scientific and methodical (covers all stages of training, specialization, and advanced training of civil servants and includes the National Academy of National Statistics, a network of higher education institutions, a professional development institute, branch institutions of higher and postgraduate education licensed to improve the qualifications of civil servants), informational (implies the use of modern information and communication technologies (electronic governance, unified information computer system "Kadry", public

electronic services, etc.) and social and psychological support (implements the introduction of psychological testing in the selection process personnel for public service, determination of training needs, etc.) personnel management.

A modern personnel management system and approaches to its implementation should use the fundamental and latest principles of scientific management theory. Therefore, the main task of HR managers is the construction of a personnel management system, which to the greatest extent allows the implementation of creative initiatives of employees at all levels of the hierarchy. Here, an important role is given to the methods of personnel involvement. The first stage in the HR cycle is search and recruiting (Table 2). Recruiting provides a clear understanding of the request and the ability to provide the necessary personnel to local self-government bodies [20].

Table 2. Characteristics of recruiting

Types	Features	Advantages	Disadvantages
Internal	Search for a candidate within the organization. This is an important element of employee development	A large amount of information about the transferred employee, about his professional potential (areas of development, strengths and way of working) A short period of adaptation of the employee, less search effort	Lack of opportunities to compare the employee's potential with the competencies of other potential candidates
External	Search for a candidate for a position outside the staff of the OMS	A greater selection of potential candidates, and as a result, an opportunity to hire the person who best meets the requirements for the position	The procedure requires more effort and is longer than internal selection, may be associated with a higher risk of selecting the wrong person, in particular, in the case of a poor selection procedure

In the process of selecting employees, it is necessary to understand the concepts of internal and external recruiting [20]. That is, you can hire people who have already adapted to the team, or select employees from outside the territorial community. In Ukraine, there is a high level of population mobility, and therefore, desired candidates for the position can change their place of residence and move to a territorial community with a bright brand and good working conditions. In this direction, it is important to cooperate with higher education institutions when it comes to the selection of young workers, and it is also advisable to specify the requirements for vacancies in a concise style.

An important stage of recruiting is the search for candidates. In order to expand the possibility of

attracting a larger number of qualified personnel and to popularize the vacancy, it is necessary to pay attention to additional places of posting the vacancy, in particular: <https://www.work.ua/>, <https://rabota.ua/ua>, <https://www.olx.ua/> and on the official pages of the organization in social networks. Also, external resources can be expanded with the help of the Employment Center, announcements in the local newspaper, work with specialized educational institutions.

One of the methods of personnel selection and evaluation, which is a process of information exchange between two parties, is an interview. And at the same time, this is a true cross-section of human behavioral characteristics that are manifested in working conditions. We suggest using the following types of interviews (Table 3).

Table 3. Modern technologies of personnel recruitment methods

Title	Characteristic
Structured interview	is made according to a standard model; a clear sequence of pre-prepared questions with precise wording; everything is important: how the candidate builds his story, how well he speaks the language, whether he knows how to quickly switch attention; a universal method that is widely used in the practice of selection staff

Table 3, Continued

Title	Characteristic
Competency interview	the questions are structured in such a way as to suggest an extended response; the candidate is asked to describe one or two stories on a certain topic from past professional experience
Stress interview	Stressful conditions are created for the candidate, for example, in questions are asked at a fast pace on various topics, even too personal, the same question is repeated several times.
Projective interview	The candidate is asked various open-ended questions “not about him”, for example, what motivates people to work effectively? An auxiliary technique for forecasting the model is quite effective behavior, motivation, internal values of the candidate.
CASE interview	“Cases” can be set for creativity, the ability to think outside the box. It's convenient to assess skills, behavior patterns, as well as complex things like learning ability, Source stability etc.

Source: [20, 24]

It is important to note that in 2021, the General Department for Personnel Management in the Civil Service and Local Self-Governing Bodies of the Ukrainian National Socialist People's Republic of Ukraine conducted a survey of personnel management services regarding the need for methodological assistance in human resources management. In the course of the survey, 212 responses were received from employees of local self-government bodies, who deal with personnel management issues. Respondents were asked to choose from the list of issues in the field of personnel management those for which it would be most relevant and important for them to receive additional information and methodical support. It is important to note that both in state bodies (87%) and in local self-government bodies (86%), respondents confirmed the use of additional personnel management methods and tools that are not directly provided for by the law, but correspond to it. In particular, such as adaptation, mentoring, development of organizational culture, team building and formation of a favorable atmosphere in the team [18].

The need for adaptation and promotion of personnel development in the context of increasing the efficiency of personnel management

Newly appointed employees, as a rule, lack practical experience of working in local self-government bodies, which leads to a decrease in the level of productivity and quality of performance of tasks set by the community. Instead, it is impossible to attract highly qualified workers with experience in local self-government positions due to the lack of financial resources to stimulate their work. We believe that this problem can be solved by qualitative and systematic adaptation of those who work for the first time. The application of such practices will help to quickly adapt the employee to new working conditions, which will significantly increase productivity and positively affect the functioning of the state body.

Adaptation of personnel is a process aimed at the optimal entry of a new employee into the workforce in order to increase the efficiency of his work, both at the stage of entry and in the future [14].

Adaptation of an employee to a new situation depends on various conditions of his production environment, workplace, workforce, as well as conditions that are not directly related to them. The presence of a significant number of such conditions leads to the existence of various types of adaptation: professional, psychophysiological, social-psychological, organizational-administrative, economic, sanitary-hygienic adaptation.

The result of the adaptation process should be not only the acquisition by the new employee of the knowledge necessary for work, but also the creation of a favorable moral and psychological state upon joining

the team. The employee must begin to realize himself not as an alien body in the team, but as a full-fledged and useful member of the team. The stages of the employee adaptation process are presented in Fig. 1.

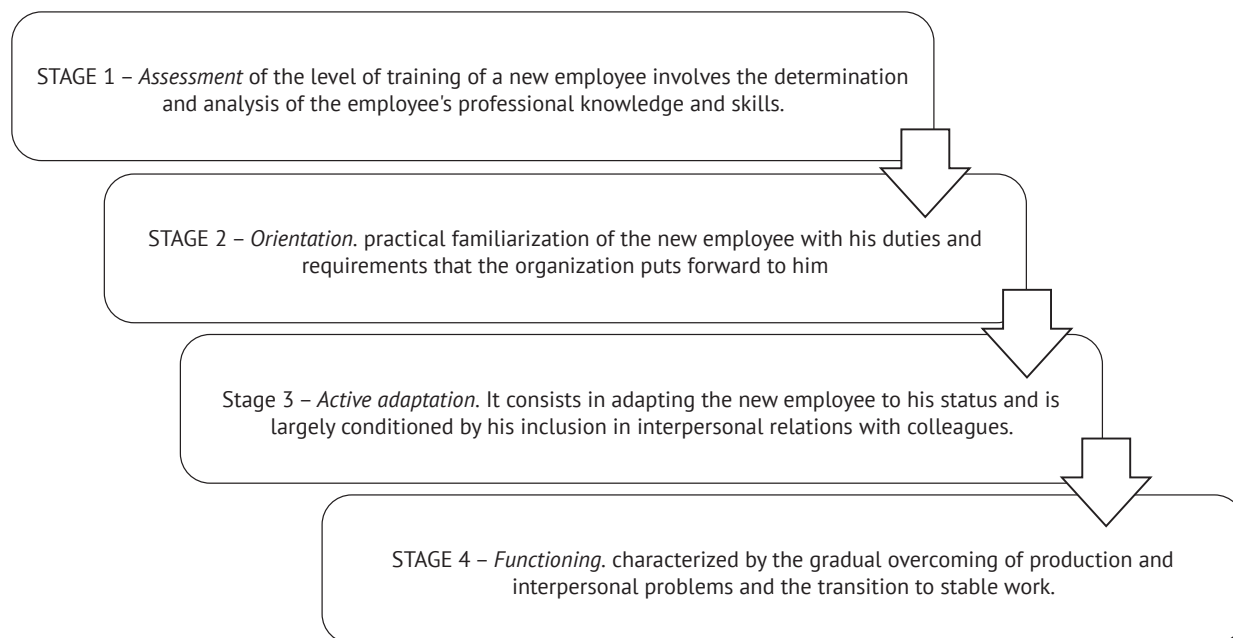


Figure 1. Stages of the employee adaptation process

The most popular form of employee adaptation today is the mentoring method. Mentoring is on-the-job training aimed at the long-term acquisition and development of professional knowledge, skills and personal qualities of newly appointed civil servants, necessary for the performance of official duties, and is carried out in the form of consultations, advice and explanations provided by a mentor established under this person [21]. Mentoring can be established for a duration of up to 3 months depending on the complexity of the duties provided for by the position and the level of professional competence of the newly appointed civil servant and can take place simultaneously with the probationary period.

The modern direction of using this method is the use of badging. Its essence is that advice, recommendations, information and feedback are transmitted two-way, without distinguishing between “senior” and “junior”, between those who teach and those who learn.

Budding is often referred to as informal mentoring. However, if mentoring is aimed at staff development, then budding is aimed primarily at the psycho-emotional support of the newcomer.

The head of the structural unit determines (on a public basis) a “buddy” for the beginner. “Buddy” does everything to make the newcomer comfortable. For a buddy, there is the following algorithm for his interaction with a newcomer. In the first weeks, the “buddy” usually communicates regularly with the “newbie” to make sure that everything is okay with him and that he is adapting successfully. As a result, the new employee does not feel like a “stranger”, knows who to contact with any questions, quickly integrates into the team and gets to know the rules. This practice is complemented by the experience of the state body in introducing a well-planned “productive working day” for newly appointed civil servants. As a result, on the first day of work, the newcomer does not feel abandoned

and rationally uses working time. Communications are being established [10].

Considering the growing role of the human factor, one of the most important tasks of improving personnel management is to ensure personnel development, which implies the need to invest in personnel, and not just to form them quantitatively according to available jobs. We consider it expedient to increase the professional qualification level of employees by forming continuous corporate training systems. Thus, we believe that the effectiveness of training and its impact on the specific results of employees can be high

only if there is an emphasis on the innovative activity of those who learn, their active involvement in the training process. In this regard, the issue of corporate universities is particularly relevant.

A corporate university is a well-thought-out system of continuous training of personnel, within which, together with traditional methods of modern business education, the following methods of human resources development are used: business trainings, coaching, problem seminars, analysis and discussion of cases [26], the general characteristics of which are presented on Figure 2.

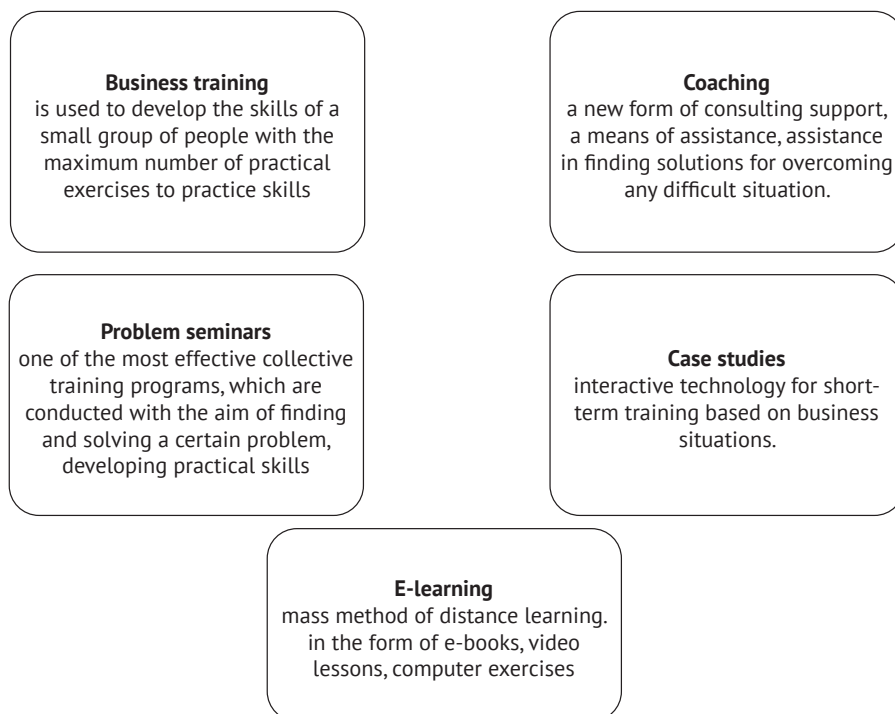


Figure 2. Modern methods of personnel development

E-learning should be highlighted among the modern methods of personnel development for local self-government bodies. E-learning is a fast and effective way of obtaining knowledge necessary for work, which involves the intensive implementation of video, audio, multimedia, computer simulations and their combinations [26]. The use of E-learning is possible with the help of an educational platform in the field of professional training of civil servants, heads of local state administrations, their first deputies and deputies,

officials of local self-government – Knowledge Management (<https://pdp.nacs.gov.ua/>). The advantages of using E-learning for local self-government bodies are the following:

- professional development, provision of valuable, highly specialized knowledge takes place without separating employees from the main workplace;
- choosing an e-learning system allows you to optimize financial costs for personnel education;
- electronic education provides an opportunity for

individual classes, independent study of the material to the required extent;

- during the training process, participants can consult with business trainers and coaches online.

We are convinced that the high-quality implementation of the E-learning system in the activities of local self-government bodies will allow us to achieve high results of productive activity, to solve the issue of improving the qualifications and educational and intellectual level of human resources.

CONCLUSIONS

It was determined that effective personnel management is the key to the success of every organization, local self-government in particular. Each community has appropriate teams of professionals who work on the development of territories, but many territorial communities lack such people. The methods proposed by us have been integrated into the public service from business and are already widely used in the field of personnel management. By understanding and using modern approaches to the selection, attraction and

training of personnel, local self-government bodies will be able to work more effectively in this direction.

It is substantiated that for the purpose of effective personnel management, it is worth starting to pay attention to such an approach to managing the development of human resources as the formation of continuous corporate training systems. Yes, we believe that the effectiveness of training and its impact on the specific results of employees can be high only if there is an emphasis on the innovative activity of those who are studying, their active involvement in the training process. We singled out E-learning among the modern methods of staff development of local self-government bodies. The use of E-learning is possible with the help of an educational platform in the field of professional training of civil servants, heads of local state administrations, their first deputies and deputies, officials of local self-government - Knowledge Management. Thus, the proposed tools allow local self-government bodies to increase the efficiency of human resource management, which will contribute to the economic growth of the territorial community as a whole.

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Дієві інструменти управління персоналом в органах місцевого самоврядування

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Анотація. У статті досліджено сутність управління персоналом в органах місцевого самоврядування, яка полягає в забезпеченні оптимального кількісно-якісного складу, організації підвищення кваліфікації персоналу, досягненні раціонального ступеня мобільності персоналу в органах місцевого самоврядування. Обґрунтовано особливості управління персоналом в органах місцевого самоврядування шляхом узагальнення теоретичних основ. Досліджено інноваційні методи та інструменти управління персоналом, які прямо не передбачені законодавством, але відповідають йому. Визначено, що з метою ефективного управління персоналом варто приділяти увагу такому підходу до управління розвитком людських ресурсів як формування систем безперервного корпоративного навчання

Ключові слова: персонал, управління персоналом, органи місцевого самоврядування, територіальні громади

Marketing research of grain market conditions (niche crops)

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Abstract. The grain market has absolute priority compared to other options for establishing economic relations, because the market system naturally combines the interests of consumers and producers of grain crops, in economic terms it is interesting for producers to meet the needs of buyers in bread products, which are reflected in significant demand. Ukraine has a huge potential for leadership in the world ranking of grain production and has tendencies to further strengthen its own positions on the international market, but it needs to improve technologies in this direction, as well as study the problems of the world grain market and justify algorithms for solving them at the national level. The purpose of the article is to determine trends in the grain market of Ukraine over the past five years and identify the most profitable crops for cultivation. During the research, the method of system analysis, generalization, induction, deduction, modeling and planning was applied. It has been established that the grain market has undeniable advantages compared to other forms of organization of economic relations. Trends to a significant decrease in the price policy on the market of grain and oilseed crops during 2016-2018 were revealed, and the transition from classic and traditional grain crops to legumes became characteristic of 2019-2020, which took place under the influence of a number of factors, including the increase in demand for leguminous crops, profitable relevance of leguminous crops, positive impact on soil cover. The prospects for the cultivation of niche crops are outlined, and the existing situation on the grain market and the situation of niche crops are highlighted. The segmentation of operators of the crop market was made regarding the production of niche crops. The practical value of the work consists in determining the further development strategy of the field of grain production in Ukraine

Keywords: marketing, price, sales prospects, infrastructure, global export

INTRODUCTION

The implementation of logistic approaches to increase the dynamics of international grain trade is becoming more relevant at the current stage of any country, as well as for the development of the Ukrainian economy, which specializes in this field. The dynamics of grain production is increasing every year. It is also

necessary to realize that the grain can be of different quality and, as a result, have a different intended use. Thus, forecasts have been made that "over the next 10 years, Ukraine will continue to improve its position on the world grain market and, potentially, enter the top 5 grain exporting countries, increasing its share to

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14% [1]. This is stated in the forecast of the Organization for Economic Cooperation and Development and the World Food Organization. It is expected that the tendency to increase grain production will continue on the world market" [1]. Given the increase in yield, world production will increase by 375 million tons and exceed 3 billion tons, in particular, wheat production will increase by 86 million tons to 839 million tons. At the same time, the forecast is based on the current grain market situation, including niche crops in Ukraine. Therefore, we consider the issue of studying the development trends of the domestic market of niche crops to be relevant and important.

In the scientific literature, we find the work of modern authors who turned their research into the field of studying, substantiating and forecasting the grain market situation, in particular niche crops in Ukraine. In particular, T. Artyukh studied the marketing aspects of ensuring the activities of agricultural enterprises producing vegetable products [2]. While R. Buryak carried out a marketing research of crop production markets [3]. In the scientific works of V. Vlasyuk, A. Maksyuta, and S. Povazhnyuk, the trend of economic revival due to the industrial development of Ukraine is traced [4]. Instead, I. Demchak, O. Mytchenok, and G. Trofimova studied the foreign trade turnover of agricultural products [5]. Features of conducting marketing research by Ukrainian agribusiness subjects in modern conditions are reflected in the works of O. Yerankin [6]. T. Ilchenko identified the prospects of marketing research in the agricultural market of Ukraine [7]. In turn, M. Ilchuk, I. Konoval, O. Baranovska, and V. Yevtushenko traced the genesis of the development of the grain market in Ukraine and its stabilization factors [8]. In the conclusions of V. Mesel-Veselyak, potential opportunities for grain production in Ukraine were revealed [9]. The conclusions of V. Osetsky regarding innovative industrialization in the agro-industrial complex seem interesting [10]. Y. Kindzersky singled out the determinants of deindustrialization in the world and in Ukraine [11]. Modern research by scientists is related to the study of the effectiveness of the functioning of agricultural enterprises on the grain market: scientific foundations, state, prospects (M. Lyshenko [12]), substantiation of

the scientific foundations of the development of the economy of Ukraine and certain countries of the world (A. Popova, O. Lohonya [13]), marketing studies of grain market conditions (D. Semenda, O. Semenda [14]). However, the problem of studying the marketing of niche crops on the grain market of Ukraine remains insufficiently studied. Therefore, the purpose of the article is marketing research of the grain market situation in the context of the development of the market of niche crops in Ukraine.

Prospects of the cereal market in the context of the form of organization of economic relations

The study of open data [15;16;17;18;19] regarding the market conditions of niche crops makes it possible to highlight several trends in its development over the past ten years. Let's consider the singled out factors in more detail.

The grain market has undeniable advantages compared to other forms of organization of economic relations, since the market mechanism naturally connects the interests of grain producers and its consumers, sellers and buyers, without orders and commands, materially interests producers in meeting the population's needs for bread products, which are expressed through demand. Under the influence of market processes, there is a natural selection of those producers who are able to effectively produce, promote, exchange, and consume bread products at equilibrium prices. The following economic characteristics are used to analyze and assess the state of the grain industry in Ukraine: "market size; market growth rates (%); industry life cycle stages; the structure of competition, the number of consumers and their financial capabilities; pace of technological changes and product innovations; the volume of investments and innovations; average industry profit" [13].

According to the USDA, ranking 8th in the ranking of world grain producers with a share of 3.3-3.5%, Ukraine provides almost 15% of global export needs and in 2019/20 took an honorable second place in the ranking of world exporters. As of November 30, 2020, the total gross collection of Ukrainian agricultural producers for the main crops reached 80.9 million tons, and work was carried out on 23.8 hectares. However, such record yield indicators were not achieved immediately. According to D. Semenda: "...the grain

market of Ukraine is one of the main segments of the agro-food market, the state of which determines the food security of the country.”

It should be noted that the forecast regarding the supply and demand balance of grain and leguminous crops in 2020/2021 was successful (Table 1).

Table 1. Forecast regarding the supply and demand balance of grain and leguminous crops 2020/2021

	Grains in total, thousands of tons	including crops			
		wheat, thousand tons	barley, thousand tons	corn, thousand tons	others, thousand tons
Offer of grain	72907	26398	8269	35154	3086
Production	68163	25096	7772	33089	2206
Transitional residues	4486	1288	467	2029	702
Imports	258	14	30	36	178
The need to use	68725	24898	7769	33654	2404
Internal consumption	20811	7398	3937	7582	1894
Export	47914	17500	3832	26072	510
Expected balances	4182	1500	500	1500	682

Source: summarized by the author based on data [15]

At the same time, researchers are now emphasizing the significant prospective opportunities of the agricultural sector of Ukraine for the cultivation of niche crops. Cultures that “are not characteristic of the agro-industrial complex of Ukraine and therefore are not grown much” are usually called niche crops [12]. Among such crops, according to T. Ilchenko [7], “there are often those that are in great demand on the markets of other countries and are expensive at the same time. Thanks to this, if the business is effectively organized, the production of niche crops will be characterized by increased profitability” [8].

At the same time, when a profitable niche crop becomes known in broad farming circles, it often ceases to be a niche crop and quickly loses its market appeal. In particular, we are talking about spelled. When the profitability of its cultivation was mentioned at the “Million from a Hectare” conference, the following year,

Ukrainian farmers were able to send so much spelled to the European market that its price immediately dropped three times. Therefore, niche crops should not be considered an agricultural Klondike today.

The question arises: which agricultural crops in Ukraine are now gradually leaving the niche category. We consider soybeans and rapeseed as such, which, thanks to their higher margins compared to, for example, traditional corn and sunflower, are grown today not only by small farmers, but also by large agricultural companies. Peas and lentils can also be included here – their crops are increasing every year. On the contrary, the areas sown under mustard are decreasing. The sorghum niche is also expanding rapidly. Experts predict an increase in the medium-term perspective of sorghum sowing areas from the current 40,000 hectares to 1.5 million hectares, and in particularly arid regions of Ukraine, sorghum may well replace corn [18].

Outlining the listed prospects for the cultivation of niche crops, we consider it necessary to highlight the current situation on the grain market and the conjuncture of niche crops.

Current situation on the cereal market

Thus, Ukraine is one of the top three countries in the world for exporting sunflower oil. In 2018, sunflower was grown on 23% of all sown land in Ukraine. Other oil crops occupied much smaller relative areas: soybeans – 8%, rape – 3%. Such an imbalance in favor of one oil crop is explained by the very high profitability of sunflower, which is 60-80%. In 2016, the export duty

on sunflower seeds was reduced to 10%, for example in 1999 the export duty was 23%. At that time, the purpose of the high duty on grain was to stimulate the domestic production of sunflower oil, not the export of raw materials. However, the decrease in the export duty caused an increase in the profitability of the sale of sunflower seeds, and as a result, an increase in the cultivation of sunflower on Ukrainian lands. Table 2 shows the dynamics of cultivated areas, production and yield of sunflower in 2016-2020. Within the framework of the study, it was considered appropriate to analyze the sunflower market, because this fragment has not been studied.

Table 2. Dynamics of sown areas, production and yield of sunflower in 2016-2020

Year	Sown areas, thousand ha	Production, thousand tons.	Yield, tons/ha
2016	6086.7	13629.9	22.4
2017	6033.7	12235.5	20.2
2018	6117.1	14165.2	23.0
2019	6514.8	13998.2	23.8
2020	6812.2	14452.2	24.3

Source: summarized by the author based on data [15;16;17;18;19]

So, as can be seen from the data in Table 2, sunflower production decreased in 2017, which can be explained by a decrease in the area allocated for sunflower sowing, but since 2017, sunflower production has increased by approximately 15% and in 2018

amounted to 14.2 million tons. In the following years, a similar trend was observed in sunflower cultivation.

Constantly growing demand for soybean products and soybean oil, increased exports forced Ukrainian producers to increase capacity for soybean production (Table 3).

Table 3. Dynamics of sown areas, production and productivity of soybeans in 2016-2020

Year	Sown areas, thousand ha	Production, thousand tons.	Yield, tons/ha
2016	1859.4	4277.0	23.0
2017	1999.8	3899.8	19.7
2018	1716.2	4460.8	25.8

Table 3, Continued

Year	Sown areas, thousand ha	Production, thousand tons.	Yield, tons/ha
2019	1889.2	4296.0	24.0
2020	2010.8	4836.2	26.4

Source: summarized by the author based on data [15;16;17;18;19]

Compared to 2016, soybean acreage decreased slightly by 8%, but soybean production increased by 4% due to increased yields and capacity expansion. Soybean production in Ukraine decreased in 2017, which was associated with a decrease in production due to weather conditions and a reduction in the export of this product due to competition in foreign markets. In 2018, soybean production increased by 14%, which was caused by an increase in the export of this product. Production increased due to the increase in production capacity. The drought in Argentina led to an increase in world prices and had a positive effect on the marginality of soybean processing in Ukraine. Over the past two years, soybean cultivation has increased due to the use of modern technologies.

Despite the fact that the main solution for increasing production in Ukraine is to increase the area

of sowing, the yield of soybeans has increased by 12% since 2016 and in 2020 amounted to 26.4 quintals from 1 hectare of land.

Historically, cereals (corn, wheat) and oil crops (sunflower) were most often grown in Ukraine. In recent years, the market price for this raw material has started to decrease, and the costs of cultivation and production are increasing. In search of higher earnings and reduction of cultivation costs, Ukrainian farmers began to grow leguminous crops, which are non-traditional for Ukrainian land.

The largest part of the sown areas is occupied by peas – about $\frac{3}{4}$, in second place – beans and already lentils, chickpeas, mung beans, lupins and others. In the Table 4 demonstrates the dynamics of the production of legumes in Ukraine in 2016-2020.

Table 4. Dynamics of sown areas, production and yield of legumes in 2016-2020

Year	Sown areas, thousand ha	Production, thousand tons.	Yield, tons/ha
2016	320.6	876.6	27.3
2017	506.3	12387.9	24.6
2018	565.4	9445.9	17.2
2019	598.6	14582.3	26.9
2020	602.3	14985.6	27.1

Source: summarized by the author based on data [15;16;17;18;19]

Despite the fact that the area of sowing and production of legumes has been constantly growing since 2016, this part of the market remains a niche for Ukraine. Demand on the international market for legumes significantly exceeds supply. Since 2016, the number of areas under leguminous crops has increased

by 76% and amounted to 565.4 thousand hectares. The area sown under peas has increased significantly. Since 2016, the area has increased by 73%, and in 2017 it amounted to 415.8 thousand hectares.

However, despite the constant growth of the area sown under legumes, production in 2018 compared

to 2016 increased by only 8%, and if compared with 2017, it fell by 29%. This dynamic occurred due to the low yield in 2018. According to the State Committee of Statistics, "...in 2016, leguminous crops entered the TOP-5 most profitable agricultural products. They provided manufacturers with more than 76% profitability. In 2017, the situation only improved. Ukraine took third place in the world in terms of pea production, and the total volume of leguminous production in Ukraine was 1.2 million tons, which is one and a half times more than in 2016. The dynamic development of the leguminous industry in Ukraine is also evidenced by the fact that another six years therefore, these crops were grown only in the south and center of the country, and in 2018, farmers from Polissia and other northern zones joined the cultivation of legumes" [1].

Since 2016, the yield has decreased by 37% and in 2018 it was 17.2 quintals from 1 hectare. There are many factors for the development and market entry of legumes, the main ones are the huge sales market, the popularization of a healthy lifestyle in the world, the transition of the majority from eating meat to soy products, the growth of the population in Muslim countries, where most people cannot afford purchase, such an expensive product as meat, and completely replace it with soy products, as well as, which is important in agrarian business, the ability of legumes to revive the fertility of the land.

According to modern researchers, "...leguminous crops are the only crops that can provide a continuous supply to the food market of deficient protein, which is similar to animal protein in its amino acid composition" [7]. But even such a replacement does not satisfy the needs of humanity. "Manufacturers, who are focused on intensive technologies, strive to create a larger quantity of the product, and hardly pay attention to quality indicators. Therefore, the study of the optimal combination of technological methods of crop cultivation, which will ensure the formation of a high yield and quality, is relevant and timely" [11].

The presence of a large amount of protein in the grain is the main value of leguminous crops. This, according to T. Ilchenko, "...shapes the value of the

product in terms of taste, technological and economic indicators" [7]. From the entire variety of legumes, promising and interesting for cultivation in Ukraine, according to the scientist, can be:

- "Peanuts – the oil of which is used in the confectionery, canning, oil and fat industry. Groundnut stalks and leaves are good fodder for cattle. The yield per hectare is from 1.1 to 2.3 t/ha of beans and 2.5-4.5 t/ha of hay. On irrigation – up to 4.2 t/ha of beans and 5.5 t/ha of hay.

- Cowpea – it is grown on an industrial scale in Mexico, Colombia, China, Japan and in relatively small quantities in the USA - as a vegetable, grain, fodder and cider plant.

- Astragalus – has a huge potential as a fodder, medicinal, honey and energy crop. Contains: 3.1% ash residues, 9% sugars, 18.6% dry matter. The average yield of above-ground mass of individual types of astragalus can reach 107 t/ha.

- Beans – which is the most cultivated representative of the legume family. Beans contain proteins (25-35%), carbohydrates, nitrogenous substances, flavonoids, sterols and organic acids, as well as vitamins B6, B5, B1, C.

- Galega (goat field) is both a fodder, medicinal, and honey crop. And another good option for improving soil fertility. Galega can leave behind in the soil from 400 to 600 kg of nitrogen per year" [7].

Ukraine owns a fourth part of all sunflower areas in the world, and grows a third part of the world crop. Over the past decade, the oil-fat complex of Ukraine has been characterized by steady growth in the production of vegetable oils.

"The influx of investments, according to V. Vlasuk [4], stimulates the expansion of production capacities, which strengthens the export capabilities of domestic manufacturers and contributes to strengthening their positions in global trade" [4]. In 2017, the capacity of the oilseeds market decreased by 13% due to high demand in foreign markets. In 2018, the increase in capacity is due to the increase in prices on the domestic market. The outlined trend was also observed in 2020 (Table 5).

Table 5. Market capacity of oilseeds and legumes in 2020, excluding soybeans and sunflowers, thousand tons

	Oil	Legumes	Soybeans	Sunflower
Production, thousand tons	21439.7	14985.6	4836.2	14452.2
Export, thousand tons	4783.9	9863.7	2456.1	61.2
Import, thousand tons	82.25	0.01	5.3	29.9
Market capacity, thousand tons	16738.2	14685.2	2489.1	14236.7

Source: summarized by the author based on data [15;16;17;18;19]

Sunflower occupies 84.5% of the entire Ukrainian market of oil crops. The remaining 3% was distributed between peanuts, linseed, rapeseed and other oil crops. The legume market in Ukraine is 81% represented by peas,

the share of other legume crops on the market is insignificant. Ukraine is one of the leaders in the world export of grain and oil crops. Most of the largest agricultural holdings in the country work with these crops (Table 6).

Table 6. Segmentation of crop market operators by crops (by production)

Name of Company	Crops				
	Grain	Technical	Beans	Vegetable	Oil
UkrLandFarming	+	+		+	+
Kernel	+				
Agroprosperis	+				
Myronivski khlebo product	+				
Astarte	+	+		+	
Mriya Agroholding	+	+		+	
Ukrprominvest-AGRO				+	
IMC	+		+	+	+
AGROTON	+				+
AgroGeneration	+				+
Agroholding 2012	+		+		+
Agress	+	+			+

Table 6, Continued

Name of Company	Crops				
	Grain	Technical	Beans	Vegetable	Oil
Harvest	+	+			
Tas Agro	+				+
Agrarian system technologies	+	+			
Nibulon	+				
Svarog West Group	+	+			+
Privat-AgroHolding	+	+		+	
Dawn	+	+	+	+	
UkrAgroCom and Hermes-Trading	+				+

Source: summarized by the author based on data [15; 16; 17; 18; 19]

Based on the segmentation by species, 19 of the top 20 companies in the crop market cover the grain crops segment, almost 50 percent of the companies cover the oil crops market. The least amount is in the field of leguminous crops, they are grown by only 3 agricultural holdings out of 20.

The largest amount of land owned by holdings included in the TOP 20 is located in Vinnytsia region, 10 out of 20 enterprises were located in this region, Zhytomyr and Kyiv regions, with 8 out of 20 agricultural holdings, are in second place in terms of the concentration of crop market operators. Cultivation of pulses is profitable for export-oriented enterprises, since the outlined crops have a large margin compared to crops of the oil family or cereals. A big jump in exports between 2016 and 2017 occurred as a result of the fact that in 2017 Ukraine began to export non-dried peas, until 2017 all peas were exported under the VED code – dried. Since 2017, the export of grain legumes has fallen by 15%, this trend is related to their low harvest in 2018.

In 2018, most legumes were exported to Spain and India – 81.36 thousand tons and 54.1 thousand tons, respectively. The export of other leguminous crops, except for peas, is very insignificant, so it can be

assumed that Ukraine exports only peas from legumes to the international market. The next most popular leguminous crop, beans, was exported in 2018 in the amount of 0.02 thousand tons.

Traditionally, Ukraine is one of the leading exporters in the sunflower market, primarily due to the appropriate climate and soil. The decrease in export duties to 10% had a positive effect on the dynamics of the export of oil crops. Sunflower seeds accounted for only 1% of the total export of oilseeds, as a large part of sunflower seeds is used to make sunflower oil. The largest amount of sunflower seeds was sent to Turkey and Italy. Turkey accounted for 41% of Ukraine's total export of sunflower seeds, followed by Italy with 17%. A small share of the export of oil crops was linseed and peanut, 0.14 and 0.02 thousand tons, respectively. In total, 12.9 thousand tons of flax seeds were exported from Ukraine, the most to Bangladesh and Poland, 1.6 and 1.4 thousand tons, respectively.

Among all oil crops, peanuts are grown in much smaller quantities, unlike other groups. Its exports amounted to only 23.1 tons, of which 23 tons were exported to Kazakhstan. In 2018, 2,440.6 thousand tons of rapeseed were exported from Ukraine, most of them to Germany and Belgium. Soybeans were exported the

most to Turkey (853 thousand tons) and to Belarus (355 thousand tons), which accounted for 38 and 20% of the total export of soybeans from Ukraine. In 2016-2020, the import of legumes in Ukraine increased by 33% and amounted to 0.01 thousand tons in 2020. Beans account for most imports from other countries. The import of oilseeds in Ukraine from other countries has decreased, and since 2016 it has increased by 21%, most of the oilseeds we import are peanuts, which are not a traditional crop for Ukrainian lands.

Among legumes, the most common imported crop is beans, its share is 86% of the total amount of imports of legumes, the second most popular is peas, its share is 14%, and a very small part of other, less popular, leguminous crops (lentils, chickpeas, mung bean) they were imported only 0.01 tons during 2020. Canada is one of the largest players in the market of legumes in the world and ranks first in the import of legumes to Ukraine. It accounts for 44% of all Ukrainian imports of legumes in 2020. In second place in the import of legumes to Ukraine is Kyrgyzstan, which accounts for 19% of the import of leguminous crops. Egypt, Turkey and Guatemala are also among the TOP-5 countries of bean importers.

CONCLUSIONS

Historically, Ukraine is a country in which crop production plays a major role in GDP. The main reasons

for this trend are a favorable climate and suitable soil. Ukraine is the leader in the export of grain and oil crops. The main trend of the crop market was price reduction in 2016-2018, the price of grain and oil crops fell by almost half. On the other hand, one of the trends of the Ukrainian market in 2019-2020 was the transition from traditional grain crops to legumes, which was influenced by several factors:

- high profitability of leguminous crops;
- demand for legumes on international markets (transition to healthy food, since legumes are a source of high-quality protein, and the cheapness of legumes compared to meat)
- having the ability to restore soil fertility, legumes have a positive effect on land cover.

Leguminous crops, which are not traditional for our country, are a niche industry for Ukrainian enterprises. Of all the various groups, Ukraine grows only peas and some beans. There is a huge potential for the development of this type of crops and access to the market with such rare and currently popular leguminous crops as chickpeas and lentils, mung bean. However, for Ukraine, the task of changing productivity indicators is a priority. While today, global agricultural holdings direct technical and human resources to the production of defined niche crops. Prospects for further research consist in forecasting the economic indicators of the export of niche crops for the next five years.

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Маркетингові дослідження кон'юнктури ринку зерна (нішевих культур)

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Анотація. У статті проаналізовано результати сучасних маркетингових досліджень кон'юнктури ринку зерна, зокрема нішевих культур в Україні. Встановлено, що ринок зерна володіє незаперечними перевагами порівняно з іншими формами організації економічних відносин. Окреслено перспективи вирощування нішевих культур та висвітлено існуючу ситуацію на ринку зернових та кон'юнктуру нішевих культур. Зроблено сегментацію операторів ринку рослинництва щодо виробництва нішевих культур

Ключові слова: зерно, нішеві культури, кон'юнктура, ринок, маркетинг, ціна, збут, перспективи збуту, інфраструктура

The impact of the development of digital technologies on consumer behavior

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Abstract. Digital space, in accordance with today's trends, has become an essential part of every individual's everyday life. Social media has emerged as an effective tool in promoting marketing strategies. In a digital ecosystem where companies must understand their users and consumers online, the fundamental basis of online business models must include strategies such as user experience, influencer marketing, user-generated content or digital word-of-mouth. The development of mechanisms for influencing the audience is based on the analysis of consumer behavior in the digital environment. After the application of innovative marketing technologies, the activity of consumers undergoes changes. The purpose of the work is research and analysis of methods of digital adaptation to market conditions and development of a system of techniques for improving digitalized service in all spheres of life. To achieve the goal, the method of system analysis, comparison and modeling was applied. It has been determined that over the past decades, digital technology and social media have led to an evolution of consumer behavior that correlates with the actions that users take through the digital channels in which they invest their time. Consumer behavior in the digital age, digital marketing strategies, digital business models such as mobile applications or the sharing economy are explored. Concepts of digital strategies are revealed: content marketing, user experience, influencer marketing, user-generated content, digital word-of-mouth. The practical value of the work is to clarify the elements that should be developed into a quality security model and improve data management at each stage of work

Keywords: digital economy, strategies, content, social sources, brand loyalty

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INTRODUCTION

The popularization and development of digital technologies, the use of the Internet, social networks, and mobile applications have become part of the everyday life of billions of people. For example, the current rate of Internet use among adults is around 87% and closer to 100% for demographic groups such as adults with higher education and higher income. Young people – the next generation of mass consumers – have the same high levels. In the UK, for example, the number of hours adults spend online has more than doubled over the past decade and now averages 20.5 hours per week [1; 2]. In Ukraine, this figure is 18.3 hours per week. Part of this growth is fueled by social media: worldwide, more than 2 billion people now use social media, with Facebook alone having about 1 billion daily active users.

Social media has been largely implemented as an effective mechanism that advances the marketing objectives and strategies of firms, especially in aspects related to customer engagement, customer relationship management and communications. Internet strategies have developed rapidly over the past decade. In response to modern challenges, users have adapted their behavior on the Internet. These changes have led to the development of new user habits and behaviors in a digital environment that is increasingly characterized by personalized strategies to attract new consumers. Therefore, research on consumer behavior should be aimed at studying and analyzing consumer behavior in the digital environment. The researches of L. Ziaran, K. Antonil, O. Lakatsi, O. Merlo, A. Yesingerich, L. Sandys are devoted to the processes of development of digital technologies.. The theoretical and methodological foundations of the formation of the interaction of the subjects of the consumer market in the conditions of the digital transformation of the economic systems of Ukraine are highlighted in the studies of O. Baranova, A. Dzyubinoi, K. Kopets, G. Dzyubinoi, N. Kraus, O. Sienkovych and others. It should be noted that most of the research is focused on digital consumer behavior issues. However, the impact of digital technologies on consumer behavior needs further research, especially given the ever-changing nature of social media and mobile environments in which consumers

of different companies are and interact. This article summarizes current facts and events regarding the development of the impact of digital technologies on interaction with consumers and organizations, based on research on consumer behavior and psychology.

The purpose of the article is to analyze, systematize, and justify the relevance of the processes of digital transformation of business entities, the impact of digital technologies on changing consumer behavior, and the formation of recommendations for business interaction with consumers in the field of digital technology development in all spheres of society.

Analysis of factors that determine the purchasing behavior of users in the digital segment

Data generated by users as a result of their activities on their social media profiles, websites, digital platforms or interactions with multimedia elements that belong to companies' digital marketing strategies create data points that contain important information about demographics, geographic data, interests or lifestyle habits of users. All this data must be analyzed by companies in order to properly segment advertising and propose digital segmentation strategies that can adapt to user behavior in this digital ecosystem [3].

Based on the analysis of such data and the behavior of Internet users, companies are increasingly trying to understand the factors that influence users' online decision-making. These factors can be determined by users' online exposure, feedback or opinions, personal experiences of close friends, and a host of other factors and interactions that can occur in digital environments such as social media.

Additionally, there is evidence that customer journeys are changing over time as customer behavior is increasingly influenced by digital advertising and the ease of shopping in a digital environment. The ease of use of e-commerce websites has changed dramatically over the past decade. In this context, it becomes imperative to know how these changes in user behavior should be adapted – both from the point of view of the users themselves, i.e. taking into account factors related to the privacy and processing of their data, and

from the point of view of companies that must adapt your digital strategies to capture and generate leads to retain customers online.

Accordingly, the role of factors such as user-generated content and digital word-of-mouth has been extensively explored in the literature. With regard to user-generated content, companies can use this type of content to understand the underlying concerns of users and to analyze their comments, opinions, attitudes or any other online activity. This type of content is publicly generated by users and is free of bias caused by companies.

Analyzing such content allows companies to better understand trends in user communities that focus on the company's products and services. By following this line of research, companies can identify user communities and find thought leaders within them who can become influencers (and thus help companies promote their products and services). Likewise, in recent years, digital word-of-mouth has become one of the main strategies for both attracting and retaining users. Users feel comfortable using social networks and their profiles on multimedia platforms to create videos, music or any other type of multimedia content.

In these ecosystems, users are influenced by increased followers or increased involvement in user communities. The opinions of other users – for example expressed through reviews and comments – also play a fundamental role in decision-making. From the point of view of companies, it is necessary to develop a strategy to create positive opinions about products and services on the Internet, so that users can determine a positive reputation for the company and its products on the Internet.

In this context, the study aimed to investigate the factors that influence user behavior in the digital age, with a particular emphasis on the main digital marketing techniques used to promote different types of content published by online users.

A study of consumer purchasing behavior in restaurants through social media analysis found that the restaurant industry and social media have seen an increase in the generation of digital data and publicly available information in recent years. Based on

the results, it can be argued that social media can influence consumers' pre-purchase behavior and online purchase decisions.

Focusing on the Ukrainian restaurant industry, particularly the food sector, the application of the digital word-of-mouth concept and its relationship to social media and online marketing communities was explored. In particular, it was interesting to determine whether greater access to information and an online ordering system could stimulate consumer purchasing behavior.

The author conducted a study using the PLS-SEM analysis methodology, 270 consumers of the restaurant sector were selected for data analysis during three months (September-November 2021), the research indicates that the application of the concept of digital word of mouth transmission, social media advertising and online ordering systems are central factors that determine the purchasing behavior of users. At the same time, it was found that the opinions of other Internet users do not have a significant impact on users' purchase decisions in the restaurant and leisure sector.

This data suggests that companies should focus on monitoring and managing the opinions and reviews that users make online about their products, taking into account the specific industry in which they operate. In other words, it is not enough to have a well-designed digital platform, the product or service itself must also provide touch points with the user.

So, although negative opinions and comments from users can significantly affect the strategy of online companies, a well-designed digital platform is not the key to increasing purchases, these actions do not affect the behavior of users before purchase, but influence the opinion of users about the process of purchasing a product.

A. Reyes-Menendez and others. [4] argue that to study user behavior online, companies should adapt their strategies to include mobile applications. Mobile applications, understood as a new channel of communication and sales, have forced many users and consumers to change their behavior in the digital ecosystem, as the mobile phone is a new means of purchase.

According to the research of the previously named author and his team, the differences between the answers to the questionnaire and the eye tracking analysis, when the respondents saw for themselves the stimuli and motivation presented in the questionnaire, were determined.

The results of this study demonstrate that it is possible to predict user responses simply by observing the items in the questionnaire. The results of this study can be used in mobile applications to improve both the design of such applications and the user experience.

Implications are presented, focusing on measuring the relevance that a biometric approach has for analyzing user behavior for the creation or design of future mobile applications. The results of this study highlight the importance of avoiding distractions in ecosystems where there is a lot of “noise” to implement marketing strategies when we are moving around using mobile phones, for example.

The results published by the authors A. Reyes-Menendez [4] & J. Saura [5] can help to improve aspects of navigation related to visualization and user concentration, as well as provide a deeper understanding of how users browse the Internet and how to change user behavior. The iconographic and visual elements identified in this study can inform companies' identity strategies and guide the design of their social media platforms and profiles.

The importance of new sharing economy platforms should also be considered and analyzed. These platforms are focused on understanding and influencing user behavior. There are various digital strategies to attract and retain users who like such platforms. In their study, Polanco-Diges & Debasa [6] analyze the strategies, methods and tactics implemented on sharing economy platforms and derive added value from the analysis of user-generated data.

The authors show that sharing economy platforms influence online user behavior and explain how digital platforms link the supply and demand of internet users. Likewise, these types of platforms offer transactions related to the purchase and rental of real estate, as well as collaborative ways to build relationships online. Using such platforms, brands can create

experiences to create consumer trust and an emotional connection between users and companies.

In an effort to understand how users develop their behavior and actions online, Polanco-Diges & Debasa [6] review a total of 13 relevant articles on the collaborative economy and digital marketing. Based on the results of the review, eight digital marketing strategies were identified, namely:

- user experience;
- marketing in search engines;
- SEO (search optimization);
- SMM (marketing in social networks);
- Freemium strategies;
- content marketing;
- CRM (Customer Relationship Management) or influence marketing.

The authors also identify and analyze 12 key factors needed to understand user behavior on sharing economy platforms.

In addition, using an exploratory approach, Muniesa & Giménez [7] investigate digital marketing strategies in the fashion industry and measure their effectiveness. This study also analyzes how fashion brands use digital media and social media to retain their consumers.

The authors point out that companies should create quality content to identify and analyze specific audiences. Millennials are the most active generation in fashion, so fashion brands must use digital media and social media to retain their consumers. An effective digital strategy often used in the fashion industry is influencer marketing.

Through influencers in the fashion sector, brands try to change the way users think about their products and services. Through the content that influencers share through digital channels, brands build trust among consumers.

In their study, Muniesa & Giménez [7] reviewed a total of 11 articles on digital marketing in the fashion industry focusing on user behavior online. The authors explore different options for developing digital marketing strategies that focus on user loyalty, investing in influencers and other digital strategies to increase engagement.

Based on the results of the study, Muniesa & Giménez [7] argue that one of the ways to effectively convey a message from a brand to its customers is through creativity. Creativity increases brand awareness, so communication should be spontaneous and through appropriate channels.

According to Muniesa & Giménez [7], the most frequently used tools in the fashion sector to retain users and influence their online behavior are SEO and SEM, as well as channels such as Instagram, Facebook and Twitter. The authors also highlight the importance of information systems such as CRM to manage customer data, the use of QR codes to convey to users the channels through which companies develop their strategies, and the analysis of big data to understand how users create content.

In recent years, the topic of how the social media environment affects consumer behavior is still relevant. We can observe how different informational and social characteristics of the social environment, such as the influence of other consumers' opinions or choices (such as bidding on online auctions), or even the lives of friends through social networks, can influence subsequent behavior.

Scientists have investigated how people respond to how Facebook use affects their self-control. They found that when in contact with their closest friends on Facebook, consumers subsequently demonstrated lower levels of self-control when choosing, for example, a healthy lifestyle (choosing a healthier food instead of an unhealthy option) [1; 2; 6].

However, this was only for people who knew their closest friends on Facebook. Consumer behavior in mobile settings is becoming increasingly important as consumers use mobile devices more often. This is especially interesting in the context of shopping. Researchers have analyzed how consumers respond to mobile offers in brick-and-mortar stores, finding that mobile coupons can influence consumer journeys. In an online store, consumers focus on shopping on mobile devices (such as tablets) and, in particular, how touching products (rather than clicking on them) can increase their sense of belonging. This is an interesting

research topic because the study of how consumers physically interact with mobile devices and how this affects decision-making is poorly defined.

Social media can strategically improve two-way communication between firms and customers and, consequently, connect more customers to organizations. This fact becomes another possibility to what can already be done through social media business, namely social media represents content that is published visually, verbally or textually, or using a combination of text, visual and verbal content. In various contexts, firms have looked forward to using social media in many aspects of their customer interactions, such as facilitating information retrieval, interactivity, promotion, and improving customer purchasing behavior.

People are showing themselves more and more in social networks. This is done for many purposes, including their role as consumers as they search for information about products, buy and consume them, and communicate with others about their experiences. Marketers have responded to these fundamental shifts by increasing their use of digital marketing channels. In fact, in 2019, about a third of global ad spending was on digital channels. Thus, consumer marketing is beginning to focus on the digital environment, especially on social media and mobile devices.

Consumers rely on information from social sources. Image language in online surveys positively influenced consumer attitudes and hedonic product choices. T. Kumar et al. [8] reviewed explanatory language in online surveys, finding that what consumers attribute to actions or responses influenced perceived usefulness. Consequently, businesses with small resources and personnel must develop quickly, implement new marketing channels and skills, and be innovative in order to continue to function effectively. T. Kumar [8] investigated that the use of softening vocabulary in expressing negative thoughts increases the trust and attractiveness of the consumer.

J. Saura [5] considered two types of neutral language, mixed (positive and negative) and indifferent, showing that neutral language enhances the direct effect of positive and negative affect on purchase when mixed.

Development and rapid growth of the social network market

Another important topic that has recently begun to be researched is the difference between online and offline so-called “word of mouth” [4]. Online word of mouth is determined by the social and functional characteristics of a brand, while offline is determined by

the emotional characteristics of a brand based on a large set of brand data.

The number of users of social networks is growing every day. Compared to 2016, the number of Internet users worldwide increased by more than 1.5 billion, or 52% in five years. (Fig. 1).

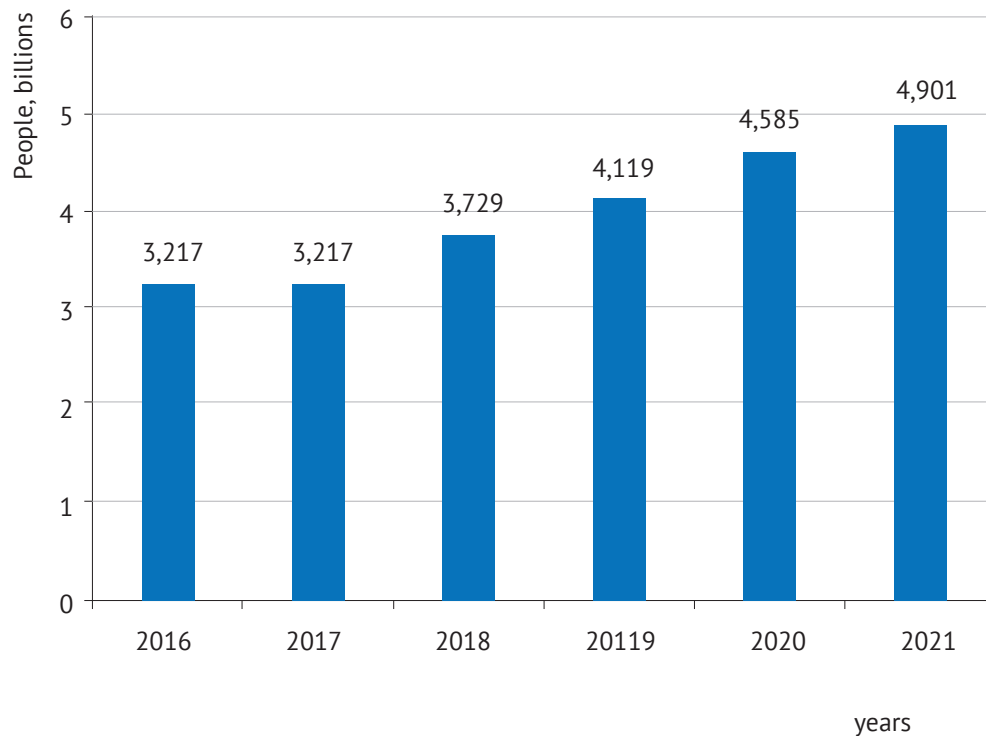


Figure 1. Growth dynamics of the Internet audience from 2016 to 2021

Source: built by the author based on data [9]

According to the International Telecommunication Union, it took 16 years to reach the first billion Internet users. The second billion joined the network in just 6 years. Today, the Internet is growing at a rate of 1 billion new users in 2.7 years. The dynamics of the growth of the audience of social networks over

the past 5 years is even more impressive than the data on the use of the Internet for the same period – since 2016, the total number of users of social networks in the world has almost doubled. The indicator for 2021 is 4.62 billion users of social networks – 2 billion more than in January 2016 (Fig. 2).

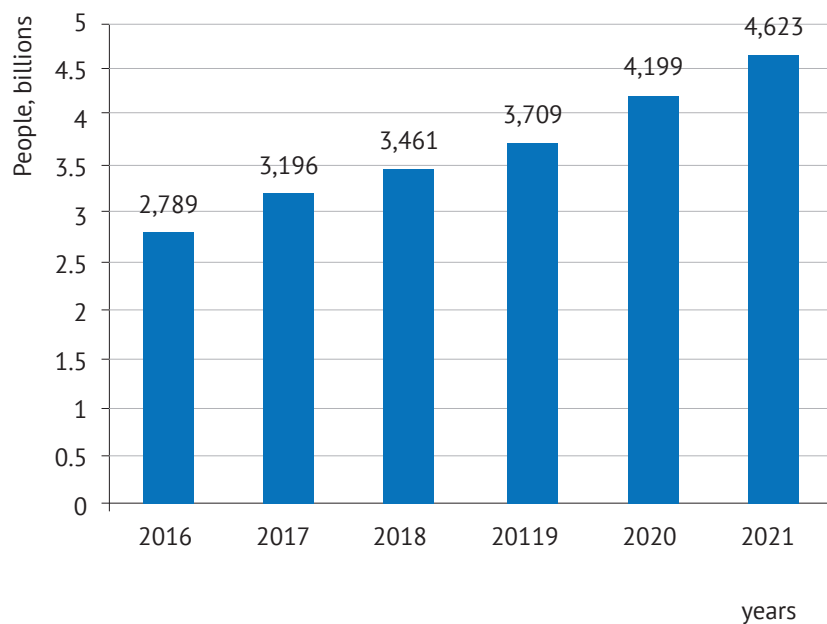


Figure 2. Growth dynamics of social networks from 2016 to 2021.

Source: built by the author based on data [10]

This year, the amount of time people spend on social media has increased again, albeit slightly. The Digital 2022 Global Overview Report reports that today the average user (globally) spends 2 hours and 16 minutes on social platforms every day, up from 2 hours and 15 minutes in 2018. That's about a third of all internet time and a seventh of total waking time. It is worth noting that the amount of time spent on social networks varies significantly between cultures – in Japan, for example, Internet users spend only 36 minutes a day on social networks. On the other side of the spectrum are Filipinos, who (like last year) are the most active on social media platforms. This year, the average for the Philippines is 4 hours 12 minutes, up 15 minutes per day (6%) from last year.

The global social networking market is valued at USD 192.950 billion in 2019 and is projected to grow at a CAGR of 25.38% to reach a market size of USD 939.679 billion by 2026.

The market for social media platforms is growing exponentially. The increase in demand is not only from millennials, but also due to significant adoption by all age groups. In addition, the use of social media platforms has grown significantly due to demand from

companies that also use the platforms for marketing purposes. In June 2020 alone, one app in the Apple App Store (LINE) generated \$6.78 million in global app revenue. The main factors expected to drive the growth of social media are increasingly recognized as a platform that helps drive search keywords to company websites, resulting in increased website traffic and brand popularity/exposure. The proliferation of smartphones is also playing an important role in the growth of the market. Social media apps designed for smartphones regularly track activity and make social media marketing even more relevant.

In addition, the exponential rate of data generated from social media platforms has led companies to make marketing and customer-related decisions based on customer data. The analytics performed with the help of these online platforms are considered to be an important business and marketing tool in today's business scenario. To gain real-world insights into consumer perceptions and improve their services and product portfolios, companies around the world are using social media analytics. Rising popularity of social media platforms by various end users for multiple purposes is expected to drive the market over the next 5 years.

For example, according to Facebook, it had 1,562 million daily active users as of the first quarter of 2019. Twitter claims that 500 million tweets are sent every day and that 9% more people are using Twitter every day, resuming the growth of social media penetration globally.

It should be determined that the increase in available electronic devices connected to the Internet, smartphones, phones and tablets, leads to an increase in the time spent on websites and social networks.

The emergence of COVID-19 has had a diverse impact on the global social media market. The market was heavily impacted during the first few months as businesses were disrupted by the lockdowns imposed by governments around the world. Measures taken by national governments to contain the spread of the infection have led to a decrease in economic activity and restrictions on the movement of goods and services with countries that are in a state of quarantine. Although e-commerce businesses operating only through social media platforms were negatively affected, the overall use of such platforms increased significantly during this period. According to the Digital 2022 Global Overview Report, 43% of consumers spent more time on these platforms, 54% watched more shows and movies on streaming services [10]. It should be noted that the many new digital behaviors that people have adopted during the quarantine restrictions have led to a significant increase in a variety of digital activities.

The growth of the market for social media platforms is helping to increase the number of e-commerce platforms that use these platforms for various purposes. Average revenue per user - ARPU (Average Revenue per User) is one of the most important indicators for large social media companies such as Facebook, Instagram, Twitter and TikTok. ARPU is how much revenue a company makes per user and is an important measure of how successful a business is, especially when it comes to leading social media sites.

In Tab. 1 presents the average revenue per user of the world's largest social networking platforms.

Analyzing the information, we can say that, firstly, such an amount of investment indicates that these are not fleeting investments, and secondly, many people want to promote their product or service on a social network that they like, this is confirmed by psycho-emotional communication in tongue. The purpose of advertising is to win the market through brand loyalty. Consequently, companies around the world are increasingly investing in social media marketing to achieve business goals. Also, if the company wants to enter completely different markets, for example, Spain, it can advertise in the country's popular social network, thereby effectively presenting its products to the target audience. If the goal of the business is to attract as many customers as possible, a presence on social networks is necessary. Social media marketing is the most economical way to advertise any product.

Table 1. Average revenue per user and number of users of the top 10 largest social networks in the world in 2021

Nº n/n	Name of the social network platform	Average revenue per user, USD USA	Number of social network users, billion people
1	TikTok	46.86	0.732
2	Facebook	30.75	2.8
3	Linkedin	25.97	0.310
4	Twitter	9.39	0.396
5	YouTube	8.64	2.3
6	Instagram	5.28	1.3

Table 1, Continued

Nº n/n	Name of the social network platform	Average revenue per user, USD USA	Number of social network users, billion people
7	Pinterest	3.69	0.459
8	WhatsApp	2.75	2
9	Snapchat	1.73	0.528
10	Reddit	0.49	0.430

Source: built by the author based on data [10]

CONCLUSIONS

The article provides an in-depth overview of user behavior in the digital age. Through the use of different methodologies, the contributions to this topic aim to understand how users behave online. It is important to point out that online user behavior is related to the actions users take through the digital channels in which they invest their time. The results of the research in this article show that the actions of online users depend on the field of operation. Pre-purchase and post-purchase user behavior, as well as user engagement and user interaction in online communities, are important factors to understand in this ecosystem.

Social media advertising, while not without its drawbacks, is an effective way to build brand loyalty in the digital economy, especially since it allows businesses to interact directly with potential customers on a regular basis. The demand in social networks is significantly expanding due to the information field of people and enterprises, the costs of searching, exchanging and storing information are reduced, the role of information as a resource in the economic management system is strengthened, which helps the enterprise to reach a larger number of consumers, increase

the amount of income and increase competitiveness. The use of marketing technologies allows for the promotion and realization of joint resources of enterprises, including goods and services, and to choose effective methods of promotion of each product separately. It also contributes to increasing the efficiency of their activities. Using social media in marketing builds brand loyalty directly and on a regular basis to interact with potential customers in the digital economy, so many companies understand the importance and necessity of using social media in marketing.

Data management and protection are the main issues that companies need to adequately address so that users feel safe when browsing digital platforms.

Future research will need to analyze how users make decisions online, as well as which digital marketing methods are perceived as safer by users.

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Вплив розвитку цифрових технологій на поведінку споживачів

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Анотація. Визначено, що за останні десятиліття цифрові технології та соціальні медіа призвели до еволюції поведінки споживачів. Досліджено поведінку споживачів у цифрову епоху, стратегії цифрового маркетингу, цифрові бізнес-моделі, такі як мобільні додатки або спільна економіка. Розкрито поняття цифрових стратегій: контент-маркетинг, користувацький досвід, маркетинг впливових осіб, контент, створений користувачами, цифрова передача «з вуст в уста»

Ключові слова: поведінка споживачів, цифрова економіка, цифрові технології, стратегії

Weed control and sunflower productivity in the southern steppe of Ukraine

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Abstract. The results of research on the growth and development of sunflower plants in the period of formation of its productivity in the southern steppe of Ukraine, depending on the methods of basic tillage and the degree of weeding agrophytocenosis. The effectiveness of chemical weeding with the herbicide Euro-Lightning® Plus crops of sunflower, the plants of which were grown against the background of deep (28-30 cm) shelfless tillage, has been proven

Keywords: sunflower, weediness, methods of basic tillage, weather conditions, productivity

INTRODUCTION

It is well known that sunflower (*Helianthus annuus* L.) is one of the main technical oilseeds in Ukraine. It is able to provide the population with important food-stuffs, the livestock industry with highly nutritious fodder, in particular cake and the processing industry with raw materials. In our country, the share of sunflower oil is 98% of total production of this product. Currently, *Helianthus annuus* L. remains highly liquid, the most profitable crop in the agricultural sector [1, 2, 3].

According to Oleksandr Maslak [4], the high price of sunflower seeds and an attractive level of profitability (up to 90%) will encourage farmers to grow this oilseed crop.

At the same time, according to the State Statistics Service of Ukraine on the main economic results of agricultural enterprises in agriculture, the level of profitability of sunflower seeds in 1990 was 236.5%, but in 2020 it has decreased significantly and did not exceed 39.4% [5].

According to scientists [6], in the steppe of Ukraine, the part of sunflower in the structure of crop rotation should not exceed 20%.

Currently, the area under sunflowers is growing every year. Thus, according to the State Statistics Service of Ukraine, it was covered on an area of 6457.2 thousand hectares in 2020 in Ukraine. Gross collection

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was concentrated at 13,110.4 thousand tons. 2.02 tons of seeds were obtained from 1 hectare of harvested area.

During the period from 2000 to 2020, the sown area of this oilseed crop in the Mykolaiv region increased from 235.1 thousand hectares to 513.0 thousand hectares, i.e. 2.2 times and their portion in the total sown area in 2020 (1564.8 thousand hectares) reached to 32.8%, which, of course, negatively affects soil fertility. During the study period (2000-2020) in the Kherson region there was an increase in the area under sunflower from 177.6 to 335.3 thousand hectares, i.e. 1.9 times. Farms in the Odessa region are characterized by a slightly smaller increase in the area of this highly liquid oilseed plant. Areas under sunflower in this southern region have increased over the past 21 years from 265.8 to 356.6 thousand hectares, i.e. by 34.2% [7].

At the same time, it should be noted that the yield of sunflower in the South of Ukraine is quite low. Thus, in Mykolaiv region in 2000 1.07 t/ha were harvested, in 2010 – 1.48 t/ha, in 2020 – 1.35 t/ha seeds [8].

Therefore, the increase in gross seed yield is achieved by increasing the sown area, i.e. in an extensive way. As a result, crop rotations are disturbed.

At the same time, hybrids have appeared on the seed market that can provide much higher yields. There is a need to improve the technology of their cultivation, in particular to control the level of weediness of crops.

Under the conditions of the energy crisis, as a result because of the high level of fuel costs, it is necessary to explore different methods of basic tillage and their impact on crop litter and sunflower productivity and determine a more efficient resource-saving measure of autumn tillage.

Analysis of recent research and publications

A number of scientific works have been devoted to the ways to reduce weed infestation in the formation of the productivity of sunflower agrophytocenoses.

I. Tkalic and others [6] consider the basic tillage for sunflower to be one of the most important factors in increasing the productivity of this oilseed crop. This is due to the fact that it preserves the reserves

of productive moisture, improves the microbiological condition of the soil and controls the level of weeds, which is essential part in modern technologies for the production of sunflower seeds.

According to M. Popova, V. Balduiev, O. Borisyuk [9], *Orobanche cumana* Wallr. causes significant damage to sunflower plants, because its seeds can be stored in the arable soil layer for a long time. According to the results of many years of research by scientists of the Mykolaiv State Agricultural Research Station (now the State Institution “Mykolaiv State Agricultural Research Station of the Institute of Irrigated Agriculture NAAS of Ukraine”), shows that the return of sunflower to the previous place in crop rotation after 10, 6 and 4 years 2, 12 and 38 pieces/m², respectively, and the yield of sunflower seeds of 2.01; 1.33 and 1.11 t/ha, respectively, i.e. the more insects there is, the lower the crop productivity.

In the eastern part of the Forest-Steppe of Ukraine, sunflower agrophytocenoses, located in a 9-field steam-grain-row crop rotation after spring grain crops, were weeded by 42 species of weeds and contaminants, including blue mice, common mouse, white quince, common squirrel, black nightshade, garden purslane, ragweed, bitter mustard, pink thistle, birch. The largest number of weeds and pests in sunflower crops were counted on the background without fertilizers for plowing and in areas of organicmineral intensive background (manure aftereffect, 30 t/ha + N30P30K30, chiseling). Due to the application of the herbicide system, the dominance and subdominance of some species of undesirable plants have changed significantly over the years of research. Scientists [10] claim that in the abovementioned zone the better way of basic tillage under sunflower should be plowing, against the background of which the weediness of crops under study was reduced compared to free tillage (chiseling).

Common weeds include ragweed. According to K. Saenko [11], for the formation of 1 ton of dry matter, this plant removes from the soil 15.5 kg of nitrogen, 1.5 kg of phosphorus, in addition, consumes about 950 tons of water. Fields littered with ragweed deteriorate the quality of field work, in particular during shelf

tillage and harvesting. To limit the harmfulness of ragweed, you can use more than 50 herbicides, for which one it is very sensitive.

According to N.V. Markova [12], herbicides reduce the degree of weeding of crops *Helianthus annuus* L., and in combination with agronomic measures have a positive effect on the preservation of productive moisture in the soil. In the research areas where herbicides were used, the moisture was actually used by sunflower plants. Weed-protected crops produced higher yields.

O.O. Onishchenko [13] reports that according to the scientists from the Institute of Oilseeds of NAAS of Ukraine (D.I. Nikitchina, A.I. Polyakova, I.V. Aksonov), biometric indicators, as well as the highest seed yield at the level 3.45 t/ha was obtained for plowing to a depth of 20-22 cm, and for tillage to the same depth – 0.24 t/ha less. However, according to its three-year data, the yield of sunflower seeds during deep loosening of the soil increased by 5.0 c/ha compared to plowing. The methods of tillage they studied in the experiment on the southern black soils had different effects on the reserve of productive moisture in the root-containing layer of the soil. They found that this indicator during sowing of sunflower against the background of plowing was lower by 8% compared to deep loosening of the soil. Due to the improvement of soil moisture supply of the experimental plot, sunflower seedlings appeared 2 days earlier, compared to plowing. This pattern was observed throughout the growing season of cultivated plants.

In the experiments of M. Berezhnyak, E. Berezhnyak [14] determined that flat-cut (shelfless) and chisel tillage had a positive effect on the agro-physical parameters of black soils with different particle size distribution. Due to the use of these methods of basic tillage, the yield of corn grain was slightly increased compared to the use of traditional plowing.

A. Melnyk and S. Govorun [15] found that the highest level of yielding on black soils of typical low-humus, in the north-eastern leftbank Forest-Steppe of Ukraine, is formed by sunflower (3.14 t/ha) after steaming. The minimum yield was obtained after corn for silage (2.46 t/ha).

Studies by A. Babenko [16], conducted in the

right-bank Forest-Steppe of Ukraine, found that weeds significantly constrain the increase in sunflower productivity. She claims that weed vegetation remains the most potential factor in the deterioration of growth and development of crops, because in its crops there are 40 to 80 species of weeds, of which 8-16 are the most harmful and dangerous, especially in the first 60 days after appearance of sunflower seedlings. It is proved that the decrease in its yield ranges from 11% if weeds litter the crops within 20 days after germination, to 41% if unwanted plants grew in crops 60 days after germination, i.e. + the shorter the period of weeds in sunflower crops, the higher its seed yield and the better – the quality of oil.

A. Ostapko [17] also insists that the main reason for the decrease in sunflower yield is the increase in weediness of its crops.

The aim of the study was to determine the impact of the methods of basic tillage and herbicide Euro-Lightning® Plus on crop weeds and the formation of productivity of Pioneer P64LP130 (P64LP130) sunflower hybrid in the south of Ukraine.

MATERIALS AND METHODS

Studies to determine the productivity of sunflower, to identify the most effective method of basic tillage in non-irrigated agrophytocenoses of arid conditions, were conducted in southern Ukraine (a branch of the Mykolaiv National Agrarian University). The relief of the soil under the experiment was flat. Soil – southern black soils are residual weakly saline, heavy loam on the carbonate scaffold. The content of humus according to Turin (in a layer of 0-30 cm) – 2.9%. The reaction of the soil solution is close to neutral: the pH of the salt extract is 6.6-6.8. 100 g of soil contains an average of 1.2 mg of nitrates, 8.5 mg of mobile phosphorus and 18 mg of exchangeable potassium.

The density of the soil layer 0-60 cm is 1.25 g/cm³, HB – 23.5%, wilting humidity – 11.4%. Groundwater lies deeper than 20 m and does not affect the process of soil formation. An average of 400 mm of precipitation falls per year, and the hydrothermal coefficient is 0.7-0.8. The average height of snow cover is 6-8 cm, and the average reserves of productive moisture in the soil

layer 0-100 cm in spring are 130 mm. Pioneer P64LP130 sunflower hybrid was used in the experiments. First (in 2019) they set up a production experiment in which, against the background of plowing, chemical weeding of crops with the herbicide Euro-Lightning® Plus was carried out. The uncultivated part of the area (0.2 ha) in 2 repetitions was taken for controlling. During 2020-2021, a field experiment was established, adding to the scheme, in addition to plowing, two other methods of shelfless basic tillage: deep and shallow.

The sown area of the plot was 100 m², the accounted area was 50 m². It was Repeated three times. Predecessor is winter wheat.

Sunflowers were sown in 2020 in the third decade of April, and in 2021 – in the first decade of May in a wide row (70 cm). Pre-emergence and post-emergence harrowing and row spacing have also been used to improve phytosanitary conditions, including the destruction of weeds in the white thread phase, also used pre-emergence and post-emergence harrowing and loosening between rows.

In general, the technology of sunflower seed production was generally accepted for the zone, except for the studied factors. According to the scheme of the experiment, plowing was carried out to a depth of 28-30 cm with a plow PLN-435 with plowshares, tillage to a depth of 28-30 cm – cultivator-flat cutter-deep cultivator KPG2-150, and shallow tillage to a depth of 12-14 cm – KPE-3.8.

Spraying of plants was carried out once in the morning until 11 o'clock at an air temperature of 19-20°C in calm, windless weather. Herbicide Euro-Lightning® Plus was applied with a knapsack sprayer according to the manufacturer's recommendations (consumption rate for sunflower – 2.0 l/ha). Its active ingredients are as follows: imazamox (16.5 g/l) + imazapyr (7.5 g/l). The chemical group of DR is imidazolinones. Formulation – in the form of soluble concentrate (RC).

Weather conditions during the sunflower growing season in 2020 were drier than in 2021.

Weed counts of crops of the studied crop were performed quantitatively (30 days after sunflower sowing) and quantitatively by weight before harvesting according to generally accepted methods [18].

They set up experiments and conducted observations and records taking into account generally accepted methods in crop production [19, 20].

Processing of the received information and results of the research was carried out by means of software packages: Microsoft Excel, Agrostat New [21]. Presenting main material. Weather conditions are one of the decisive factors in the formation of productivity of both cultivated plants and the weed component of the agrophytocenosis. During May-September 2020, 181 mm of precipitation and rain fall, which is 78 mm less than norm. At the same time, during this period in 2021, 266 mm of precipitation fell, i.e. crops were moistened almost at the level of the average long-term, more precisely 8 mm more than norm.

It was found that under drier conditions in 2020 the water consumption coefficient of sunflower increased, especially when growing on the background of shallow shelf-free basic tillage and herbicide-free technology (1506 m³/t) compared to 2021 (1096 m³/t). The consumption of moisture by crops for the formation of the unit of yield (in our case per 1 ton of sunflower seeds with the appropriate amount of accumulated aboveground biomass) is reduced by applying the herbicide, in particular Euro-Lighting® Plus. This is due to the decrease in the crops of the studied crop of competitive plants, weeds. On average, in two years of determining the coefficient of water consumption of sunflower, the highest index was for its cultivation against the background of shallow shelf-free basic tillage and herbicidefree technology – 1301 m³/t. During chemical weeding of crops, moisture is used more sparingly for the formation of sunflower seeds, especially against the background of deep shelfless main tillage – 836 m³/t (Fig. 1).

It should be noted that due to the reduction of weeds in the crop, the coefficient of water consumption for sunflower seed production on the background of shallow shelf-free basic tillage decreased by 407 m³/t, i.e. 1.5 times, and on the background of plowing slightly less – 1.4 times, because with the shelf tillage of undesirable for sunflower concurrent plants came down less.

Weeds inhibit the linear growth of sunflower plants in height.

On average, during two years of research, the free, basic tillage and herbicide-free technology, height of plants was 139 cm for growing while for

plowing to a depth of 28-30 cm this sunflower on the background of shallow tillage-indicator increased by 6 cm (Fig. 2).

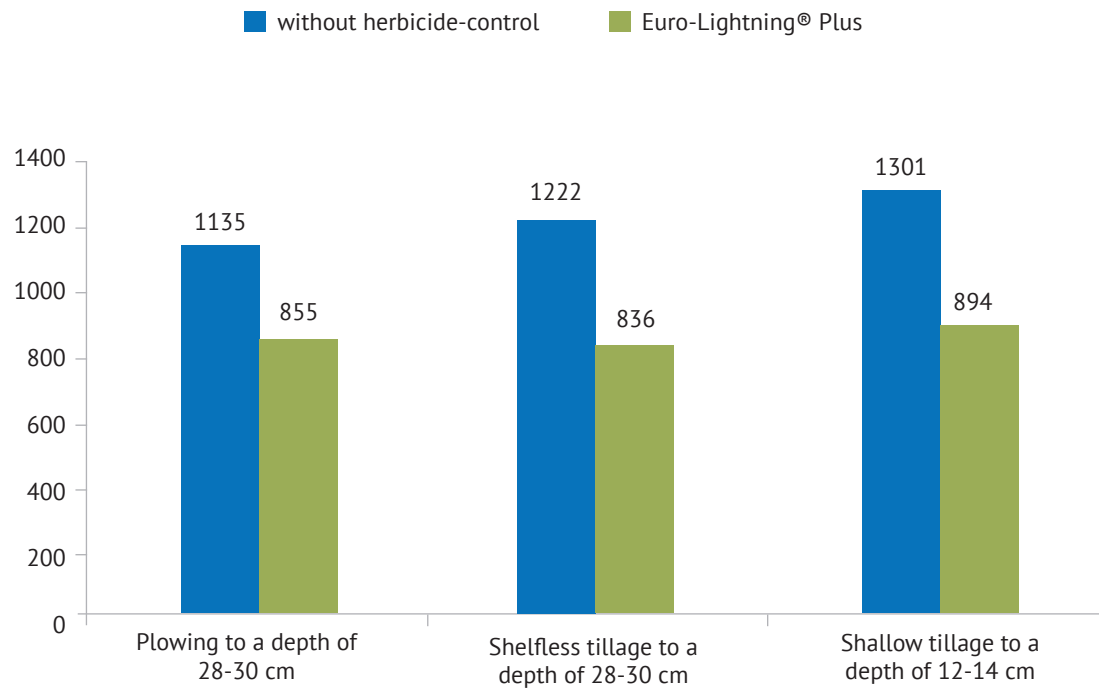


Figure 1. The coefficient of water consumption of sunflower depending on the methods basic tillage and herbicide Euro-lightning® Plus (average for 2020-2021), m³/t

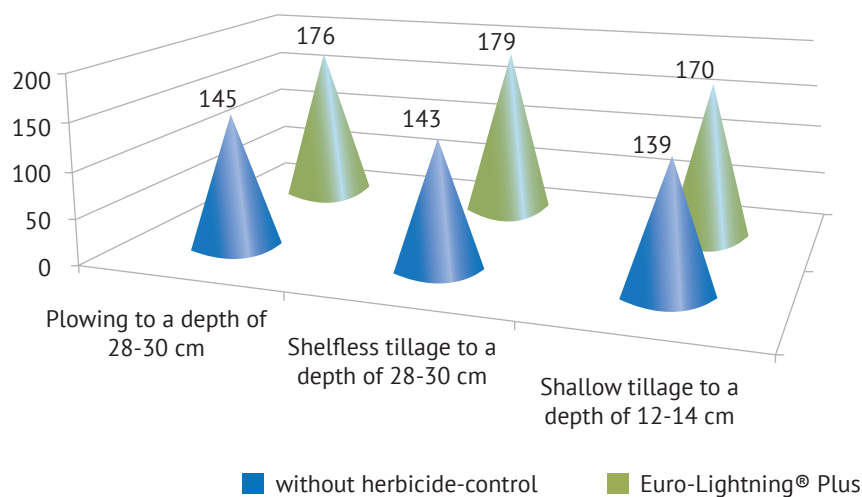


Figure 2. The height of sunflower plants, depending on the main methods tillage and herbicide Euro-lightning® Plus (average for 2020-2021), cm

The highest sunflower plants were noted in the areas practically free of weeds, with chemical weeding of crops against the background of deep (28-30 cm) shelfless main tillage – 179 cm.

Weather conditions also significantly affect this indicator. Thus, under drier conditions during the growing season in 2020, the height of plants ranged from 123-130 cm (in areas not protected from weeds by herbicides) to 146-151 cm – in the options of chemical weeding. The amplitude of fluctuations in the height of the plants of the studied culture in 2021 was characterized by values from 155-159 cm to 170-179 cm, respectively.

An identical conclusion was made by D. Bozhko [22], for research at the Central Ukrainian National Technical University. It was found that with the application of soil herbicides, the height of plants was higher against the control variant. For example, in the phase of basket formation the height of control plants was 103.5 cm, and in the variants with the use of herbicides it was higher by 3.0-7.5 cm. Almost the same pattern was observed in the phase of full maturity (increase 3.0-6.5 cm), which was due to better conditions for growth and development of crop plants in weedprotected agrophytocenoses. The author states that the basic mass of weeds consume significantly more nutrients than cultivated plants, and therefore crop losses due to weed infestation can be significant.

We found that weeds in the initial period of growth in sunflower crops were represented by 64% of annual plants. The main ones were late spring (about 49%). Perennial weeds, primarily root weeds, played a smaller share in the structure of the weed phytocenosis.

During the years of research, the fields intended for sunflower sowing were practically littered with weeds of dicotyledonous species. Among the juveniles, *Amaranthus retroflexus* L., *Chenopodium album* L., *Sinapis arvensis* L., and *Matricaria perforata* Merat were found. The largest was in the crops of ragweed (*Ambrosia artemisiifolia* L.). This weed is a quarantine. Perennial mallards were mainly represented by field birch (*Convolvulus arvensis* L.) and field thistle (*Cirsium arvensis* L.). Yellow thistle (*Sonchus arvensis* L.) was

also found. Of the cereal species, a small proportion in the structure of undesirable plants belonged to the creeping wheatgrass (*Elytrigia repens* L.) – a weed from the group of perennials: *crus-galli* L.

It has been established that, on average over two years, the weeding of sunflower crops by the herbicide Euro-Lightning® Plus is more effective in controlling weeds in all the studied methods of basic tillage.

A much larger number of weeds littered the sunflower agrophytocenosis with leafless loosening both to a depth of 12-14 cm (189 pieces/m²) and to a depth of 28-30 cm (186 pieces/m²), while during plowing this figure was 13-16 pieces/m² (7.0-8.5%) less and amounted to 173 pieces/m² (Table 1).

When counting 30 days after germination, there were only 14 units/m² of undesirable plants in the crops for plowing in areas treated with the herbicide Euro-Lightning® Plus. Against the background of shelfless cultivation to a depth of 28-30 cm and the application of herbicides, the number of weeds has become even smaller – 12 pieces/m². The percentage reduction in the number of weeds in the above methods of tillage under the action of herbicides was 91.9 and 93.5%, respectively.

The number of weeds in the period of harvesting sunflower seeds by herbicide-free technology, on average on all backgrounds of tillage, was 144 pieces/m². Due to the spraying of crops with the herbicide Euro-Lightning® Plus, this indicator decreased by 89.6%.

No significant toxic effect on the plants of the studied crop was detected, although initially there was a slight suppression of sunflower, which lasted several days. Slightly less toxicity of the drug was observed in cereals.

A.I. Babenko [16] claims that in agriculture, vegetable growing, horticulture due to weeds does not get 25-30% of the crop, and in many cases the loss reaches 50% or more. She suggests that weed damage to sunflowers should be considered from two perspectives: the effect on sunflower yields than weeds. There is an inverse linear dependence between crop weeds and crop seed yields, which increases as weeds increase, especially the weight of unwanted plants.

Table 1. Weediness of sunflower crops depending on the methods of basic tillage and herbicide EuroLightning® Plus (average for 2020-2021)

Indications	Plowing to depth 28-30 cm		Policeless tillage to depth 28-30 cm		Shallow shelf-free tillage to a depth of 12-14 cm	
	without herbicide - control	EuroLightning® Plus	without herbicide - control	EuroLightning® Plus	without herbicide - control	EuroLightning® Plus
Number of weeds 30 days after germination, pcs/m ²	173	14	186	12	189	15
Number of weeds in seed collection period, pcs/m ²	136	15	145	14	151	17
Weed reduction, % to control	0	89.0	0	90.3	0	88.8
Dry mass of weeds during the period of seed collection, g/m	449	62	469	59	487	63
Biological efficiency,%	0	86.2	0	87.4	0	87.1

It is worth noting that according to the results of our research, the dry weight of weeds under control was 449 g/m². Due to herbicide spraying, this indicator decreased by 86.2%. Higher biological efficiency (87.4%) was shown by the herbicide Euro-Lightning® Plus in the model of sunflower seed production against the background of deep shelfless cultivation (28-30 cm).

It is clear that the presence of weeds in crops limits the ability of agricultural plants to realize their genetic potential for high yields. Thus, when studying the influence of different methods of basic tillage under alfalfa seeds, it was found that no significant difference was found between them. At the same time, with non-shelf loosening of the soil to a depth of 1214 cm, the total energy consumption for this agricultural event is reduced by 226.7% compared to deep plowing [23]. The density of the soil, on which the yield significantly depends, for all studied methods of basic tillage was

at the level of optimal values (1.1-1.3 g/cm³) [24]. Crop productivity decreases significantly when grown in years with insufficient moisture.

Moderately warm weather in April 2019 with sufficient moisture (45.6 mm at 25 mm) was favorable for the initial growth and development of the studied crop. In June and August, 63.9 and 44.7 mm as norm fell at 54 and 42 mm, respectively, which had a positive effect on sunflower productivity.

During the growing season of sunflower plants in the production experiment, the crops were heavily weeded, so chemical weeding against the background of deep autumn plowing was used to control unwanted plants. The results showed the high effectiveness of the chemical method of plant protection against weeds.

It was found that due to spraying crops with Euro-Lightning® Plus herbicide, seed yield increased in 2019 by 0.51 t/ha compared to the control, which was 20.8%. (Table 2).

Table 2. Yield of sunflower seeds depending on spraying of crops with herbicide Euro-lightning® Plus in 2019, t/ha

Variant	Yield, t/ha	± to control	
		t/ha	%
Without herbicide - control	2.35	0	0
Without herbicide - control	2.96	0.61	26.0

As already mentioned, 2020 was characterized by drier conditions during the growing season, which affected the yield of sunflower. It ranged from 1.70 t/ha (in areas without herbicide application on the background of shallow tillage) to 2.83 t/ha (for chemical weeding of herbicide crops on the background of deep tillage) (Table 3).

A similar pattern between the options was observed in 2021. It should be noted that the average yield in the experiment in 2020 was 2.31 t/ha, i.e. it was lower by 0.99 t/ha compared to more moisture provided in 2021.

We have found, on average, two years of accounting, that the production of sunflower seeds on the background of deep plowing is more efficient with herbicide-free technology. Yields in the plots of this variant reached 2.50 t/ha, while deep shelfless loosening (tillage) of the soil was 2.33 t/ha, and shallow

no-tillage - only 2.21 t/ha of sunflower seeds. It should be emphasized that the difference in yield was significant.

A more effective model was the cultivation of sunflowers using the chemical method of weed control against the background of deep shelfless loosening (cultivation) of the soil. The yield reached the level of 3.36 t/ha, i.e. 1.03 t/ha more seeds were formed compared to the control crop (without herbicides).

Significant increase in yield due to the chemical weeding of crops was also obtained against the background of plowing (0.78 t/ha) and shallow tillage – 0.93 t/ha of seeds. Proper weed control has also increased oil yield.

It was found that the main share of influence on the formation of sunflower productivity in the experiment belongs to factor B (herbicide application) 94.5% – in 2020. Almost the same (94.7%) was in 2021.

Table 3. Yield of sunflower seeds depending on the methods of basic tillage and herbicide Euro-lightning® Plus, t/ha

Methods of basic tillage (factor A)	Herbicide (factor B)	2020	2021	Average for two years	± to control
Plowing to depth	Without herbicide - control	2.02	2.97	2.5	0
	28-30 cm	2.79	3.76	3.28	0.78
Policeless tillage to depth 28-30 cm	Without herbicide - control	1.85	2.81	2.33	0
	Euro-Lighting® Plus	2.83	3.88	3.36	1.03

Table 3, Continued

Methods of basic tillage (factor A)	Herbicide (factor B)	2020	2021	Average for two years	± to control
Shallow shelf-free tillage to a depth of 12-14 cm	Without herbicide - control	1.7	2.72	2.21	0
	Euro-Lighting® Plus	2.65	3.63	3.14	0.93
Average in the experiment		2.31	3.30	2.80	-
NIR05, t/ha	Factor A	0.02	0.10	0.05	
	Factor B	0.03	0.02	0.03	
Combined factors A and B		0.06	0.08	0.06	

CONCLUSIONS

The growth and development of sunflower plants depends on the degree of weed infestation, which ultimately affects its productivity. The coefficient of water consumption of sunflower was the highest for its cultivation against the background of shallow shelf-free basic tillage and herbicide-free technology – 1301 m³/t. During chemical weeding of crops, moisture is used more sparingly for seed formation, especially against the background of deep shelfless main tillage – 836 m³/t.

The highest sunflower plants were noted for chemical weeding of crops on the background of deep (28-30 cm) shelfless tillage – 179 cm, and the smallest – for sunflower cultivation on the background of shallow shelfless tillage and herbicide-free technology – 139 cm, while plowing on depth of 28-30 cm, this indicator increased by 6 cm.

During plowing for the period of sunflower harvest, the dry weight of weeds under control was

449 g/m². Due to herbicide spraying, this indicator decreased by 86.2%. The herbicide Euro-Lighting® Plus showed higher biological efficiency (87.4%) for seed production against the background of deep tillage.

Seed yields are also significantly affected by weather conditions during the growing season of the crop, the methods of basic tillage. More efficient (with herbicide-free technology) is the production of sunflower seeds against the background of deep plowing, as the yield reached 2.50 t/ha, while deep tillage was 2.33 t/ha, and shallow tillage – only 2.21 t/ha of sunflower seeds. Sunflower weed control was more effective with deep weedless tillage. The yield reached the level of 3.36 t/ha, i.e. 1.03 t/ha more seeds were formed compared to the control crop (without herbicides). A significant increase in yield due to the chemical weeding of crops was also obtained against the background of plowing (0.78 t/ha) and shallow tillage (0.93 t/ha of seeds).

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Засміченість та продуктивність посівів соняшнику у південному Степу України

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Анотація. Наведено результати досліджень зростання та розвитку рослин соняшнику в період формування його продуктивності у південному Степу України залежно від способів основного обробітку ґрунту та ступеня засміченості агрофітоценозу. Доведено ефективність хімічного прополювання гербіцидом Євро-Лайтнінг Плюс посівів соняшнику, рослини якого вирощували на тлі глибокої (28-30 см) безполочної обробки

Ключові слова: соняшник, засміченість, способи основного обробітку ґрунту, погодні умови, продуктивність

The use of nanofiltration to regulate the properties of secondary products of processing animal raw materials

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Abstract. The problem of processing secondary material resources of the dairy industry, in particular buttermilk, is closely related to environmental issues. Nanofiltration is an energy-saving alternative to demineralization by ion exchange and electro dialysis. The purpose of the article is to study the membrane concentration process using nanofiltration flat membranes of the OPMN-P and OPMN-K brands for ultrafiltration of buttermilk. In order to achieve the set goal, two brands of nanofiltration membranes were tested during the experiment. The experimental study of the NF-UV process of oil pan permeate was carried out with the help of a laboratory installation, the parts of which included a container with a pressure gauge; thermostat; pump; manometers; counter (rotameter); membrane module; measuring capacity; valve; cylinder with CO₂. To identify the main filtration dependencies, two types of Vladipor OPMN nanofiltration membranes were studied. For each type, pressure in the range from 0.5 to 2.0 MPa and temperature from 20 to 40°C were used. The results show that both types of membranes effectively retain lactose at a pressure of 2.0 MPa, a temperature of 40°C, and a concentration factor of about 2. Changing the flow velocity over the membrane from 0.5 m/s to 1.5 m/s allows obtaining increase in specific productivity by 15% from the initial one. The effect of concentration polarization effects on the specific performance of nanofiltration membranes was established. The limitation of the concentration coefficient due to the increase in the osmotic pressure of the solution was determined. A conclusion was made regarding the possibility of large-scale implementation of nanofiltration of secondary material resources of milk processing in the study of membrane regeneration processes. The practical significance of the work lies in helping to solve environmental problems through the use of the nanofiltration method, which has a number of advantages over other processing mechanisms. In addition, such a process will make it possible to obtain new valuable liquids that can be used during the production of a number of dairy products, in particular lactose-free

Keywords: buttermilk, ultrafiltration, nanofiltration, lactose, membrane concentration

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INTRODUCTION

Effective processing of raw materials, in particular dairy, remains an important problem of the food industry to this day. In recent years, special attention has been paid to secondary material resources and waste. Among them, whey and buttermilk are of great importance [1-3]. This is related not only to economic indicators, but also to environmental problems. The chemical composition of these liquids defines them as an exceptionally favorable environment for the development of microorganisms. This fact causes an increase in indicators of wastewater pollution of dairy enterprises [4;5]. Ukrainian and international legislation in the field of environmental protection regularly increases regulatory requirements for the discharge of wastewater into natural reservoirs. This approach to the problem is an additional incentive for the relevant enterprises to find and implement modern technologies for the utilization of whey and buttermilk [6; 7].

Membrane technologies significantly help to solve this problem. The use of membrane processes in various combinations allows highly efficient processing of milk processing waste. This is explained by low energy consumption and the ability to preserve valuable biological properties of the main components of the chemical composition [7-9].

However, in this case, there is a problem of disposal of secondary streams formed as a result of membrane concentration or purification. This usually applies mostly to permeates. They are used worse than concentrates.

The dairy industry today remains the main one among the food industries in terms of the use of membrane equipment and technologies. First of all, this applies to ultrafiltration. Taking into account the large volumes of milk processing in this way, the importance of this problem also for ecology becomes clear. Additionally, along with ultrafiltration, reverse osmosis, microfiltration, and nanofiltration have recently been actively used.

Among the processes of utilization of whey and buttermilk, the removal of lactose and mineral substances is developed most intensively. This is explained by the significant need for these types of raw materials

as a basis for lactose-free products. Many types of ice cream, frozen desserts, dry drinks, bakery products, food additives require whey and buttermilk with a reduced concentration of salts. Traditionally, demineralization is carried out by concentration and electro dialysis or ion exchange. In any case, the energy and equipment costs are quite significant. Recently, membrane technologies have become a profitable alternative to these processes [10-12]. Membranes are successfully used not only in the dairy industry, but also in other industries for the concentration and purification of liquids. It is believed that, in the future, membrane technologies will maintain the trend of rapid growth in utilization due to low energy consumption, relative simplicity of hardware design, convenience of automatic control and management, etc. [13-15]. The minimum impact on the natural value of the composition of raw materials is also important.

Nanofiltration (NF) is a unique membrane process. It allows you to separate low-molecular organic and inorganic compounds. The basis of NF is many, including electrical and Donnan effects. The nature of the NF process depends significantly on the properties of the membranes and the filtering object [16; 17].

The presented work is a logical continuation of early research [8]. The main attention is paid to the application of NF membranes for the treatment of UV oil permeate. This product is obtained by ultrafiltration of raw materials during concentration. Ultrafiltration permeate is used extremely inefficiently today. The volumes of accumulation of this valuable raw material are quite significant. The problem of disposal of the specified liquid is significant due to the significant risk of discharge of wastewater contaminated with permeate components. In this case, the burden on the environment is a valid argument when planning the implementation of dairy by-product processing technologies. Nanofiltration has significant advantages over other treatment methods. In addition to solving environmental problems, this process can allow obtaining new valuable liquids that will be widely used in the production of a number of special dairy products, for example, lactose-free.

LITERARY REVIEW

A number of publications [18-20] previously established a clear dependence of NF on the processing method, parameters, chemical composition of raw materials and properties of NF membranes. For example, the authors [18] investigated a significant effect in the combination of NF and diafiltration using NF membranes of the roll type DS-5DL (GE-Osmonics). In this case, the UV permeate of the serum was the object of research. Special attention was paid to the main dependencies during demineralization of lactose solution.

The paper [19] indicated the hydrophilicity of NF membranes as an important factor in the process. The authors of the work [20] established that with NF a gel layer is formed on the membrane surface and the concentration of dissolved substances, especially lactose, increases. It is indicated in the work that about 1% of lactose passes into the NF permeate.

The removal of mineral substances during the processing of various dairy products was studied by scientists [21]. They achieved 27...36% removal of the mineral component depending on the degree of concentration of UV permeates of milk and serum.

In the publication [22] NF was used to obtain solutions rich in lactose. For membranes of type NFT 50 and HR95PP, better results were obtained at a pressure value of 3 MPa, when 80% of water was removed from the serum.

Mineral substances and lactic acid served as an object of attention in NF in the work [23]. The researchers achieved a significant degree of acid retention. In addition to NF, diafiltration (DF) was used in this case. This technique made it possible to remove 30...71% of mineral salts from the original solution.

The production of many dairy products requires a low lactose content. Buttermilk-based products are no exception. Special attention to the nutrition of people with lactose intolerance is the main factor of intensive search in this direction due to the steady progress of this disease [24-26]. When removing lactose from buttermilk, a good effect is achieved by UV concentration and DF. Using water as a solvent for DF is a fairly simple solution. However, in this case, there are losses of balanced low molecular weight milk. A successful replacement of water in DF is NF permeate, which is obtained by appropriate UV treatment of the permeate of the oil pan [8].

Large-scale implementation of this phenomenon in the practice of processing secondary milk streams requires data confirming this possibility. It is necessary to know the performance of the studied membranes, which determines the economic indicators of the nanofiltration treatment process. The dependence of productivity on various factors of membrane treatment is of great importance. These indicators are of decisive importance when deciding the feasibility of implementing membrane technologies in the utilization of secondary material resources of the dairy industry.

That is why the study of the main dependences of NF-UV of oilseed oil permeate is the focus of this work. In addition, there is very little published data on this topic in the available sources.

MATERIALS AND METHODS

The permeate of the ultrafiltration of the buttermilk served as the object of research. Its composition is described in detail in [8] and presented in Table 1.

Table 1. Chemical composition of products of membrane processing of oil pan

Index	Fresh buttermilk	UF retentant FK=3	UF permeate FK=3
Mass fraction of protein, %	3.2	9.61	0.11
Mass fraction of fat, %	0.4	1.21	–
Mass fraction of lactose, %	4.5	4.54	4.48

Table 1, Continued

Index	Fresh buttermilk	UF retentant FK=3	UF permeat FK=3
The mass fraction of mineral substances, %	0.7	0.94	0.7

Source: author's development

Determination of constituent components in this work was carried out: mass fraction of lactose according to [27], content of mineral substances, mass fractions of fat and protein according to [28]. The obtained quality indicators clearly confirm the high value of the oil pan.

Nanofiltration membranes. In the experiments, two brands of nanofiltration membranes were tested, which are manufactured in series by the company

“Vladipor” (Volodymyr, Russia). The characteristics of the membranes are given in table. 2. Membranes have high resistance to oxidants. The working pH range is 2...12. Membranes withstand a concentration of active chlorine of at least 1 mg/l. This allows for highly effective regeneration and disinfection. Organic compounds with a molecular weight of more than 100 D are retained highly efficiently.

Table 2. Properties of “Vladipor” nanofiltration membranes

Type	Researched conditions	Selectivity, %	Productivity, l/m ² ·h
OPMN-P	0.15% solution NaCL, 25°C, p=15 atm	30	140
OPMN-P	0.15% solution NaCL, 25°C, p=15 atm.	60...70	1400

Source: author's development

NANOFILTRATION TREATMENT

Experimental studies of the NF-UV process of oil pan permeate were carried out in laboratory conditions at

the installation, the photo of which is shown in Fig. 1. The schematic diagram of the laboratory installation is shown in Fig. 2.



Figure 1. Laboratory installation FT-01

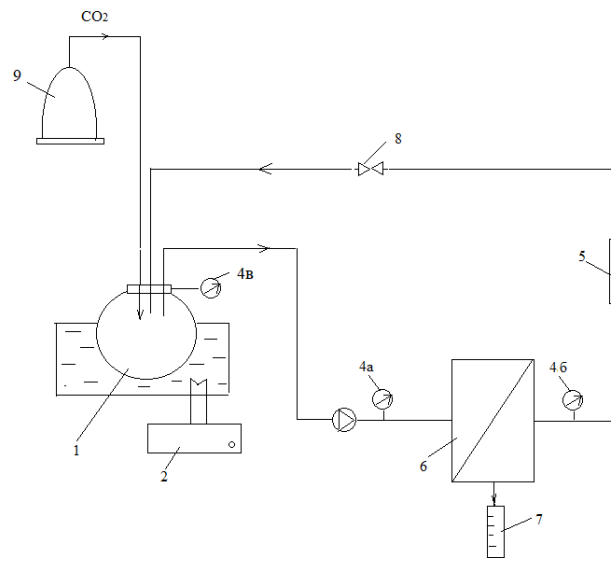


Figure 2. Schematic diagram of the laboratory installation

Notes: 1 – container with pressure gauge; 2 – thermostat; 3 – pump; 4 a, b, c – manometers; 5 – counter (rotameter); 6 – membrane module; 7 – measuring capacity; 8 – valve; 9 – cylinder with CO₂

Source: author's development

The membrane module of the installation contains 6 elements of the same type, one of which is shown in the photo (Fig. 3). The design feature of the presented elements is the spiral channels, which allow the liquid flow to be transferred to the turbulent mode at relatively low flow velocities. This contributes to the mixing of the liquid layer in the space above the membrane surface. This design of the module is extremely important in the sense of preventing the formation of

deposits on the membrane surface and eliminating the negative effect of concentration polarization. Membrane elements are made of high-quality structural plastic mass. They have high resistance to pressure and high temperatures and are resistant to corrosion under the influence of aggressive reagents. The incoming liquid flow is directed tangentially, which additionally contributes to the turbulent regime of the flow over the membrane surface.



Figure 3. Membrane module of the installation

The plant works in flow mode through membrane elements and a membrane module. This regime has a beneficial effect on the mass transfer of dissolved compounds across the membrane surface. In this way, the accumulation of compounds trapped by the membrane in a thin layer of liquid above the surface of the membrane is eliminated. That is why there are additional positive conditions for increasing the specific productivity of membranes. When the unit is operating, the permeate from container 1 of the closed UV type is fed into the membrane module 6 using a high-pressure gear pump 3. Additional pressure in the unit is created by supplying compressed CO₂ from the cylinder. This method of liquid processing allows to obtain a greater value of the driving force of the process, which is inhibited by the technical limitations of the pump of the installation and the power of its engine.

The NF permeate is taken into measuring tank 7 to measure the performance of the process. The working pressure is monitored at the inlet and outlet of the membrane module using manometers 4 a, b and is determined by the formula:

$$P = \frac{P_1 + P_2}{2}, \text{ MPa} \quad (1)$$

where P_1, P_2 are the fluid pressure at the inlet and outlet of the module, respectively, MPa. Concentrate flow rates are controlled by a meter.

A periodic mode of concentration was implemented in the installation. In this way, after UV concentration, the permeate was sent to the output tank 1 through the valve 8. The flow rate in the system was regulated by setting the valve in a certain position and closing the "by-pass" channel provided in the pump. The flow rate was calculated using the expression:

$$V = \frac{Q}{S}, \text{ m/c} \quad (2)$$

where Q is the volume flow rate of the concentrate, m³/s; S is the cross-sectional area of the intermembrane channel, m². The necessary filtration temperature was set with the help of a thermostat, which controlled the degree of heating of the electric heat exchanger.

After a certain time, the concentration factor was determined by the expression:

$$FK = \frac{V_B}{V_K}, L \quad (3)$$

where V_v, V_k are the volumes of the initial liquid and concentrate, liters.

The volume of the concentrate was determined by the equation:

$$V_K = V_B - V_p, L \quad (4)$$

where V_p is the permeate volume, L.

Selectivity was determined in NF permeate samples for each membrane:

$$\varphi = \left(1 - \frac{C_n}{C_k}\right) \cdot 100\% \quad (5)$$

where C_n, C_k are the concentrations of components in permeate and concentrate, respectively, g/L.

RESULTS AND DISCUSSION

Specific performance of membranes. The NF process was carried out at different operating parameters of pressure, temperature and flow rate. The obtained results are shown in Fig. 4 a, b, c and Fig. 5.

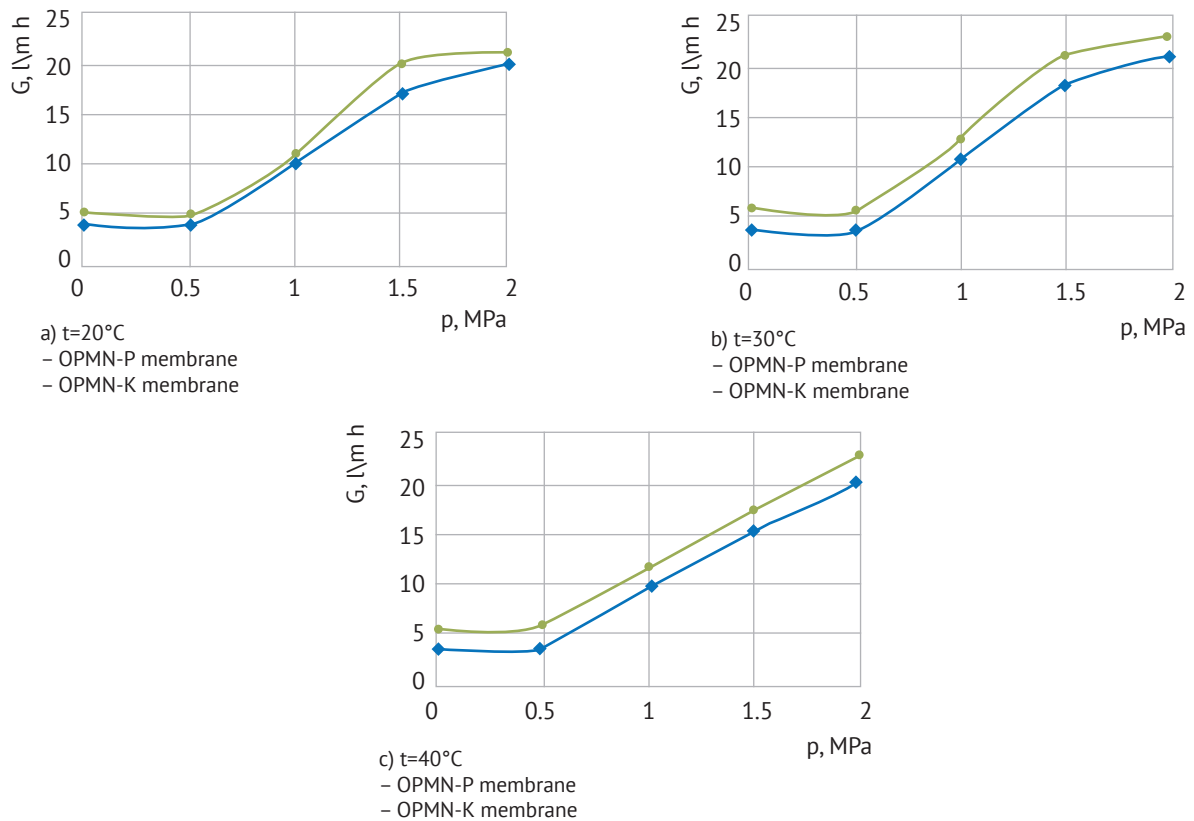


Figure 4. Effect of temperature on membrane performance

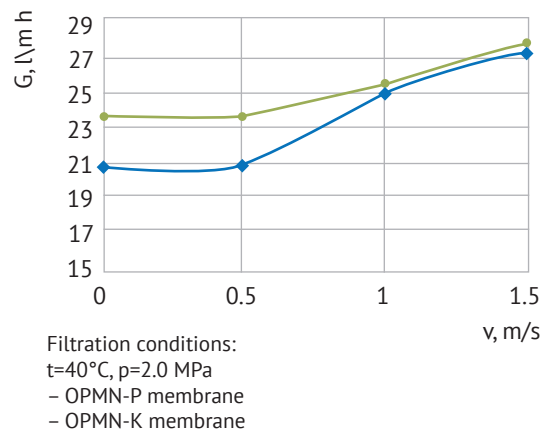


Figure 5. Effect of flow rate on the specific performance of membranes

In all cases, the same trend was investigated: with increasing pressure and temperature, the specific performance of the membranes increased. However, when the value of 1.5 MPa was exceeded, this growth became less pronounced. This phenomenon can be explained by the formation of a dense layer on the

separating surface of the membranes. It is called mud polarization of the membrane. This phenomenon occurs due to exceeding a certain limit of solubility of the compound. Intensive transfer of the solvent (water) through the distribution layer of the membrane leads to an increase in the concentration of dissolved

compounds and the formation of a precipitate in the form of a thin, uniform layer on the membrane. It mostly contains proteins that were not separated from the buttermilk in the UV process and got into the UV permeate. The phenomenon of concentration polarization also has a certain influence on the performance of membranes by nanopermeate. It occurs near the membrane surface due to the accumulation of molecules and ions. Molecules and ions of the same charge begin to repel each other, which prevents the transfer of solvent and dissolved compounds that pass through the membrane. In this zone, intensive transfer of solvent molecules through the membrane takes place. It is because of this that the concentration of proteins increases, their aggregation, and a thin layer of gel is formed. Together, these phenomena add up to additional resistance and impair mass transfer through the membrane. In each of the experiments, the indicators of the specific productivity of the membranes of the OPMN-P brand were significant in comparison with the OPMN-K brand.

The increase in the performance of the membranes when the oil pan is heated can be explained by the decrease in the viscosity of the solution. In this case, there are better conditions for liquid circulation, increasing flow speed and its turbulence. Accordingly, under such conditions, liquid layers are better mixed. This weakens the phenomenon of concentration polarization and the formation of a gel layer. In this case, the increase in the flow of the solvent through the membrane is investigated.

It is interesting that increasing the temperature of the oil pan from 30 to 40°C did not cause a significant increase in the performance of the membranes for any pressure. Temperatures higher than 40°C were not used in the experiments due to the threat of denaturation of the remaining proteins after UV treatment. Denatured proteins are known to form a dense layer on the membrane more intensively. This phenomenon can be explained by the irreversible loss of higher forms of spatial organization of the molecule by denatured proteins. As a result, the loss of protein solubility and the formation of sediment on the surface of the membrane. Therefore, for further experiments, a temperature of 40°C was chosen as the optimal temperature in terms

of productivity and energy savings. In addition, there were manufacturer's temperature limitations for the membranes. For these conditions, the effects of the flow rate on the specific productivity were investigated. The results were obtained (Fig. 5), which prove that in the range of speeds of 0.5...1.5 m/s the increase in productivity was noticeable. The highest result of 15% was achieved at a flow rate over the membrane surface of 1.5 m/s. This tendency was later much less pronounced. It is possible that at higher speeds the increase in productivity would be more significant. The technical capabilities of the experiments did not allow to fully investigate this effect. Perhaps this would cause additional energy costs, which would have a negative impact on the overall economic indicators of the NF process.

The change in the specific performance of the membranes with the treatment time is an important indicator that is needed to estimate the total membrane filtration area of a certain volume of liquid. Without this indicator, it is impossible to determine the economic feasibility of introducing the nanofiltration process into the practice of processing secondary raw materials. The change in specific productivity is crucial when choosing a membrane plant and regeneration methods. The necessary results are presented in Fig. 6.

The dynamics of the process is reflected by the increase in the oil concentration factor. This indicator was calculated according to the decrease in the volume of the concentrate. It shows how much the volume of the original liquid has decreased compared to the initial value. In the range of FC changes from 0.5 to 2.0, the decrease in the specific productivity of both brands of membranes was quite significant (by 60% of the initial). It is interesting that at FC values greater than 1.0, the studied membranes showed almost the same performance. This can be explained by the significant increase in the osmotic pressure of the NF concentrate and the thickening of the membrane structure due to the prolonged exposure to high operating pressure. Osmotic pressure, as is known, is a function of the concentration of certain soluble compounds. In this case, this indicator is affected by dissolved compounds retained by the nanofiltration

membrane (lactose and part of mineral salts). The compact structure of the membrane mechanically prevents the transfer of molecules through the membrane due to the reduction in the diameter of the holes. In this state, probably, the main role in the separation of the components of the oil pan is played by the secondary membrane, which was formed due to the phenomenon of gel polarization. It has slightly different properties from the main membrane, which adds some complexity

to the process of transferring molecules and causes unpredictable results.

Such a phenomenon is known for flat membranes that are constructively placed on a support in "plate and frame" type installations. When using a different type of membrane, for example, a tubular or roll membrane, the indicated effect might be less important. Additional research in this direction has certain interest and prospects.

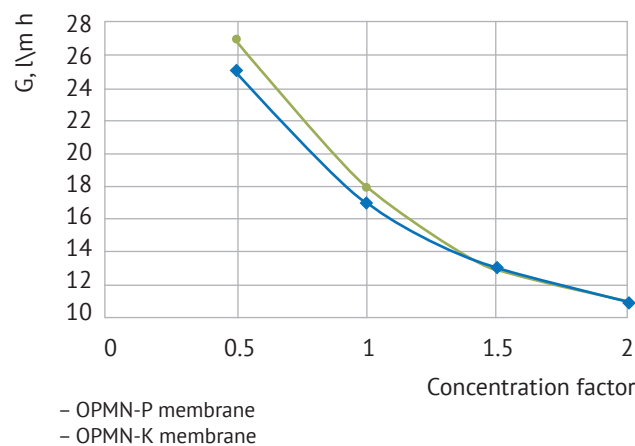


Figure 6. Influence of the concentration factor on the specific performance of membranes

MEMBRANE SELECTIVITY

There were certain changes in the selectivity of membranes in the process of NF treatment of buttermilk

established in a series of subsequent experiments. Their results are shown in Fig. 7

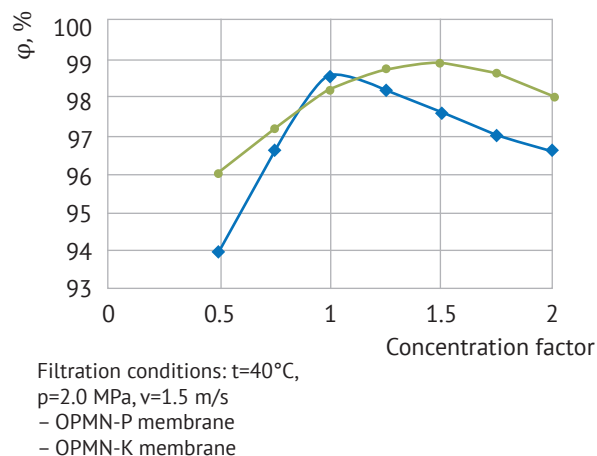


Figure 7. Influence of the concentration factor on the selectivity of the membrane

Similar effects of lactose retention were studied for both brands of membranes. At first, the selectivity increased, and then decreased. This phenomenon was more pronounced for the OPMN-K membrane. In our opinion, the obtained results can be explained from the standpoint of the theory of membrane filtration. With the growth of FC, the structure of the membranes is compacted over time, which causes a corresponding decrease in the diameter and volume of the pores. This gives, to a certain extent, an increase in the effect of lactose retention. In the future, some increase in the presence of lactose in the NF permeate due to the lack of an ideal structure of the membrane in relation to the diameter of the holes is investigated. This is explained by certain defects in the formation of membrane surfaces in industrial conditions. For example, it is impossible to achieve the same shape and diameter of the membrane pores over the entire surface of the polymer used for the manufacture of membranes. Deformation of the membrane under pressure also makes adjustments to the pore volume of the semipermeable membrane.

CONCLUSIONS

The NF process is an effective means of processing the UV permeate of buttermilk to obtain a NF permeate with a minimum lactose content.

In order to establish the main dependencies of NF processing of this valuable secondary product of milk processing, flat membranes of OPMN-P and

OPMN-K brands were investigated in the concentration mode.

It was established that the specific productivity of membranes is significantly affected by temperature, pressure, flow rate and liquid concentration factor. The best results for the investigated process were determined in the conditions of laboratory experiments: pressure 2.0 MPa, temperature 40°C, flow speed about 1.5 m/s. The studied membranes revealed minor discrepancies in the main indicators characterizing the performance of the process. Taking into account the best indicators of the lactose retention effect, it is possible to recommend the OPMN-P membrane ($\varphi=99\%$) for the practical purpose of removing lactose from the UV permeate of the buttermilk. The productivity of this membrane is 11...28 l/m²·h, depending on the concentration factor.

Further research in this direction will be conducted using industrial roll elements for NF and comparative characteristics of different manufacturers of membranes and membrane elements.

The work also did not investigate the important problem of membrane regeneration. The choice of the method of regeneration and the establishment of the main parameters of this process is a separate important link of research in membrane technologies. Large-scale implementation of NF, of course, requires an assessment of this important factor, which significantly affects the economic efficiency of the process. For example, it affects the operating time of the membranes, the duration of the technological work cycle, etc.

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Застосування нанофільтрації для регулювання властивостей вторинних продуктів переробки тваринної сировини

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Одеська національна академія харчових технологій

Анотація. Проблема переробки вторинних матеріальних ресурсів молочної промисловості, зокрема маслянки, тісно пов'язана з екологічними питаннями. Нанофільтрація є енергоощадною альтернативою демінералізації методом іонного обміну та електродіаліза. Два типи нанофільтраційних мембран ОПМН фірми «Владіпор» досліджено з метою виявлення основних залежностей фільтрування. Питома продуктивність та селективність тестованих мембран є головними предметами досліджень. Є підстави для висновку щодо широкомасштабного впровадження нанофільтрації при утилізації маслянки

Ключові слова: пахта, ультрафільтрація, нанофільтрація, лактоза, мембранне концентрування

The effect of functional feeding of young broiler chickens of meat crosses on the quality and safety of meat

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Abstract. Food security, providing the population of the country with high-quality food is essential. aspects of the economic situation of Ukraine. Therefore, the poultry industry is one of the priority suppliers of high-quality animal protein, it is considered the most capable of modernizing production processes and attracting innovative solutions developed by scientists. The purpose of the article is to find out the effect of functional poultry feeding on the chemical and morphological composition of broiler chicken carcasses and their parts, meat quality indicators. In order to achieve the specified goal, a comprehensive evaluation of the meat of broiler chickens, grown using functional feeding, without the additional use of hormonal drugs and antibiotic substances contained in traditional compound feed for chickens, was carried out. Data on the functional and technological properties of meat, chemical composition, microbiological well-being of raw materials and morphological features of cartridge carcasses are provided. The conducted studies showed compliance of the quality of the meat with the requirements of the standard and confirmed its safety for consumption. It was found that the proposed tool for influencing the functional and technological properties of poultry meat, i.e., the use of phosphate when feeding poultry, is not only effective for poultry health, but also has a positive effect on its preservation. This fact was confirmed with the help of microbiological studies. The results of physico-chemical and sensory studies showed that the metabolic processes in the body of birds are able to utilize phosphates and transform the quality with a significant improvement of indicators. The practical significance of the work lies in the fact that the aspect of biomodification of meat raw materials and its purpose will continue to be relevant for implementation both for producers of meat products and for producers of animal products

Keywords: functional poultry feeding, quality of poultry meat, functional and technological properties, quality and safety of poultry meat

INTRODUCTION

A key aspect that affects the general economic situation of Ukraine is the quality of life of its citizens, including the resolution of issues of ensuring food security and providing the population with high-quality and

safe food [1]. In this context, poultry farming in Ukraine is an important supplier of high-quality animal protein, which is able to solve the problem of protein hunger and provide not only Ukrainians, but also residents of

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other countries who suffer from a lack of protein in the diet. Poultry farming, as one of the branches of agricultural production, being science-intensive, material-intensive and energy-intensive, like all branches of agriculture, but, unlike others, is the most easily amenable to the modernization of production processes and the introduction of innovative developments by scientists. The poultry processing industry is a complex system that depends on a well-organized traceability system that ensures the quality of the final product at all stages of production, starting with rearing. The final products of this industry are meat, slaughter and processing products, down and feathers, as well as hatching and edible eggs. During 2000-2019, drastic changes took place in the meat market. If in 2000 the basis of production was beef and veal, which occupied a stable share of 45.4%, then in 2019 it decreased by almost three times. The share of pork production in vertically integrated companies also decreased.

Resource-saving technologies of the poultry processing industry provide for comprehensive processing of poultry and maximum full use of all its products. The preservation and rational involvement of poultry meat in food technologies due to the introduction of methods of deep industrial processing in order to obtain a wide range of products for various purposes is an urgent nationwide problem. One of the types of raw materials for the meat processing industry, which is quite widely used due to high manufacturability, a significant amount of protein, and low cost, is mechanically deboned poultry meat. Another promising direction of the use of raw materials of the poultry processing industry is the creation of protein and protein-collagen additives for use in the nutrition of athletes and military personnel, which are subject to preliminary processing and allow long-term storage with low humidity. [2-4].

The problem of the development of the poultry industry occupies a leading place in the works of domestic scientists. The following authors paid attention to the mentioned problem: M.V. Zubets, S.V. Merzlov, P.T. Sabluk, I.I. Vinichenko and many others. In their works, they studied the trends in the development and functioning of poultry farming in Ukraine and the

possibilities of increasing the productivity of the specified industry. However, despite the significant number of publications and taking into account the rapid development of poultry farming in a changing market environment, it is necessary to continue researching the specifics and features of the functioning of enterprises in this industry in order to identify reserves and find ways to increase its efficiency [9; 10].

Research results indicate that many factors affect the quality and safety of chicken meat, taste properties and its chemical composition:

- hereditary (species, breed, line, cross), gender and age;
- proper sanitary and hygienic condition of poultry houses, equipment, inventory;
- zoohygienic parameters of the microclimate (ventilation, lighting, temperature and humidity regimes, etc.);
- compliance of building materials, compliance with requirements for design, location and construction of the poultry house;
- availability of walking platforms, insolation and exercise of birds;
- action of stress factors,
- effectiveness of disinfection, disinsection, deratization;
- quality and quantity of litter;
- balanced diet, frequency of feeding and watering, quality of fodder;
- use of prophylactic or therapeutic drugs, etc. [2].

As researches of recent years have shown, of the large number of factors affecting the yield and quality of raw meat from broiler chicken carcasses, the influence of feeding factors on meat yield, morphological structure, and energy value is of particular interest, which in turn depend on the technological schemes of processing and rolling of carcasses and on the principles of sorting individual parts during their processing [6]. Modern economic conditions dictate new approaches to the improvement of the technology of deep processing of poultry, especially regarding the development of scientifically based output standards and the determination of objective characteristics of the meat merits of cartridge carcasses and their anatomical parts, which ensures rational use and effective price policy of production.

All over the world, great attention is paid to the principles of processing and deboning of broiler chicken carcasses, while, along with the differences caused by national characteristics of meat consumption and the range of products, in each country there are general rules that provide for the selection of the best meat from carcasses and their parts from the energy value and development of muscle, fat and connective tissues for sale in natural form. The rest of the raw materials with lower nutritional characteristics are used for further industrial processing and production of various semi-finished products, sausage and culinary products and canned food. A more detailed study of the composition and properties of the meat of broiler chickens, as well as the establishment of output standards for the processing and deboning of carcasses and their anatomical parts, with the justification of objective quality criteria, will allow rational use of meat resources in the production of poultry products and scientific arguments for differentiated pricing enterprise strategy [11-13].

By its composition, the meat of broiler chickens is a high-quality, protein-rich product with a lower energy value, compared to pork and beef. For many years, experts have been studying the chemical and morphological composition of cartridge carcasses and their parts, taking into account mainly the fattening of the bird (first, second grades and industrial processing).

However, with the same fattening, the weight of cartridge carcasses (the main characteristic of the breed) can differ significantly, and, therefore, the meat qualities of the carcasses and their parts will also differ. Some authors use a qualitative protein index to characterize meat raw materials, which is determined by the ratio of the proportion of complete proteins to incomplete proteins, while others use the pure protein index, which is determined as the difference between the amount of common and connective tissue proteins.

Among the most important aspects of a healthy diet, nutritionists include reducing the amount of fat consumed by a person [14-16]. It is considered appropriate to reduce the fat content of the cartridge carcass without reducing the amount of intramuscular fat. It should be a method of calculating the "leanness" of meat, which will allow you to calculate not the value

of the mass of a separate cut or part of the carcass, but the value of its lean part (or protein), as well as determine the technological advantage of using this raw material. It should be noted that until now, the quality index of meat (the "fat: protein" ratio) was used to characterize the quality of meat and meat products, taking the 1:1 ratio as a benchmark. The effectiveness of the use of meat raw materials is largely influenced not only by the meat quality of an individual cartridge carcass, but also by its parts, which have different energy value and economic significance [17].

The purpose of the article is to determine the influence of functional poultry feeding on the morphological and chemical composition of broiler chicken carcasses and their parts, meat quality indices. To achieve the goal, a pathomorphological evaluation of the carcasses of broiler chickens was carried out and the morphological and chemical composition of the carcasses and their parts, as well as the content of proteins, fat and dry matter were determined. The work was carried out in 2019 in the laboratory conditions of the Odesa National Academy of Food Technologies and at the enterprise of the industry, namely – on the basis of the agricultural production enterprise "NIKAGROSTAR".

MATERIALS AND METHODS

The research was conducted in a farm that specializes in production, including chicken. An experimental site for growing broiler chickens was created. The chickens of the research and experimental groups were planted separately, in specially equipped territories, but at the same time they were raised in close proximity to the main stock. The experiment was organized in such a way that it was possible to determine the direct influence of feeding and drinking, under the same stress factors, under the same temperature conditions, lighting conditions, and so on. As a functional component, a mixture of phosphates was used for drinking broiler chickens (hereinafter referred to as the Experimental sample). So, in the first enclosure there were control chickens that received a diet without additives and drinking was carried out without phosphates, and in the second – chickens received a diet and drinking was carried out with phosphates. Control of zootechnical

indicators was carried out every decade according to generally accepted methods [7]. The indicators of the dynamics of body weight gains and livestock conservation were studied.

The composition, properties and quality of experimental samples of cartridge carcasses and their parts were examined according to the following indicators: mass of individual weight categories of cartridge carcasses and their parts; morphological composition of carcasses and their parts; physico-chemical studies - mass fraction of moisture – SSTU ISO 1442:2005; mass fraction of fat – SSTU ISO 1443:2005; mass fraction of protein – SSTU 25011-81; bacteriological examination of muscle tissue and parenchymal organs was carried out according to SSTU 7702.2-74, KMAFAnM – SSTU 7702.2.1-95, and the presence of pathogenic and opportunistic microorganisms – SSTU 7702.2.3-93. Together with bacterioscopy of smears-imprints, cultures were carried out on liquid and dense nutrient media. Biometric evaluation was carried out using methods of mathematical analysis and statistical processing [8].

After slaughter, the bird was evaluated by the appearance of the carcass, the location of fat, the slaughter yield, the ratio of edible and inedible parts was determined; muscle-bone index (MBI) – the ratio of muscle mass to bone mass; meat quality index (MQI) – the ratio of the mass of muscle tissue with skin to the mass of bone; the part index (PI) is the ratio of the mass of the part to the bone mass, and the meat quality index (F/Pr) is the ratio of “fat: protein”.

At the first stage of scientific research, pathomorphological studies of the internal organs of the bird were carried out: experimental and control.

RESULTS AND DISCUSSION

As a result of the evaluation of experimental birds, the following was determined. The total weight is 1488 g. The weight of the carcass without internal organs is 1226 g. The pectoral muscles are well developed, the consistency is elastic, the fossa is quickly leveled when pressed. The color of the muscles is beige with a brown tint. The thickness in the area of the middle third of the muscles is 4 cm. Liver: weight 32 g, the surface is smooth and shiny, the color is light brown, the

parenchyma is light brown, fine-grained. Gallbladder is significantly full. Kidneys: dark red color, soft texture, dark red parenchyma, juicy. The total weight is 10 g. Spleen: the surface is smooth and shiny, 1.4 cm in diameter, the color is brown with a brown tint, the parenchyma is fine-grained and homogeneous. Lungs are red in color, soft consistency, fine-grained red parenchyma, total weight – 5 g. Sternum with pectoral muscles weight – 272 g. Heart – weight 10 g. The surface is smooth and shiny, the myocardium is structured, red in color, the cavities are empty. Gastrointestinal tract: the mucous membrane of the esophagus is pale pink in color. The goitre is moderately filled, the contents are mushy, light brown in color. Glandular stomach: mucous pale pink. Muscle belly: the cuticle peels off easily, the muscle layer is red, structured. Small intestine: the mucous membrane is pale pink, contains a small amount of food masses. Large intestine: contains a small amount of feces, the mucous membrane is pale pink. The total weight of the intestine is 160 g. No systemic pathology was detected.

Evaluation of the control sample of poultry gave the following results. The weight of the carcass without internal organs is 1306 g. The pectoral muscles are satisfactorily developed. In the area of the middle third of the sternum (keel), there are small point hemorrhages, the consistency is flaccid, the color is beige with a bluish tint, the thickness of the middle third is 3.4 cm. The sternum with the pectoral muscles weighs 258 g. The liver weighs 40 g, the surface is smooth and shiny, the color is dark brown with a brown tint, the consistency is soft, the parenchyma is medium-grained, brown in color. The lungs are red in color, soft in consistency, dark red parenchyma, foamy liquid is released when pressed. The total weight is 10 g. The kidneys are dark red, the consistency is soft, the total weight is 12 g, the parenchyma is dark red, granular. Spleen: size, length 1.7 cm, surface smooth and shiny, consistency soft, parenchyma dark red juicy. Heart: weight 16 g, epicardium smooth and shiny, myocardium red, structured, empty cavities. Gastrointestinal tract: the goitre is significantly filled with mushy gray-green contents. Glandular stomach: the mucous membrane is pale, the muscular stomach is moderately filled with

food masses, the cuticle separates with some difficulty. The muscle layer is fine-grained. Small intestine: the mucous membrane is red in some areas, dark red spots in some areas. The large intestine is significantly filled with fecal masses. The total weight of the intestine is 154 g. Table 1 shows the comparative results of the weight of the internal organs of the birds of the experimental and control groups.

Based on the obtained data, it can be concluded that the control sample of poultry developed catarrhal enteritis against the background of the absence of preventive measures to ensure the health of the poultry in the diet, unlike the experimental sample.

In order to carry out further evaluation of the raw materials, the cartridge carcasses of the experimental

and control batches and their parts were used. The processing of pellet carcasses of broiler chickens of different weight groups (from 600 to 1800 g, with an interval between groups of 200 g) was carried out in laboratory conditions with the selection of wings along the shoulder-scapular joints, femurs along the hip joint, and the chest along the line of the ribs. If necessary, the wing was divided by joints into three component parts, and the thigh - into two (shin and thigh). The back obtained after processing could be divided into front and back parts along the line of connection of the corresponding vertebrae. Carcasses of chickens of the parent flock of the meat breed weighing up to 3000 g were processed and collapsed according to a similar scheme.

Table 1. Results of pathomorphological studies $M \pm m, n=7$

Experiment		Control	
Total weight	1488 gr ± 0.5	Total weight	1660 gr ± 0.5
Carcass	122gr 82% ± 0.8	Carcass	1306 gr 78% ± 0.9
Sternum +m	272 gr 18% ± 0.8	Sternum +m	258 gr 15% ± 0.8
Pectoral muscles	4cm ± 0.3	Pectoral muscles	3.4 cm ± 0.3
Liver	32 gr ± 0.5	Liver	40 gr ± 0.5
Kidneys	10 gr ± 0.5	Kidneys	12 gr ± 0.5
Lungs	5 gr ± 0.5	Lungs	10 gr ± 0.5
Heart	10 gr ± 0.5	Heart	16 gr ± 0.5
Spleen	1.4 cm ± 0.5	Spleen	1.7 cm ± 0.5
Intestines	160 gr ± 0.5	Intestines	154 gr ± 0.5

Selected parts were manually deboned with anatomical removal of bones, the weight of muscle and bone tissue, as well as skin was determined by weighing, the morphological and chemical composition of the obtained parts and whole carcasses was studied. The results of the experiment show that with an increase in the weight condition of the bird, the yield of carcass parts is almost linear, with the exception of the yield of meat and skin in carcasses weighing from 600 to 1,200 g and the yield of bones in carcasses weighing from 1,800 to 3,000 g: in these cases, deviation from linear dependence. The data obtained in the experiment provide a generalized description of the yields

of carcass parts and their morphological components, which is the basis for calculating the quality indices of cartridge carcasses and their parts after determining the chemical composition. The chemical composition (content of moisture, fat, protein and ash) of each part was determined separately for muscle tissue, skin and bone. At the same time, some tolerances were made, in particular, indicators of the chemical composition of the skin of whole dressed carcasses were determined by the arithmetic mean value. For example, in weight categories from 600 to 1,200 g, the moisture content was 60.0%, fat – 22.2%, protein – 17.3% and ash – 0.5%; for groups from 1,200 to 1600 g – 58.1, respectively;

24.7; 16.7 and 0.5%; from 1,600 to 1,800 g and above – 56.2; 28.0; 15.3 and 0.5%. As the weight of the carcass increased, the amount of fat in the skin increased. Abdominal fat was separated from the carcass separately and taken into account when determining the quality indices of the cartridge carcass.

The chemical composition of the bone was determined for each part separately and the average arithmetic values of the indicators, equal for all weight groups of the treated poultry carcasses, were found. Data on the morphological and chemical composition, the content of connective tissue in dressed carcasses and their parts, as well as on individual quality indices, show that with an increase in the weight condition of dressed carcasses, the mass fractions of individual parts increase in the following sequence: wings, then the dorsal and thoracic parts and itself a large share is made up of the thigh. However, the highest values of the meat-bone index and meat quality index for thighs

were obtained only in the weight category of dressed carcasses weighing 600 g.

The intensity of the development of muscle tissue and pulp, as well as the content of pure protein, is always higher in the chest; these indicators increase until the mass of the cartridge carcass reaches 1200 g, then the rate decreases slightly due to the growth of skin and bone particles.

The morphological and chemical composition of the carcass and its parts on the example of broiler chickens weighing 1200 g, presented in Tables 2 and 3, allows you to objectively characterize the yield of poultry meat and the possible profit of the enterprise. This approach was used to determine the ratios of dressed carcasses of chickens, chickens and broiler chickens of different weight groups weighing from 600 to 1,800 g (with an interval between groups of 200 g), chickens of the parent flock of meat breed weighing up to 3,000 g and other types of poultry .

Table 2. Morphological and chemical composition of the cartridge carcass and its parts, $M \pm m$, $n=7$

Parts of the carcass	Morphological composition	Moisture, %	Fat, %	Protein%	Ash, %	Connective tissue, %	Pure protein, %
Lump							
Muscles	20.0	76.0	4.5	19.6	0.9	1.9	90.3
Muscles and skin	23.0	73.0	7.0	19.2	0.9	2.3	88.2
Muscles and bones	26.1	71.9	7.4	18.5	2.2	3.0	82.9
Chicken breast							
Muscles	20.7	71.0	11.1	16.9	1.0	3.5	79.4
Muscles and skin	23.1	69.1	13.1	16.9	0.9	3.7	77.9
Lump (Muscles and bones)	33.0	67.2	13.4	16.2	3.2	4.9	69.8
Wing							
Muscles	5.1	68.3	13.2	17.0	1.5	3.1	81.8
Muscles and skin	8.3	64.3	17.7	16.8	0.5	3.8	77.3
Wing (Muscles and bones)	12.1	64.3	14.8	16.1	4.8	5.6	65.5
Back							
Muscles	11.0	68.0	19.9	10.6	1.5	3.4	67.9
Muscles (Muscles and bones)	18.1	63.5	22.1	13.4	1.0	4.1	69.2
Back (Muscles and bones)	25.0	62.4	20.8	13.1	3.7	5.2	60.5

Parts of the carcass	Morphological composition	Moisture, %	Fat, %	Protein%	Ash, %	Connective tissue, %	Pure protein, %
Carcass							
Muscles	57.0	71.6	10.6	16.8	1.0	2.6	84.6
Flesh (muscles and skin) of the carcass without abdominal fat	74.0	68.3	14.0	16.8	0.9	3.2	80.6
Abdominal fat	5.0	8.4	90.0	1.5	0.1	-	-
Flesh (muscles and skin) of the carcass with abdominal fat	80.1	64.7	18.6	15.9	0.8	3.0	80.6
Carcass without skin	79.0	65.7	16.1	15.1	3.7	4.0	73.2
Carcass	98.0	64.0	17.6	15.4	3.0	4.1	70.7

Table 3. Indices of the meat quality of the patra carcass and its parts $M \pm m, n=7$

Part of the carcass	MBI	IMB	IP	A/C
Chicken breast				
Muscles	7.90			0.23
Muscles and skin		9.05		0.37
Muscles and bones			10.05	0.40
Lump				
Muscles	3.68			0.65
Muscles and skin		4.32		0.78
Lump (Muscles and bones)			5.33	0.82
Wing				
Muscles	1.14			0.78
Muscles and skin		1.90		1.06
Wing (Muscles and bones)			2.90	0.92
Back				
Muscles	2.00			1.88
Muscles (Muscles and bones)		3.68		1.65
Back (Muscles and bones)			4.68	1.59
Carcass				
Muscles	3.20			0.63
Flesh (muscles and skin) of the carcass without abdominal fat		4.51		0.55
Abdominal fat				0.78
Flesh (muscles and skin) of the carcass with abdominal fat	4.45			1.06
Carcass without skin			5.51	0.80

In the production of poultry meat, there is a problem of obtaining raw materials with high humidity and low functional and technological properties, which can cause the production of low-quality products with the use of a large number of additives, which will affect its safety [18; 19]. Thus, at the first stage, the mass fraction of moisture, protein and dry matter in the control and experimental samples was determined. The results of the research are shown in Fig. 1.

According to the results of the conducted research and comparison of the control and experimental samples, it was determined that a greater amount of moisture was obtained in the meat of chickens from the control group, which is an undesirable factor, because such meat has a shorter shelf life and corresponds to the indicators of "immature" meat.

On the one hand, this is explained by the fact that the growing period was 42...45 days, this particular

period is used for industrial growing in contrast to the home or organic growing method, which ensures economic efficiency and profitability of production with the minimum possible growing period at the enterprise, and is explained by the use phosphates, which are able to retain moisture, but in this case it should be investigated in which form the moisture is, in a chemical form or in a physical form. For this purpose, studies were conducted on the definition of VZZ and VUZ.

In previous studies, the amount of protein in different parts of the carcass was determined, in this experiment, the average value of protein and dry matter of the carcass of the control and experimental samples was calculated and determined. The amount of protein practically did not differ and is 0.72%. Based on the above, it is expedient to evaluate individual parts and determine directions of use, taking into account such characteristics.

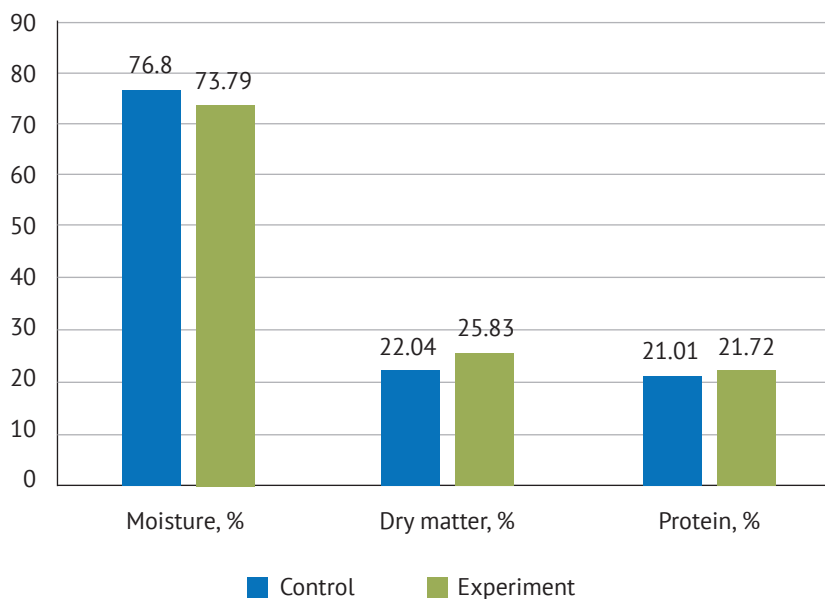


Figure 1. Chemical composition of muscle tissue of experimental chickens

Determination of the mass fraction of fat showed the result presented in fig. 2 and is 2.01% in the experimental group, and 1.04% in the control group. Based on the fact that the duration of cultivation is 42-45 days, the amount of fat depends on the stage of physiological

development and during this period it was incomplete. On the one hand, a small increase in the amount of fat leads to improved taste characteristics during heat treatment, on the other hand, such an increase will not lead to a deterioration in quality characteristics.

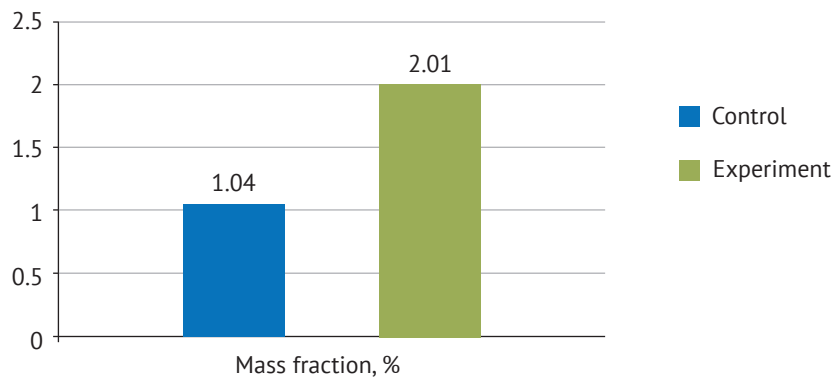


Figure 2. Determination of the mass fraction of fat in the muscles of experimental chickens

In the production of poultry meat, special attention is paid to microbiological indicators, on the basis of which it is possible to predict the behavior during

further processing and storage [20; 21]. The results are shown in Table 4.

Table 4. Microbiological parameters of experimental samples

Indicator	Pathogenic microorganisms, salmonella, CFU	KMAFAnM, lg CFU/g
Control	Not identified	3,54 ± 0,04
Experiment	Not identified	3,03 ± 0,02
Limit value	25	Not more 5

Based on the results of the sensory assessment, it was established that the test and control samples have a light color – for the fillet part, and a pale pink color – for the thighs and other parts with a higher myoglobin content. The surface of both samples is evenly covered with a thin layer of adipose tissue,

which indicates that the chicken can be classified as 1 fattening category. From the side of the abdominal cavity – the color is pale pink, the blood vessels are not enlarged, there are no hemorrhages. The smell is characteristic of this type of meat and category. The results are shown in Figure 3.

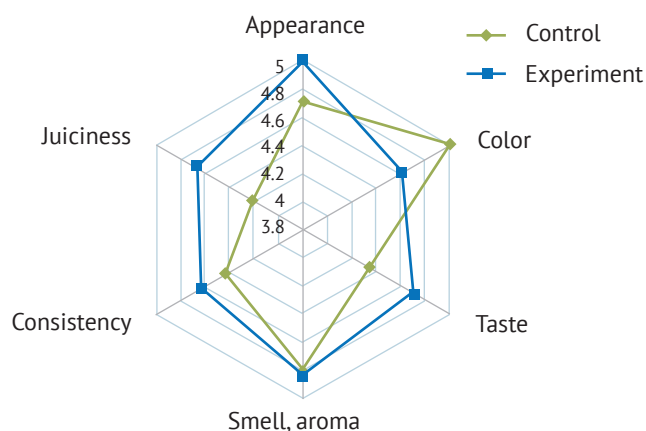


Figure 3. Profilogram of meat samples of broiler chickens depending on the form of feeding

A study on determining the taste and aroma profile of different parts of chicken was conducted by a group of experts and it was determined that the chickens of the experimental group had a more pronounced taste and aroma, namely: for pectoral muscles – 4.8 versus 4.4 in the control sample; for the femoral part – 4.6 versus 4.3 for the control group. The results are correlated with the fact that the experimental sample had a higher amount of moisture, which in turn was a consequence of the higher juiciness of the sample compared to the control one. The results of the cooking test established that the broth met the parameters of the State Food and Drug Administration, namely, it was transparent, aromatic and without sediment in the form of flakes, without extraneous aroma.

Therefore, the addition of phosphates to the ration of drinking water contributes to obtaining a high-quality product with functional and technological properties.

CONCLUSIONS

The issue of intra-life modification of meat raw materials and its directed use was and will be relevant

both among producers of livestock products and for producers of sausage and meat products. This is explained by the fact that currently the quality of meat raw materials according to autolysis indicators has certain defects, for example, low moisture-binding capacity or a high amount of moisture that does not meet the requirements of DSTU. As a result of the conducted research, it was established that the proposed method of influencing the functional and technological properties of poultry meat, namely the use of phosphates in the process of watering poultry, is effective not only in relation to the health of the bird, but is able to positively affect its preservation, which is confirmed by microbiological data of research. The results of physico-chemical and organoleptic studies indicate that metabolic processes in the bird's body allow phosphates to be utilized and quality to be modified with a significant improvement in performance.

As can be seen from research, a healthy bird gives high productivity, and drinking in the specified way ensures high taste qualities of meat. At the same time, all of the above contributes to increasing the nutritional value of broiler meat.

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Вплив функціональної годівлі молодняка курчат бройлерів м'ясних кросів на якість і безпечність м'яса

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Одеська національна академія харчових технологій

Анотація. Стаття присвячена комплексній оцінці м'яса курчат-бройлерів, вирощених з використанням функціонального годування, без додаткового використання гормональних препаратів та антибіотичних речовин, що містяться в традиційних комбікормах для курчат. Наведено дані про функціонально-технологічні властивості м'яса, хімічний склад, мікробіологічний добробут сировини та морфологічні особливості патраних тушок. Проведені дослідження показали відповідність якості м'яса вимогам стандарту та підтвердили його безпеку для вживання

Ключові слова: функціональна годівля птиці, якість м'яса птиці, функціонально-технологічні властивості, якість та безпечність м'яса птиці

Study of the relationship between oxidation kinetics and deterioration of sensory characteristics of vegetable oils

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Abstract. The oil and fat industry is a branch whose development is rapidly gaining momentum in the food industry of Ukraine. However, it is currently facing new challenges that require solutions at the expense of both increasing production volumes and finding new mechanisms for technological solutions. The purpose of the article is to establish the relationship between the appearance of rancidity in vegetable oils and the composition of the main oxidation products in them - hydroperoxides and aldehydes, that is, to find a way to predict the moment of rancidity of oils using the peroxide number and/or anisidine number. A tasting commission consisting of 10 people was formed to carry out the organoleptic evaluation of vegetable oils for the appearance of bitterness. A sensory panel with a scale of taste variation was developed to study the nuances of bitterness. Oil samples for the experiment were placed in transparent glass (Petri dish). The article examines the possibility of predicting the appearance of rancidity by the main indicators of oil oxidation – peroxide and anisidine numbers. During oxidation at 28°C and access to oxygen, the oils accumulated significant amounts of hydroperoxides (up to 160-180 mmol₁/20/kg), but there was no feeling of rancidity. It has been proven that the moment of deterioration of organoleptic indicators of oils can be predicted based on the kinetics of oil oxidation based on the data of anisidine numbers. The practical value of the research is to contribute to the transformation and improvement of the products of the oil and fat industry, including through awareness of the changes that occur in fats during their extraction, processing and storage

Keywords: oxidation, rancidity, vegetable oils, anisidine number, aldehydes, peroxide number, hydroperoxides

INTRODUCTION

Currently, the oil and fat industry faces fundamentally new tasks that are solved not only by increasing production volumes, but also require qualitatively new approaches and new technological solutions. The main task can be called the production of high-quality and safe products. Accomplishing these tasks requires a

deep understanding of the changes that occur in fats during their extraction, processing and storage.

One of the main problems of deterioration of the quality and safety of fats is their ability to undergo oxidative deterioration [1]. This problem is also related to the appearance of the so-called rancidity in fats that

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have been oxidized for some time. Primary oxidation products – hydroperoxides do not make a negative contribution to changing the taste and smell of oils [2], but their transformation products – secondary oxidation products, including aldehydes, ketones, spits, oxyacids, epoxy compounds, etc., have a specific taste and aroma of their own [3]. Odorous (aromatic) compounds should be distinguished from volatile compounds, because the latter are not always characterized by their own specific smell. Food products of various types have about 12,000 volatile compounds, but only about 5% of them play a significant role in the formation of the aroma of these products [4]. They can be perceived by the human olfactory system if present in concentrations exceeding their odor threshold.

Degradation of edible oil by oxidation during extraction, processing, storage, and use has long been recognized as a major problem in the edible oil industry [5]. Oxidation of cooking oil leads to undesirable taste, smell, loss of nutrients and formation of toxic compounds. These toxic compounds cause mutations, aging, stroke, emphysema, heart disease and cancer in the human body [6]. A particularly low odor threshold is characteristic of aldehydes, they are the main secondary oxidation products for vegetable oils presented on the Ukrainian market – sunflower, soybean, rapeseed, linseed [7]. Differences in the volatile substances of edible oils lead to the characteristic taste and smell of oils and differ significantly depending on the fatty

acid composition and other characteristics inherent in different oils. Essential polyunsaturated fatty acids are particularly susceptible to oxidation, and their presence in food products is associated with reduced shelf life and changes in their sensory perception [8;9]. At low temperatures, peroxides break down with the formation of secondary oxidation products slowly, and there may be a correlation between their content and the appearance of a feeling of bitterness. Most secondary products have a low molecular weight and are volatile [10].

These molecules form the aroma of oils and can be identified using solid-phase microextraction combined with gas chromatography and mass spectrometry (HS-SPME/GC-MS) [11-13]. It should be remembered that the method is not exhaustive, that is, it does not reflect the actual composition of volatile compounds in a certain product, but their relative contribution. Provides important information regarding the presence of odorants. Determining the content of volatiles in fats is a difficult task due to their low concentrations, the simultaneous presence of compounds in ppm (10-6%) and ppb (10-9%) concentrations, and the fact that odorant molecules belong to different chemical classes and are characterized by a wide range of molecular weights [14].

Data on the main odorous vegetable oils, including those formed in the oxidation process, are given in the table. 1.

Table 1. Main volatile vegetable oils and their perception thresholds

Volatile compound (ROAV)	Threshold of perception, ng/L	Content in oxidized oil, ng/L			Sensory characteristics
		Soybean	Linseed	Rapeseed	
1	2	3	4	5	6
Pentanol	38	11.5	1.96	1.98	Spicy, almondy, malty
Hexanol	51	11.4	23.7	10.17	Grassy
Heptanol	48	3.3	-	0,84	Rancid, greasy, citrusy
Octanol	9.3	41	42.8	40.37	Soapy, green, oily, fresh
Nonanol	12	100	100	100	Soapy, green, oily, fresh
Decanol	4.3	19.1	40.75	17.1	Floral, orange peel, soapy, greasy, green, fresh
2- butanol	350	-	0.6	0.11	Spicy
(E)-2-pentenol	1500	-	0.14	0.13	Strawberry, fruity, apple

Table 1, Continued

Volatile compound (ROAV)	Threshold of perception, ng/L	Content in oxidized oil, ng/L			Sensory characteristics
		Soybean	Linseed	Rapeseed	
1	2	3	4	5	6
(E)-2-heptenol	88	3.6	1.2	2.46	Greasy, soapy, almond, fatty
(E)-2-octanol	20	4.6	-	nd	Green, nutty, fatty
(E)-2-decanol	3,2	10.3	-	2.42	Orange
Benzaldehyde	186	1.8	2.65	1.91	Almond, burnt sugar
1-heptanol	3590	0.11	0.05	nd	balsamic
1-hexanol	360	-	0.5	nd	Green, floral
1-octanol	73	0.52	-	0.53	Chemical, metallic, annealed
Acetic acid	1384	-	0.26	nd	Sour
Hexanoic acid	3000	-	0.11	0.02	Sour, cheesy
Neanoeva acid	12	10.96	-	9.35	Green, fat
Dodecanese	5300	-	0.15	0.064	Gasoline
D-лімонен	718	2.75	1.06	0.38	Lemon, orange

Source: Adapted from [15]

All volatile substances are characterized by different perception thresholds. Aldehydes are the main volatile components of most vegetable oils [16]. According to the data in the table, 1, octanal, nonanal, decanal, (E)-2-decanal, nonanoic acid exert the greatest main influence on the feeling of rancidity of vegetable oils. Thus, mainly aldehydes affect the specific taste and aroma of various oils, as well as the change in their sensory characteristics as a result of oxidation [17]. The low level of hexanal (approximately 5 ng mL⁻¹) as a result of its low perception threshold is easily distinguished by smell [18].

Among the other volatiles of sunflower oil, which are present in noticeable quantities, are alcohols, hydrocarbons, acids and ketones. Alcohols are usually formed as a result of the decomposition of unsaturated fatty acids [16]. 1-octen-3-ol is the main alcohol of sunflower oil. However, in general, alcohols are characterized by high perception thresholds, it is unlikely that they significantly affect the sensory characteristics of the oil [19]. Unsaturated alcohols have a lower odor threshold compared to saturated alcohols and, thus, their contribution to the organoleptic properties of oils is greater [20].

Ketones are formed as a result of the enzymatic

decomposition of polyunsaturated fatty acids during the degradation of amino acids or the Maillard reaction. The content of ketones increases in the process of oxidation [8]. For fats, autoxidation and photooxygenation, which are caused by the presence of oxygen in the air, are practically inevitable [21]. Fats always contain a certain amount of hydroperoxides (already in the composition of oilseeds), which are susceptible to decomposition into secondary oxidation products, including at the stage of extracting oil from seeds, for example, when obtaining the pulp before pressing, etc.

The term "rancidity" is used to characterize two different processes: oxidative rancidity caused by the formation of lipid oxidation products and hydrolytic rancidity caused by lipid hydrolysis [22]. Oxidative rancidity occurs in fats and oils that contain almost no water [21].

There is quite a lot of data on the relationship between rancidity and the content of oxidation products [23; 24]. The impact on organoleptics of the low-temperature oxidation process has not been sufficiently studied due to its duration and the greater complexity of such studies. The main volatile oxidizing compounds formed during oil storage at ambient temperature are partially different from those formed at

high temperatures [25]. The purpose of the research is to establish a connection between the formation of a feeling of rancidity in vegetable oils and the content of the main oxidation products in them – hydroperoxides and aldehydes, that is, the search for the possibility, using the indicators of peroxide number and/or anisidine number, to predict the moment of rancidity of oils.

MATERIALS AND METHODS

The most widespread in Ukraine oils belonging to different fatty acid types were chosen as the object of the study, and thus, they can differ significantly in terms of oxidation kinetics and the time of rancidity. The following oils were studied and the initial amount of oxidation initiators – hydroperoxides (value of peroxide number – PM) was determined: unrefined sunflower oil (DSTU 4492:2005), PM=1.7 mmol 1/2O/kg, unrefined corn oil (DSTU 8808:2003) PM=1.4 mmol 1/2O/kg, unrefined rapeseed oil (DSTU 8175:2015), PM=1.5 mmol 1/2O/kg.

The anisidine number was studied according to DSTU ISO 6885-2002. The peroxide number was studied according to DSTU 4570:2006. The fatty acid composition of oils was studied by gas-liquid chromatography according to DSTU ISO 5509-2002.

To conduct an organoleptic evaluation of vegetable oils in order to determine the appearance of a feeling of bitterness, a tasting commission was formed in the number of 10 people (5 men, 5 women, aged 23-60 years), voluntarily included in the group. Commission members underwent at least 10 hours of training to determine variations in organoleptic changes in the process of oil oxidation. A sensory panel was developed to investigate the nuances of rancidity: “rancid” was defined as associated with the aroma of long-life fats with soapy-metallic aromas (minimum fried

potato chips, maximum linseed oil stored for 1 month with access to oxygen). A 5-point scale was used, with a variation of 1 – absent (characteristic of sunflower or other oil without extraneous odors and a taste of bitterness), 2 without extraneous odors, satisfactory taste, but slight bitterness, 3 – slightly sour smell and taste, 4 – sour smell and taste with notes of oxidized oil, 5 – the strongest (oxidized, musty smell of oxidized oil or olive oil). The first manifestations of bitterness were understood to mean “2” on the scale. Oil samples (fresh without rancidity and those stored for different times) were placed in a transparent glass (Petri dish), closed before serving and marked with coded numbers. The samples were kept at room temperature and analyzed in daylight. Samples were randomized and tested on different days.

RESULTS AND DISCUSSION

The most destructive, from the point of view of oxidation, lipids are unsaturated fatty acid components. For example, the rate of self-oxidation of oleic, linoleic and linoleic methyl esters is 1:40:100 [26]. Linoleic acid is an important precursor of volatile compounds in edible oils and is readily oxidized to form hexanal, pentanal, heptanal, and trans-2-heptenal. Oleic acid is also an important precursor for the oxidation of volatile compounds, especially nonanal and octane compounds. The rate of oxidative degradation of linoleic acid is faster than that of linoleic acid and oleic acid, and linolenic acid is an important source of trans, trans-2.4-heptadienal, and trans-2-hexenal in the oxidation products of edible oils [27]. Thus, for the correct interpretation of the obtained data on the rancidity of oils, it is necessary to establish their fatty acid composition. The results of the research are given in Table. 2.

Table 2. Fatty acid composition of the studied oils

Oil	Fatty acid, %					
	C ₁₆	C ₁₈	C ₁₈ ⁼	C ₁₈ ²⁼	C ₁₈ ³⁼	C ₂₀
Soybean	4.5	3.4	28.2	54.9	9.0	
Corn	7.3	5.3	44.5	42.9		–
Linseed	5.9	3.8	22.6	37.8	28.8	8.5
Sunflower	6.2	3.5	20.1	64.2	5.4	0.7

Table 2, Continued

Oil	Fatty acid, %					
	C ₁₆	C ₁₈	C ₁₈ ⁼	C ₁₈ ²⁼	C ₁₈ ³⁼	C ₂₀
Rapeseed	3.8	1.2	67.2	18.7	8.3	0.8

Unrefined sunflower and linseed oil contain the maximum number of unsaturated fatty acids among the studied oils – sunflower oil linoleic, linseed oil – linolenic (Table 2).

In order to establish the influence of the number of hydroperoxides on the organoleptic parameters of oils, the kinetics of the accumulation of peroxide number in the

samples under conditions of access to oxygen at a storage temperature of 28°C were studied. Measurement of hydroperoxides is a general assessment for determining the oxidation status of oils [28], and significantly more correct results are obtained at low oxidation temperatures. On Fig. 1 shows the graph of the kinetics of oil oxidation according to the change in the peroxide value (PH).

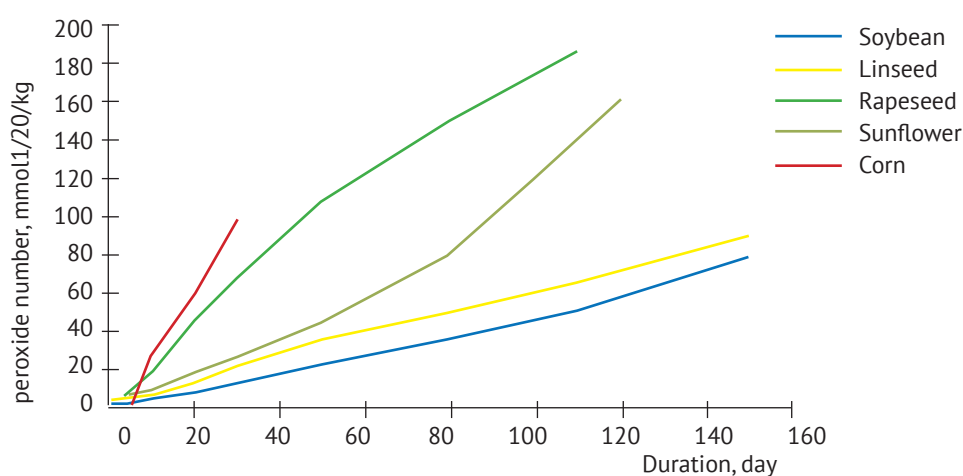


Figure 1. Kinetics of oil oxidation according to the change in peroxide values (under conditions of air oxygen access, storage temperature 28°C)

A correlation was observed between the rate of oxidation and the content of unsaturated fatty acids (see Table 2 and Fig. 1). Linseed oil accumulates hydroperoxides the fastest, corn and soybean oil the least, which is connected not only with the high content of linoleic acid (soybean oil), linoleic and oleic acids (corn oil), but also with the naturally high content

of antioxidants in these oils.

During the study of the kinetics of oxidation of oils based on the values of peroxide numbers, the organoleptic commission established changes in the smell and taste of oils and looked for the first manifestations of the feeling of bitterness. The results are shown in Table 3.

Table 3. The relationship between the amount of hydroperoxides and the formation of the rancid feeling of oils

Oil	The first signs of bitterness		Significant changes in taste and smell	
	PM, mmol/20/kg	Storage time, days	PM, mmol/20/kg	Storage time, days
Soybean	78	80	161	120
Corn	79	150	-	-
Linseed	45	20	120	50

Table 3, Continued

Oil	The first signs of bitterness		Significant changes in taste and smell	
	PM, mmol1/2O/kg	Storage time, days	PM, mmol1/2O/kg	Storage time, days
Sunflower	65	110	90	150
Rapeseed	18	7	59	20

In our opinion, no correlation was found between the values of the peroxide number and the onset of rancidity of oils. Even with high values of peroxide values, the oils did not have a characteristic rancid smell (soybean, rapeseed oil, etc.), and linseed oil with low values of peroxide values already significantly changed the sensory characteristics – the feeling of rancidity was intense (see Table 3). At the selected research temperature (28°C), when oxygen is present in the oils, significant amounts of hydroperoxides accumulate (more than 100 mmol1/2O/kg), which is a rather rare condition for oils. In most cases, during the processing or use of oils, high temperatures are used, which leads to the rapid destruction of hydroperoxides with the formation of other oxidation products [29]. In the case of low-temperature oxidation, it is convenient to monitor the effect of hydroperoxides on the formation of the feeling of bitterness. Thus, soybean oil did not significantly change its taste and smell, despite

the high concentration of hydroperoxides (more than 150 mmol1/2O/kg). These data coincide with the results of other studies [15].

To establish the influence of the number of oxidation products on the feeling of rancidity, the kinetics of changes in the anisidine number (AN) of oils were studied, the results are shown in fig. 2-6. AC is a measure of the content of secondary oxidation products, such as aldehydes, α -alkenals and β -alkenals and all compounds that can react with p-anisidine [30]. Those aldehydes that affect the result of AH are not volatile, but have an average and higher molecular weight. However, edible oils are considered acceptable for consumption when the pH is below 10 [31]. This indicates the almost absence of non-volatile aldehydes [32]. Therefore, it would be reasonable to find out how the AP values are correlated with the organoleptic evaluation data (when low-molecular volatile aldehydes appear in amounts above the recognition threshold and a feeling of bitterness appears).

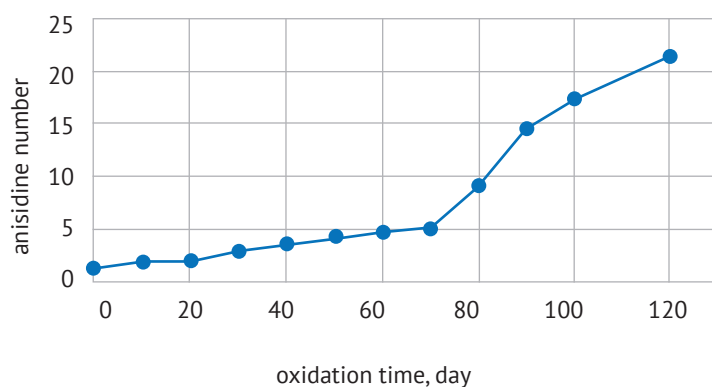


Figure 2. Kinetics of sunflower oil oxidation according to the change in anisidine numbers (under conditions of air oxygen access, storage temperature 28°C)

The period of induction of sunflower oil oxidation according to ACh data is 70 days. The first

manifestations of bitterness were noticed at AX=8.88 after 80 days of oxidation.

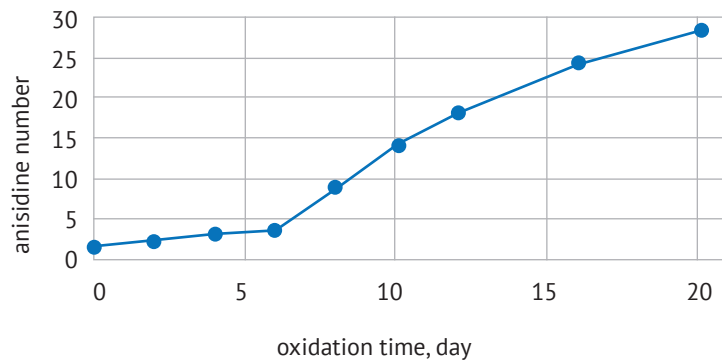


Figure 3. Kinetics of oxidation of linseed oil according to the change in anisidine numbers (under conditions of air oxygen access, storage temperature 28°C)

The induction period of linseed oil oxidation according to ACh data is 6 days. The first manifestations

of rancidity were noticed at AX=6.51 after 7 days of oxidation.

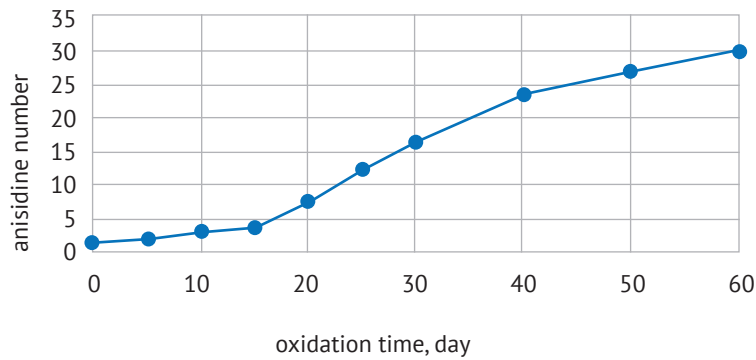


Figure 4. Kinetics of rapeseed oil oxidation according to the change in anisidine numbers (under conditions of air oxygen access, storage temperature 28°C)

The period of induction of rapeseed oil oxidation according to ACh data is 18 days. The first

manifestations of bitterness were observed at AX=7.43 after 20 days of oxidation

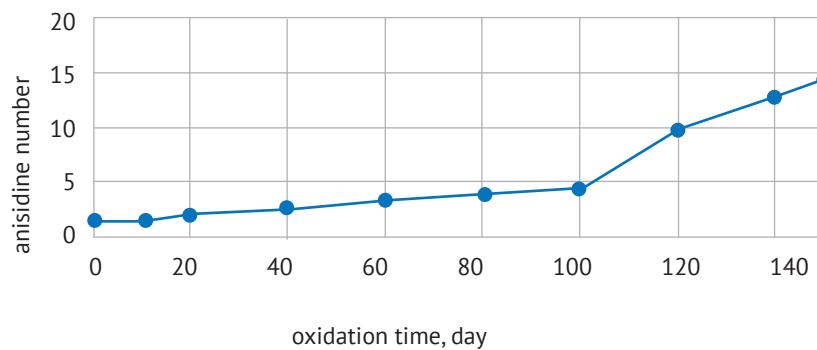


Figure 5. Kinetics of oxidation of corn oil according to the change of anisidine numbers (under conditions of air oxygen access, storage temperature 28°C)

The period of induction of rapeseed oil oxidation according to ACh data is 98 days. The first

manifestations of bitterness were observed at AX=8.48 after 110 days of oxidation.

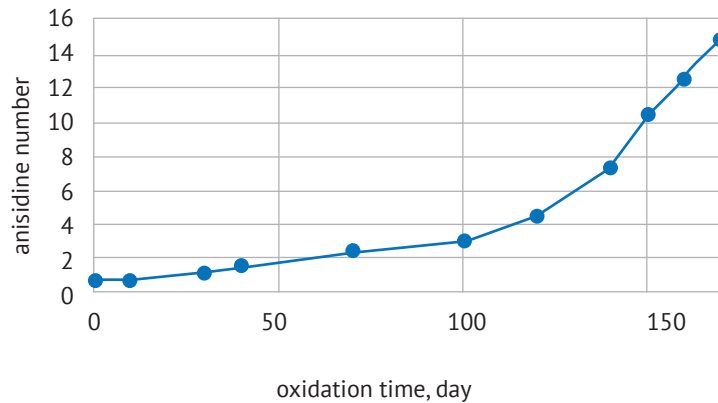


Figure 6. Soybean oil oxidation kinetics according to the change in anisidine numbers (under conditions of air oxygen access, storage temperature 28°C)

The period of induction of rapeseed oil oxidation according to ACh data is 120 days. The first manifestations of rancidity were noticed at AX=10.59 after 150 days of oxidation. No significant bitterness was detected during the investigated time interval (170 days).

A correlation is observed between the moment of exit from the induction period according to the data of anisidine numbers and the beginning of rancidity of all the studied oils. The period of induction of oils according to the anisidine number ends before the deterioration of taste and smell begins (see Fig. 2-6,

Table 4). For example, for sunflower oil, the first manifestations of rancidity appeared after 80 days of storage (Table 4), its induction period (Fig. 2) was 70 days.

It should also be noted that according to the degree of oxidation resistance, based on the change in the peroxide and anisidine numbers, the oils can be arranged in the following series (as stability decreases): soybean oil>corn oil>rapeseed oil>sunflower oil>linseed oil. There is a correlation between the oxidative instability of oils and their content of unsaturated fatty acids.

Table 4. The relationship between the value of the anisidine number and the deterioration of the sensory characteristics of the studied oils

Олія	The first signs of bitterness		Significant changes in taste and smell	
	AP, y.o.	Storage time, days	AP, y.o.	Storage time, days
Sunflower	8.88	80	21.42	120
Soybean	10.59	150	-	-
Rapeseed	7.43	20	26.87	50
Corn	8.48	110	14.53	150
Linseed	6.51	7	24.25	16

It should be noted that in all samples there is no sharp increase in AC, which is associated with the low temperature of oil storage and the absence of rapid destruction of peroxides (Fig. 2).

At the end of the studied oxidation interval, the number of aldehydes decreases (Fig. 2-6), which is probably related to their transformation into other oxidation products.

CONCLUSIONS

According to the set goal, the article investigates the relationship between the formation of the feeling of rancidity in vegetable oils and their content of the main oxidation products – hydroperoxides and aldehydes.

The level of oxidation of fats and oils, as well as the accompanying formation of off-flavors, is ultimately assessed by the senses. However, sensory evaluations are resource-intensive and cumbersome to perform (need to create tasting panels to rule out subjective errors, etc.). To avoid these drawbacks, an array of chemical tests is often used to monitor the progress of lipid oxidation. These include peroxide content (PC), anisidine value (AC), iodine value (IV), thiobarbituric acid (TBA) value, and levels of conjugated dienes (CD)

and hexanal (Hex) produced during oxidation. In order to reduce the number of necessary studies for predicting the moment of the formation of the feeling of rancidity, the article establishes a correlation between the kinetics of oxidation of oils according to peroxide and anisidine numbers and the moment of deterioration of their organoleptic indicators. It has been proven that the content of hydroperoxides does not affect the formation of the feeling of bitterness - even with high peroxide numbers of the studied oils, they did not change their organoleptic characteristics. It has been proven that using the kinetics of the change in the anisidine number, it is possible to predict the moment of rancidity of oils. Bitterness occurs after exiting the induction-period according to the kinetics of anisidine numbers.

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Дослідження зв'язку між кінетикою окиснення та погіршенням сенсорних характеристик рослинних олій

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Анотація. У статті досліджено можливість передбачення появи відчуття згіркнення за основними показниками окисненості олій – пероксидними та анізидиновими числами. Під час окиснення при 28°C та доступі кисню олії накопичували суттєві кількості гідропероксидів (до 160-180 ммоль/20/кг), однак не з'являлось відчуття згіркнення. Доведено, що по кінетиці окиснення олій за даними анізидинових чисел можливо передбачення моменту погіршення органолептичних показників олій

Ключові слова: окиснення, згіркнення, рослинні олії, анізидинове число, альдегіди, пероксидне число, гідропероксиди.

Organization and management of the technological process of the elevator for improvement of quality grain indicators

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Abstract. The article analyzes the system of automated process control at the elevator to determine promising areas for improving the quality of grain. The structural scheme of control and the algorithm of laying the transport route of grain according to the specified coordinates on the basis of SCADA-system are investigated. One of the directions of increase and improvement of technological process on the elevator is defined, which consists in improvement of control algorithms in the direction of optimization of technological processes of the elevator on many criteria (minimum of energy consumption, minimum of grain fighting, minimum of transport time), product performance

Keywords: transport-technological line, SCADA system, quality of grain products, optimization criteria, elevator

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INTRODUCTION

The current situation of elevator complexes is unsatisfactory, both in terms of storage infrastructure, in which more than 40% need adapted for storage and transportation of grain in warehouses [1], and in terms of technology, in which elevator lines are provided with obsolete equipment that requires repair or outdated method of organizing the management of equipment to ensure the transportation of grain products. From this situation it becomes obvious that there is a shortage of capacity of technological lines of the elevator complex.

Modern methods of ensuring the transportation of grain products in the elevator complex is based on industrial controllers compatible with personal computers, electronic computers and software, which together create an automated process control system [2]. Compared with relay control systems for grain transportation routes, the automated system is complex, which is characterized by the presence of a common functional purpose in all elements of the system, the systemic nature of the implemented algorithms for information exchange and processing; the presence of functional subsystems [3]. The main advantage of using these components in the enterprise is the ability to develop new advanced technological systems and create new more efficient technological processes [4], but the organizational and functional structure of elevator complexes remains unchanged, and hence the quality of technological process of grain transportation does not change [5]. Due to the fact that volumes and needs are always increasing, the question arises in improving the efficiency of processes under the same conditions with possible small changes associated with modernization, optimization and other improvements.

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

The introduction of an automated system in the elevator control process can be performed on the basis of the old relay control system, replacing old relay controls with modern microprocessor controllers, sensors and leaving the original automation elements (magnetic starters), using the already established cable line system [6].

The main advantage of the automated system is the automation of the process of laying the route of transportation of products through the elevator complex, which is not only easier several times, but also becomes more efficient and productive. The elevator can work simultaneously with several technological operations, which will form 6-7 routes, during which 2 crops are accepted, 2 are shipped and 2 are transported for drying [3]. This increases not only productivity, but also the rational use of all equipment, which also reduces energy consumption. Indicators of energy consumption of the processing process per ton of grain in the elevator with an automated control system is – 7 kW, compared with the outdated control method – 12 kW [7]. The new possibility of paving the route also affects the speed of loading vehicles with products. For example, the loading speed of a car with an automated control system is 10-15 minutes, compared to outdated control methods, from 40 to 120 minutes [8].

The use of automated control of equipment and automation elements gives this system the opportunity to increase profits by generating additional profits or equalize the quality of the grain batch for export, by drawing up the necessary terms of reference and changes in the control program for grain routes [9]. In order to generate profit, it is necessary that the grain be of the required export quality, and for this it is often necessary to artificially mix different batches. With the help of an automated control system to equalize the quality of grain for export has become more efficient – 90% of the total volume, compared to previous elevator control systems in which this opportunity was only 30% [10]. An automated system that provides control of the technological process in the elevator, is a complex system and belongs to the class of complex functional systems. This system is characterized by a large number of electronic elements that are united by a common goal, the systematic implementation of algorithms for exchanging and processing information, has a large number of functional subsystems. Considering the process control systems at the elevator, it is seen that the modern development of automated control systems is based on the use of serial basic controllers,

sensors that can be combined with personal computers and software controllers with system programming support, which allows you to create an efficient system control [3].

Since the process of managing the technological process of the elevator is continuously linked to the process of moving grain products, providing transport routes, we provide the technological process of processing grain products, the quality of which also depends on the correct route of movement, so this process is one factor in achieving efficient production process.

The aim of the article is to evaluate the automated control system of the elevator complex in order to determine promising ways to improve the quality of grain products in terms of automation of the technological process and methods of its organization and management.

PRESENTING MAIN MATERIAL

In practice, the provision of process control, namely the provision of control of technological routes of transportation can be provided in several ways. The first is based on special software that communicates with sensors and actuators using a personal computer [11,12]. This method has a low cost of technical means and has a sufficient level of unification of the technological process, in comparison with relay control systems or the use of special equipment controllers. This method of transport route management has the ability to change and make any changes to the transport route of the operator on the workplace, without the involvement of specialists and service personnel, which is typical for the scheme of partial remote control (Fig. 1). This scheme is based on the hardware algorithm for implementing the process of control of the technological process of processing at the elevator complex [13].

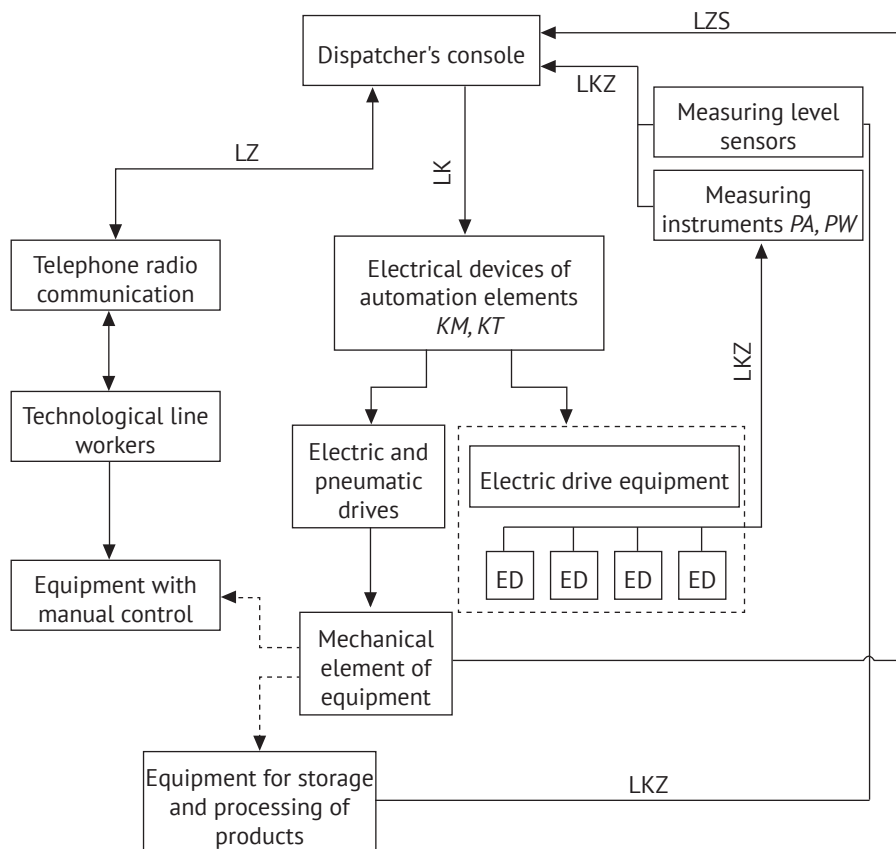


Figure 1. Scheme of partial remote control: LKZ - line of control of loading of the equipment; LZS - the line of the return alarm system; LC - control line; LZ is a communication line

However, the cost of this system still remains high due to the cost of software and its maintenance, which leads to the next negative factor – the need for highly qualified professionals and the probable

dependence of the customer on them [13-15]. To ensure the solution of the problem of elevator automation, the following structural scheme of enterprise management is used (Fig. 2).

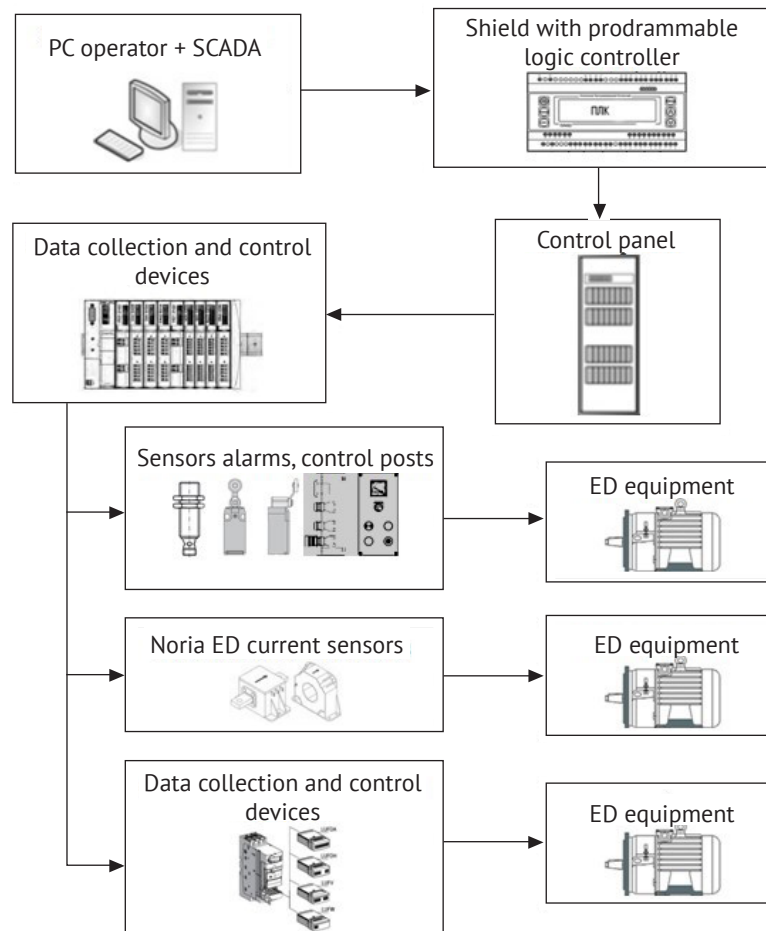


Figure 2. Block diagram of the automated process control system at the elevator

All equipment of the elevator automation system can be divided into groups, the combination of which in turn leads to the appearance of the main units that provide remote control. The modular-block principle of construction allows you to easily upgrade the system and, if necessary, add new elements to it, gradually covering additional areas of production [16]. Equipment groups include: sensors and alarms for information collection; starting and regulating equipment; devices for remote data collection and equipment control; programmable logic controller and system-SCADA. The block diagram (Fig. 3) shows the

main control units, control board, board with programmable logic controller, operator's workplace based on SCADA-system. This distribution of roles between the elements of the automation system increases the productivity and reliability of the system in comparison with classical elevator control solutions [17].

The power control board (control panel) contains starting control equipment, current sensors and controller modules, so-called remote collection and control devices. He is responsible for the supply of electricity to the electric motors of the equipment, protection of equipment from overloads and short

circuits; electrical circuit interlocks; reception of input signals from sensors; ensuring the possibility of local equipment management.

The board with the programmable logic controller (PLC) provides control of the equipment of a power board by means of the digital interface. It plays a major role in providing automation in the elevator system. He is responsible for the main part of the algorithms for control and protection of equipment.

The use of PLC and power shield is responsible for performing many operations, namely [17,18]:

- blocking the possibility of including transport equipment by the operator in the wrong sequence;
- automatic sequential switching on of equipment with time delays to reduce the shock load on the power plant;
- automated supply of grain in the tank of the grain dryer;
- protection of technological and auxiliary equipment from inadmissible operating modes;
- emergency alarm system in case of malfunction of technological and auxiliary equipment;
- emergency alarm system in case of malfunction of automation equipment;
- automatic stop of a stream at filling of capacity of storage of grain;
- automatic delayed stop of the transport equipment of the route after the cessation of product supply in order to remove grain residues from conveyors and burrows;
- the emergency warning alarm system on granary about remote start of the transport equipment.

The SCADA system is a common system used in automated control processes, so complex and large systems, such as used to control power plants, and smaller ones are used for industrial automation, this system can also be adapted to other processes. The main advantage of this system is the awareness of the operator, it can provide the necessary information, which is collected throughout the production in real time [19,20].

In [13-16] were analyzed and described an automated control system using the SCADA system to perform the process of controlling transport routes, and presented control algorithms in the form of a system of equations, as the SCADA system is a container of

various functional elements responsible for performing relevant tasks. Performing their management and using their initial data on the results of the technological process, as well as the possibility of synchronous exchange of information data with electronic resources (archives, databases), it creates efficient operation and a high level of unification of automated control system [19]. SCADA is a software system that is programmed in a specific programming language for the elevator complex, ie it prescribes the entire technological process of grain processing and ensuring the control process occurs by using control signal algorithms for logic controllers of the system. As in software-based control, the SCADA system also makes it possible to route and change the transport route at the operator's command, without handing it to programmers during the process. However, as in the first case, this system has a high cost both in the process of installation and maintenance, so it is mainly used in newly built elevator complexes, but this system is still widely used. The application of this method of providing transport routes for the movement of grain products, although facilitated in operational terms for operator work, but in technological terms, this possibility is a complex process that involves the interaction of many elements of the control system. The process of routing on the elevator complex by the SCADA system is performed by dividing the entire technological process into functional groups that have appropriate control algorithms. The process of moving the grain flow can be divided into the following groups, which perform the control process [13]:

- the first functional group is the transport mechanisms: conveyors, conveyors, norias, which first of all move the grain to the front or back, but to ensure this process, the system must take into account the control of condition, overload, speed, direction of transport, while receiving information about the state previous mechanism;
- the second group includes granaries: bunkers and silos, which provide the technological process by opening and closing latches, but to ensure a given operation, the system also takes into account the information about the level of storage, the position of latches and the state of the previous mechanism;

- the third group of elements includes guides that move only forward or backward, but as in previous groups to perform their functional purpose, the system takes into account the position of the guides, information about the level of filling and operation of the previous mechanism;

- the last group is the unloading cart which carries out movement in front and back and at achievement of the necessary place opens or closes the valve.

These conditions are used to control the transport

and technological routes of the elevator, based on the SCADA system, which are prescribed by modern general programming languages in the form of systems of logical equations that form a signal to control the elements or all equipment of each group.

The internal structure of the automated system, as mentioned earlier, consists of subsystems that are combined for one purpose, so this route management system consists of subsystems, which are presented in Fig. 3, the functions of which follow from their name [21].

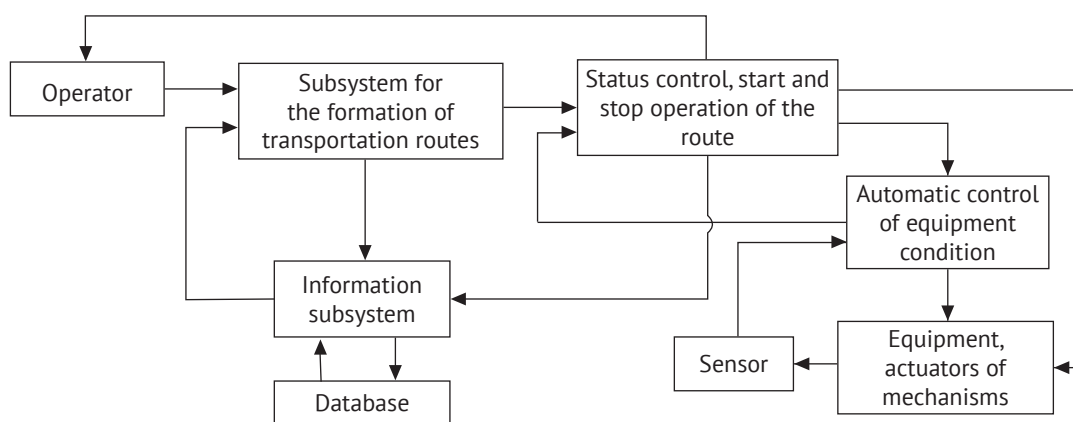


Fig. 3. The structure of management of transport and technological routes of the elevator

Considering this system, we can say that all the above subsystems are interconnected and form a single functional system, but before its formation, each subsystem is developed as a separate functional unit, which allows alternate and phased implementation of systems in the elevator control process [1]. Also, based on the specified structure of the control circuit, you can pay attention to the fact that the control process takes place in automatic and automated mode at the same time, where automatic control is carried out by transferring functional data between subsystems: automatic control of the condition of the equipment, executive elements of mechanisms and sensors, thus operations are provided: transfer and reading of the information of a condition and position of the equipment;

preventing the stoppage of the transportation process due to an unplanned situation, due to the functional processes of the security system; transmission of start and stop commands; recording information on the course of the technological process. And automated control is involving subsystems of formation and control of the transport route and the operator through the above subsystems, while providing the process of forming commands to start and stop the Considering the structure of the system of transport route, indicating the start and end automated control of transportation routes, point of the route, the ability to adjust and you can see the algorithm of the process of change the route [2,13]. laying the route, which is presented in Fig. 4.

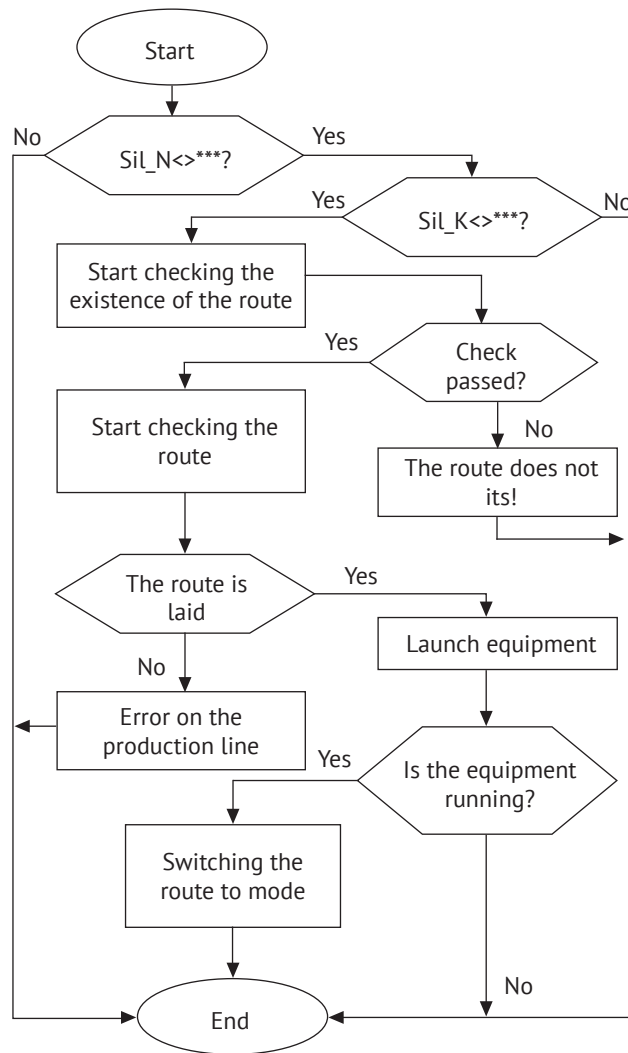


Fig. 4. Algorithm for laying the transport route at the command of the operator

From this algorithm and the structure of the automated control system follows one of the main conditions for routing and operation of the control system, which is the need to program each control device equipment separately (troughs, conveyors, valves, valves and silos) and all control sequences, engineers program and describe all possible routes using and taking into account all the mechanisms that may be involved during transportation [22]. With the operator's command, the construction of the transportation route is performed by selecting the first free route from the pre-programmed, and performing all accompanying operations. Based on this condition, to build alternative routes, engineers also need to program alternative transportation routes that are needed during emergencies, because the programmable transportation

system is not designed for reconfiguration during management. Examining the automated route and its management process, it can be noted that the problem of choosing and building a grain transportation route compared to the previous century is solved, but no one paid attention to the quality of these routes in terms of efficiency, productivity and economy.

Considering modern methods of managing the technological process of transporting products at the elevator, we can say that the means of implementing the technological process are divided into the first and second class of tasks, which in the first case are implemented through the use and implementation of software 1C, and in the second case with more complex and modern SCADA system, which can also be used in the first case. The implementation of the tasks of the

second class is carried out with the help of special equipment, which requires information and characteristics of the technological process and scope [21].

Today, the tasks posed by the technological process of the elevator are performed by systems that specify standard and nonstandard tools. These tools operate locally and form a single automated management system that reduces or fully compensates for the shortcomings of these tools, thus increasing the efficiency of the management process. The modern method of laying and ensuring the process of transportation of grain products through the elevator is based on standard and non-standard means of ensuring the technological process. As a result, the control system is characterized by the presence of actuators and equipment for transportation and electronic equipment: sensors, programmable controllers, software with support for programming – SCADA systems, etc. [3], however, paying attention to the modern organization and functional structure of the elevator complex, it becomes clear that the automated system remains unchanged, and therefore the quality of control of the technological process of transportation of grain products also does not change [5].

Improvements in technological processes at elevator complexes, in recent years, have been carried out by solving and improving certain tasks of the automated system. Such tasks include the processes of improving the quality of grain, using methods of cleaning, drying and storage, in which some progress has been made, through full automation of these processes, namely the use of additional elements that monitor product parameters during processing and parameters of the process, humidity, etc.), providing information to the operator, reducing the probability of its error [24]. Steps have also been taken to improve the process control of equipment used in the process, and many other improvements have been made that have improved the conditions for the tasks of the automated elevator control system, but there are still some problems that

are still unsolved. In the current elevator complexes and their control systems, the issue of routing remains open, or rather the process of forming the grain transportation route, as the modern automated control system does not meet all modern conditions required of the elevator complex [23,24]. This results in the unsolved problem of managing transportation at the reception and shipment of grain, which consists in confusing the route due to human intervention and maintaining the required performance at high elevator capacity and the flow of incoming products.

CONCLUSIONS

Automated elevator control system, which covers many functions to ensure the technological process, insufficiently implements the task of laying the route of transportation of grain products, which leads to losses in economic and quality areas of production. The transportation process is the result of automatic selection from the database of the first free route, which was preprogrammed by the engineer without taking into account certain criteria. Due to the fact that all constructed routes will not take into account certain conditions and requirements that would ensure the improvement of indicators, these conditions should be the criteria for optimization. Algorithms for constructing a transportation route are not optimal for the technological process, as they do not take into account certain criteria that would help them improve the transportation process (minimum energy consumption, transportation efficiency, route length, transportation time, grain quality (minimize loss and combat), equipment condition, etc.).

As a result, the system does not provide a rational and productive transportation route in terms of productivity and quality. The problem of improving control algorithms in the direction of optimization of technological processes of the elevator taking into account many criteria is relevant, the solution of which will improve the quality of grain products.

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Аналіз транспортування зернової продукції на елеваторах

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Анотація. У статті висвітлено результати аналізу транспортно-технологічних ліній на елеваторі, які забезпечені автоматизованою системою управління для визначення перспективних напрямків підвищення якості зерна, з точки зору організації технологічного процесу. Проаналізовано структурну схему управління та алгоритм прокладання маршруту руху зерна за заданими координатами. Визначено один із напрямків підвищення та вдосконалення технологічного процесу на елеваторі, який полягає у вдосконаленні алгоритмів керування в напрямку оптимізації технологічних процесів елеватора за багатьма критеріями (мінімальне енергоспоживання, мінімальна боротьба зерна, мінімальний час транспортування), показники якості продукції

Ключові слова: транспортно-технологічна лінія, система SCADA, якість зернової продукції, критерії оптимізації, елеватор

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