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# ARCHITECTURE

УДК 504.03, 620.92

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## ФУТУРИСТИЧЕСКИЕ НЕЛЕПОСТИ ГОРОДА МАСДАР

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## FUTURISTIC FUNNY OF MASDAR city

### Аннотация

Пятнадцать минут на авто, в 17 км на юго-восток от международного аэропорта столицы Объединенных Арабских Эмиратов Абу-Даби с его высотными зданиями, широкими проспектами и транспортными магистралями, и вы попадаете в настоящий эко-технологический рай под названием Масдар, похожий на фантастический город из западных кинофильмов. Строительство этого футуристического проекта в самом разгаре.

### Abstract

Fifteen minutes by car, 17 km southeast to the international airport of the capital of the United Arab Emirates Abu Dhabi with its skyscrapers, wide avenues and highways, and you find yourself in a real eco-technological paradise Masdar, similar to a fantasy city from Western films. Building of this futuristic project is at its peak.

**Ключевые слова:** Масдар, эко-город, город будущего, футуристическая архитектура, техника арколгии.

**Key words and phrases:** Masdar, eco-city, city of the future, futuristic architecture, archology technique.

**Введение.** В апреле 2006 года арабские шейхи перестали сорить деньгами, воздвигая экзотические дворцы и прочие помпезные излишества, а вложили деньги в создание поистине серьезного и дорогостоящего объекта – первого в мире эко-города, оазиса посреди пустыни под названием Масдар [1].

**Основная часть.** Проект сказочного города будущего выполнен британским архитектурным бюро «Foster + Partners» совместно с компанией «Mott MacDonald», работающей в секторе инженерно-экологического консалтинга [2, 3]. Если

взглянуть на проект города с высоты, то глазам предстанет, увы, не прекрасный городской пейзаж, а ничем не примечательный городок, чем-то похожий на киевский жилой массив Троещину, с планировкой «военного» типа: простая форма кварталов, прямые улицы, малоэтажные постройки и очень плотная застройка [4]. Иными словами, с высоты птичьего полета город будет не сильно привлекателен и особого впечатления не произведет: обычный серый «чип», встроенный в аравийскую пустыню.



Рис. 1. Генеральный план города Масдар с высоты птичьего полета

Единственное, что может броситься в глаза, – чрезвычайно плотная застройка: главные улицы Масдара будут не шире 10 метров, – хотя и это в наше время не редкость: во многих жарких европейских городах постройки лепятся друг к другу очень плотно, гораздо плотнее, чем в Масдаре. Однако впечатление о незатейливости архитектурного

пейзажа, полученное при взгляде с высоты нескольких тысяч метров, на самом деле обманчиво. Дома, практически вплотную поставленные один к другому и создающие в других городах впечатление тесноты, здесь будут создавать чувство уюта [5].

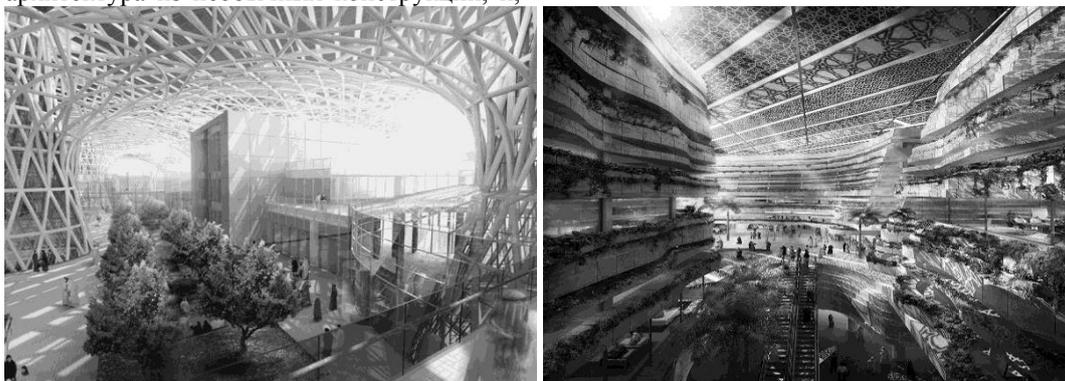


*Рис. 2. Вид с уровня улиц.*

*Город, подобно шоколадному яйцу, таит в себе немало сюрпризов*

С уровня его улиц перед жителями и туристами раскроется совершенно другая картина всей прелести этого зеленого чуда-места. Сам город будет небольшим, всего 6 квадратных километров, но невероятно уютным. Изобилие фонтанов, каналов, водопадов, городских зеленых насаждений, грандиозная архитектура из необычных конструкций, и,

главное, – экологически чистые технологии, органично вписывающиеся в инфраструктуру города. Разве не это тайная мечта жителей бетонных «джунглей», ежедневно вдыхающих смесь токсичных газов, спотыкающихся о горы мусора и унывающих от скучного городского пейзажа?..



*Рис. 3. Почти весь город будет прикрыт сверху сонмом*

*затейливых специально разработанных головоломных ажурных конструкций для защиты от солнца, создающих на улицах и площадях причудливую резную тень*

Своего рода приманкой для глаз в городе станут огромные передвижные зонтики от солнца, которые будут подниматься из земли, подобно гигантским подсолнухам, и скрывать от палящего

аравийского солнца улицы, площади, входы в гостиницы и досуговую зону. Днем они будут ориентироваться на солнце и давать тень, ведь в Арабских Эмиратах в летние дни температура воздуха

достигает порой целых 50 градусов. Ночью они будут закрываться и излучать накопленное за день тепло.



*Рис. 4. Гигантские передвижные зонты для защиты от солнца*

Дома и здания города будут иметь небольшую этажность, не выше шести этажей. Исключение сделают только для офисных зданий, например,

«Pearl River Tower», высота которого будет составлять 70 этажей.



*Рис. 5. Детали архитектуры и внешних фасадов.*

*Здания и сооружения города имеют невообразимую форму: одни то выпирают наполовину, то построены под наклоном, другие могут быть круглыми или же треугольными*

Архитектура города спланирована так, что его улицы и площади будут покрыты искусственной ажурной тенью разнообразных очертаний от зданий, что не только защитит жителей от лучей палящего аравийского солнца, создавая даже в жаркий полдень прохладу, но и обеспечит особую атмосферу уюта. Выступающие балюстрады и пло-

щадки, нависающие над тротуаром стены, специальные конструкции, оригинальные пологи – все продумано и выверено с точностью до сантиметра. В сочетании с новаторской архитектурой города ажурный полог создаст уникальную атмосферу уюта. Такая красивая техника аркологии, сочетания стиля и технологий, использовалась арабами при строительстве зданий столетиями и как создаст уют

и прохладу, так и послужит еще и с практической точки зрения, ведь значительно сократит затраты энергии на кондиционирование зданий города. Ведь только за счет точных архитектурных расчетов: очень высокая плотность настройки горда, ширина его улиц, форма стен зданий и особые строительные материалы, применяемые для их строительства, – температура в городе должна быть в среднем на 15 градусов ниже, чем в соседних городах региона. Кроме того, уменьшению необходимости включения кондиционеров в жаркие дни будет способствовать расположение города на оси юго-восток – северо-запад [6, 7]. Это поможет сохранить улицы города в тени и минимизировать количество прямого солнечного света, попадающего на окна зданий. Тем самым на кондиционирование города будет уходить максимально возможный минимум энергии.

Помимо этого, по периметру городской черты Масдар Сити планируется возвести высокую мощную стену для защиты чрезвычайно жаркой и запыленной местности от горячего пустынного воздуха, несущего пыль и песок, и отражающей его извне. Говорят, архитекторов на подобную планировку вдохновили спрятанные от песчаных бурь за высокими крепостными стенами традиционные ближневосточные города Средневековья с их узкими улочками доавтомобильной эпохи, где все необходимое для повседневной жизни находилось на расстоянии буквально вытянутой руки. Кроме того, планировка города позволит не только не пускать в него горячие пустынные ветра, но и разбить городскую зону на множество тенистых улочек, сделать пешеходные улицы Масдара узкими, что позволит легкому прохладному бризу захватываться в них воронкой и проходить вдоль затененных широкими стенами зданий улицами.



*Рис. 6. Улицы и переулки Масдара больше напоминают цепочку атриумов, как во многих современных торговых или бизнес-центрах*

Все эти планировочные решения, использованные при проектировании города: узкие тенистые улицы, затененные площади, расположенные с учетом розы ветров, – позволяют создать в городе комфортный микроклимат

Особенность города в том, что в нем трудно будет прогуляться по площадям и перейти широкий проспект, ведь здесь не планируется строительство открытых пространств – площадей и проспектов. Все архитектурные элементы городка тесно увяжутся и переплетутся между собой.



Рис. 7. Интерьеры и экстерьеры Масдара. Одно плавно и незаметно перетекает в другое

**Выводы.** В плане Масдара учтены все тонкие нюансы: и климатические условия, и потребности жителей, и влияние на экологию. При планировании города принимаются во внимание все мельчайшие детали, касающиеся как сохранения энергии, так и комфорта жителей. Для людей, которые будут обитать в этом технологическом чуде света, разработчики, архитекторы-футуристы и конструкторы попытались воссоздать гостеприимную, почти домашнюю атмосферу уюта, спокойствия и приятной радости для работы, досуга, отдыха и просто жизни. На каждом шагу – фонтаны, водопады, зеленые насаждения, постройки в технологично-космическом антураже и, что немаловажно, ни одного сантиметра раскаленного серого асфальта, к которому так привыкли жители современных городов.

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# PEDAGOGICAL SCIENCES

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## THE USE OF THE CASE METHOD IN THE PROFESSIONAL TRAINING OF FUTURE NURSES

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## ВИКОРИСТАННЯ КЕЙС-МЕТОДУ У ПРОФЕСІЙНІЙ ПІДГОТОВЦІ МАЙБУТНІХ МЕДИЧНИХ СЕСТЕР

### **Abstract.**

*The article substantiates the effectiveness of using the case method in the professional training of future nursing specialists; the peculiarities of the case method, its principles, structure, influence on the formation of qualitative characteristics of the specialist and the peculiarities of its application in the preparation of future nurses for professional activities are defined.*

### **Анотація.**

*У статті обґрунтовано ефективність використання кейс-методу у професійній підготовці майбутніх фахівців з медсестринства; визначено особливості кейс-методу, його принципи, структуру, вплив на формування якісних характеристик фахівця та особливості його застосування у підготовці майбутніх медичних сестер до професійної діяльності.*

**Key words:** *case, case method, nurse, professional competence, professional training.*

**Ключові слова:** *кейс, кейс-метод, медична сестра, професійна компетентність, професійна підготовка.*

**Introduction.** One of the priority directions of medical education is the training of competitive nursing specialists capable of self-study, analysis, synthesis, and generalization of information. Reducing the gap between the professional capabilities of graduates and the needs of patients is a priority of medical education. This is facilitated by a large number of different interactive teaching methods, in particular, the case method (case study, analysis of specific situations, the method of situational analysis, etc.).

The case method is considered as an effective tool for quality education renewal, which contributes to the development of the ability to solve problems taking into account specific conditions and in the presence of factual information. In some sense, the method contributes to the formation of a person's professional and personal qualities. It forms a sense of confidence, helps to overcome excessive self-confidence or excessive timidity. The case method develops in future medical professionals such personal characteristics as the ability to analyze and diagnose problems, communicate, discuss, perceive and evaluate information, the ability to clearly formulate and express one's position [3].

**The purpose of the work** was to study the case method in the educational process to improve the training of future nurses.

**Main part.** A significant amount of theoretical material for each disease (pathogenesis, clinical manifestations, diagnosis and nursing interventions) and the traditional educating method of teaching clinical disciplines often reduce students' motivation to study. The use of the case method, which has the advantages of specificity, flexibility, and interactivity, can help students understand information through a variety of clinical situations.

Studying with the help of cases develops the ability to analyze, teaches to avoid mistakes that often occur when performing specific tasks.

This method is a pedagogical tool that allows you to apply theoretical knowledge to solving practical problems. Solving cases is based on students' basic medical knowledge and clinical analysis under the careful planning and guidance of the teacher, and also meets the learning objectives and requirements for the learning content [5].

The case method when studying clinical disciplines requires certain prerequisites. From students □ mastering theoretical knowledge of etiology, disease mechanism, symptoms, diagnosis and scope of nursing interventions in order to fully conduct case analysis and discussion to achieve the learning goal. The role of the teacher is also changing: from the bearer of knowledge to the creator of conditions under which the student will

be able to develop appropriate professional and personal qualities, form the ability to independently make decisions in conditions of uncertainty, identify a problem, analyze, forecast the further development of the situation, develop an action plan for solving a certain situation, develop teamwork skills, etc.

The main function of the case method is to teach students to solve complex unstructured problems that cannot be solved analytically, that is, by considering certain situational problems, where a description of real or close to reality specific situations is used. After all, during training, students' motivation for professional formation and personal growth as a qualified specialist in the future occurs under the condition that they feel the importance of their own participation in such a process, and not only determine their goal to master the knowledge offered by the teacher [1, 4].

Future nurses have the opportunity to independently analyze the task before them and find the most appropriate ways to solve it. This educational method ensures better assimilation of theoretical knowledge, acquisition of practical skills, develops the ability to think independently and cooperate collectively, contributes to the improvement of analysis skills to recognize and solve specific problems, and also teaches correct management ideas, communication skills and teamwork, creates a basis for using the acquired experience when making decisions in practical professional activity.

Through equal interaction and discussion between teachers and students, students and students, students' clinical logical thinking, ability to reason and analyze to achieve high cognitive learning goals are trained [5].

In the educational process, the case method can be used as an independent method and in the organization of trainings of various directions (oriented to the development of analytical abilities by solving professional problems, making responsible decisions, organizing effective interpersonal interaction with staff, determining the level of knowledge and skills, etc.) [1].

Solving cases plays a crucial role in the development and improvement of clinical skills necessary for future specialists [6]:

1. Diagnostic justification: cases on relevant topics provide an opportunity to develop diagnostic skills in assessing information about the patient, determining his actual and potential problems, and making a nursing diagnosis. By analyzing a variety of scenarios, students can hone their ability to consider different possibilities, weigh evidence, and diagnose disease.

2. Decision-making: cases represent situations that require students to make informed decisions about diagnostic search options and nursing interventions. By examining a variety of cases, students can develop their decision-making skills by considering factors such as patient adherence, risk analysis, and evidence-based recommendations.

3. Application of medical knowledge: cases reduce the gap between theoretical knowledge and its practical application. They require students to apply their medical knowledge and develop the ability to adapt it to different clinical situations.

4. Problem solving skills: case studies often present complex clinical disease scenarios, challenging students to think critically and creatively to find appropriate solutions. By solving these complex problems, they develop problem-solving skills, learn to navigate uncertainty, and gain experience managing complex patient cases.

5. Teamwork: many cases involve the cooperation of nurses with doctors and other medical professionals. Through this collaboration, future nurses learn about the importance of interdisciplinary teamwork, effective communication, and understanding the role of different professionals in providing comprehensive patient care.

6. Ethical Issues: Case studies often involve ethical issues, requiring nurses to navigate issues such as patient autonomy, confidentiality, informed consent, and end-of-life care. Working through these ethical issues in a controlled environment helps them develop ethical decision-making skills and a strong ethical foundation.

7. Continuous learning and professional development: case studies encourage continuous learning and professional development. They highlight areas where nurses need to deepen their knowledge, identify skill gaps, and encourage them to seek appropriate solutions, guidelines, or resources to improve their professional practice.

As a result of active participation in solving situational tasks in cases, in the context of performing specific actions in simulated situations, students can improve their diagnostic skills, ability to make decisions, ability to solve problems, presentation and self-presentation of optimal models of professional actions, ability to persuade, work in a team, make responsible decisions, etc. This experience contributes to the formation and development of students' professional competence, making them better prepared to provide high-quality care to their patients. Thus, this method can be considered as a complex system in which simpler methods are combined: discussion, problem method, system analysis, modeling, etc. [1].

L.V. Kozak and other researchers [2, 4] in their studies note that the case method allows you to form competencies and successfully solve the following tasks: master the skills and techniques of comprehensive situation analysis from the field of professional activity, which helps in solving similar problems that will arise in real life practical activities; to form problem-solving skills, which are developed in the process of modeling one's own actions in a problem situation, which enables students to check their own beliefs, theoretical knowledge and prejudices; to make decisions quickly - "here and now", as well as in uncertain situations; draw up an action plan aimed at achieving a positive result; acquire the skills of presenting one's own point of view in oral or written form; develop the ability to convincingly justify and defend one's point of view; practice communication skills; practice the skills of constructive critical assessment of the point of view of others; mastering the practical experience of benefiting from one's mistakes, as well as from the mistakes of other professionals.

For effective use, cases must meet the criteria [2, 5]:

1) the case should meet the learning objectives, covering a clinical topic. To give students an opportunity during the discussion to use theoretical knowledge when solving a situational task, to deepen their understanding of the key and difficult moments of diseases and the participation of a nurse, as well as to deepen their understanding and mastery. At the same time, students' clinical thinking extends from the local to the whole, which improves the students' analysis and problem solving [5].

2) the case should be as close as possible to real professional activity and be objective, bright, to arouse the interest of students for further discussion.

3) the task should provide for different ways to search for solution options;

4) cases may differ in the level of generalization, the amount of information presented, the complexity of the problem; the case should be of a certain degree of complexity, but not too simple. It is necessary in some cases to consciously choose difficult and critical cases, in which mistakes are often made, which as a result arouses the interest of students in learning, investigating the causes of the problem, access to information and deep analysis. In addition, in order for the key questions to be reflected in the case, teachers should provide clear information to facilitate the use of cases and case learning [5].

5) case material should not be outdated, it should be updated and improved in accordance with changes in practical health care.

It should be noted that the case method can only complement the classical teaching method to achieve a perfect educational effect.

Thus, cases have a clearly defined nature and purpose. As a rule, they are related to situations that arise in real life and the practical solution of which is necessary. The choice of the best solution in the context of the given problem occurs through the analysis of the situation and the evaluation of the developed alternatives.

As noted by M. Demyanchuk [1], in order to provide methodological tools to medical college teachers in the application of the case method in order to update the professional training of future nurses, an algorithm for the methodology of using the case method has been developed, which consists of the following stages:

- preparation of the necessary materials (for example, charts, images, a videos and the necessary equipment for its demonstration; handouts; text and a script for the presentation of a professional situation, etc.) to better attract the attention of students, improve learning;

- students' involvement in the problem, which should be logically "embedded" in the topic of the lesson, reveal the purpose, significance and usefulness for the future professional activity of a nurse, which is a significant motivational factor for activating the educational and cognitive activity of students;

- clear instructions for the work of each student (participant in a situational task, analyst, critic, etc.) and time limits;

- organization of individual and group work to include all students, gradually leading to a general group discussion;

- presentation of solutions (on a flip chart, black-board), considering that visualization of solutions is more effective than oral discussion;

- discussion of the obtained results, which involves the active participation of each student. It is important to anticipate possible clinical ideas and perspectives that students may present. according to the discussion's clinical relevance and degree of difficulty, allocate time for discussion, using various ways to effectively control the discussion process in the classroom to achieve the desired effect. The teacher must listen carefully to the case analysis, raise key questions in time, make students think more deeply about the problem or adjust the direction of clinical thinking; help students understand clinical ideas and form their views based on sound medical theory.

- summing up, when the teacher structures the conclusions, summarizes and gives an example from the professional activity of the nursing staff, relevant to the discussed situation.

After summarizing, it is important for the teacher to receive feedback from students regarding the advantages and disadvantages of solving cases. Students pointed to such positive aspects of this method as: the opportunity to share experiences, close communication, the formation of the ability to find consensus, the development of communication skills through group discussion, seeing one's mistakes, the opportunity to express oneself to everyone, overcoming the barrier in communication, a sense of interest and attention to oneself on the part of others, mobilization of logical properties of thinking, development of teamwork skills, resolution and agreement of conclusions, and discussions promoted interaction between the teacher and students and interaction between the students themselves.

In doing so, the teachers felt that case studies created a calm, nonthreatening, low-stress learning environment that introduced students to clinical skills in a way that built their confidence in future patient encounters, and allowed them to make diagnostic and treatment errors without risk and negative consequences. impact on patient safety [5].

Therefore, the use of the case method requires the teacher to first perform complex creative work on creating a case and questions for its analysis. This is carried out outside the classroom and involves scientific research and methodical activity of the teacher. Then the teacher is important already in the classroom, where he gives an introductory and closing speech, organizes small groups and discussions, maintains a business-like attitude in the classroom, evaluates the contribution of students to the analysis of the situation.

The use of the case method contributes to the formation of such qualities, which are necessary for future specialists to carry out professional activities, namely: the ability to make and make decisions; ability to learn; systemic thinking; independence and initiative; readiness for changes and flexibility; ability to work with information; tenacity and determination; communication

skills; the ability for interpersonal contacts; problematic thinking; constructiveness [2].

**Conclusion.** The use of the case method in the preparation of future nurses for professional activity is particularly significant, since its application in the educational process requires students to get as close as possible to real situations of professional activity and make adequate decisions. With the help of the case method, future nursing specialists have the opportunity to study complex professional issues, develop the ability to identify problems, analyze and develop action programs, which will allow them to act wisely in a real situation in the future.

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## METACOMPETENCE EDUCATIONAL STRATEGIES AND TECHNOLOGIES IN THE CONTEXT OF FOREIGN LANGUAGE TEACHING AT AN ENGINEERING UNIVERSITY

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## МЕТАПРЕДМЕТНІ ОСВІТНІ СТРАТЕГІЇ ТА ТЕХНОЛОГІЇ В КОНТЕКСТІ ВИКЛАДАННЯ ІНОЗЕМНИХ МОВ У ТЕХНІЧНОМУ УНІВЕРСИТЕТІ

**Abstract.**

*In the article, the authors discuss the issue of introducing a metaconcept approach in the context of foreign language teaching of future engineering specialists in the context of higher professional education. The relevance of the study is determined by the necessity of developing a holistic worldview of future engineers on the basis of meta-subject integration, defined as a condition for the development of the student's personality and achievement of high-quality learning outcomes.*

*The paper provides a thorough review of national and foreign psychological, pedagogical and linguistic literature, covering the practical experience of applying the metaconcept approach in foreign language teaching at an engineering university; the authors emphasise that the competence-based training in the context of higher engineering education involves the forming a set of professional and supra-professional, soft skills or metacompetencies in future specialists. Metacompetence is considered as the ability to manage information, knowledge, personal qualities for further self-development in professional activities. The study analyses the teaching tools providing the development of metacompetence in future engineers and the pedagogical conditions for implementing the metaconcept approach in the process of foreign language teaching at an engineering university based on the MOODLE platform.*

**Анотація.**

*У статті авторки розглядають питання запровадження метапредметного підходу у контексті навчання іноземної мови майбутніх фахівців інженерного профілю в умовах вищого професійного навчання.*

Нагальність дослідження обумовлюється потребою розвитку цілісного світогляду майбутніх інженерів на засадах метапредметної інтеграції, яка визначається як умова розвитку особистості студента та досягнення ним високо якісних результатів навчання.

У роботі здійснено ґрунтовний розгляд вітчизняної та зарубіжної психолого-педагогічної та лінгводидактичної літератури, яка висвітлює практичний досвід застосування метапредметного підходу у викладанні іноземної мови у технічному університеті; авторки підкреслюють, що компетентнісна основа професійної підготовки у контексті вищої інженерної освіти передбачає формування у майбутніх фахівців сукупності професійних та надпрофесійних, м'яких навичок або метакомпетенцій. Метакомпетенція розглядається як здатність управляти інформацією, знаннями, особистісними якостями для подальшого саморозвитку у професійній діяльності. У дослідженні аналізуються засоби навчання, що забезпечують формування метакомпетенції у майбутніх інженерів та педагогічні умови реалізації метапредметного підходу у процесі викладання іноземної мови у вищому закладі професійної освіти на платформі MOODLE.

**Keywords:** professional metacompetence, knowledge management, means of education, LMS MOODLE, engineering university, foreign language teaching.

**Ключові слова:** професійна метакомпетенція, управління знаннями, засоби навчання, освітня платформа MOODLE, інженерний університет, навчання іноземної мови.

**Problem statement.** The quality of educational process at an engineering university is impossible to achieve unless innovative educational approaches and corresponding pedagogical technologies are applied. One of the educational innovations in recent years has been the introduction of the metacompetence approach in the system of professional training in higher education aimed at developing a comprehensive worldview of specialists through the promotion of supraprofessional metacompetences based on practice-oriented orientation of the educational process and interdisciplinary integration.

The last decade has been marked by the transformation of a foreign language from an academic subject into one of the basic elements of the modern higher engineering education. It is expected that as such, the discipline has a positive impact on the process of professional realization of a graduate's personality. Nowadays, we can observe the higher engineering education reform, which is caused by the process of expanding the Ukrainian business environment, establishing cooperation with multinational companies, participation of Ukrainian engineers in international conferences and symposia, establishing scientific contacts with foreign colleagues, etc. Graduates of higher engineering institutions should not only have knowledge in their professional sphere, but also have a foreign language proficiency that would help them integrate into the international community.

**The purpose of the article** - to consider theoretical and practical issues of implementing a metacompetence approach; to highlight methods and technologies for the development of metacompetences of future engineers in the context of teaching a foreign language at an engineering university based on the MOODLE educational platform.

**The statement of the main material.** Foreign researchers use the concept "meta-competencies" as well as "soft skills" to refer to the meta-skills of specialists [1]. The concept of meta-competences includes "management skills" and "leadership meta-competences", "cognitive meta-competence", "motivational meta-competence", etc. [2] According to M. T. Morpurgo, the competence model of a modern specialist includes

a set of supraprofessional metacompetences such as: communication skills, teamwork skills, persuasive skills, ability to "see a wide context", ability to innovative activity, readiness to solve problems, analytical and critical thinking, creativity, readiness to take risks, learnability, reflexivity, ethnic tolerance, etc. [3].

The development of metacompetences in foreign universities is based on the experimental training, modernization of curricula and programs, implementation of innovative methods and technologies, as well as in various situations of academic, professional and scientific communication (situational learning). The great importance is given to the research and consideration of employers' and customers' requests for educational services in order to prevent the gap (the so-called "expectation gap") between the actual requirements of the labor market and the real practice of training specialists at the university [3].

Western models of metacompetence include the following types of metacompetencies:

- Cognitive, personal and interpersonal skills - ability to persuade; teamwork and relationship building; critical and analytical thinking; self-organization and time management skills; leadership skills; communication skills; ability to present one's point of view.

- Soft (flexible) skills - critical thinking; sensitivity in interpersonal communication; team management; purposefulness [4].

- Superficial competence, mixed competence, metacompetence (cognitive competence; emotional stability; personal qualities; behavioral and social competence) [5].

The analysis of the psychological and pedagogical literature on the research topic allows us to determine that one of the integral components of the metacompetence of a graduate of a higher engineering educational institution is the supra-professional skills: critical thinking, sensitivity in the sphere of interpersonal communication, team leadership, determination, responsibility, creativity, collaboration (ability to cooperate). Supra-professional skills are related to the emotional and communication qualities of university graduates,

and also determine their potential, success and marketability, as well as their desire for self-improvement and progressive development.

Due to its general humanitarian, communicative and sociocultural orientation, foreign language training in an engineering university has wide opportunities for achieving meta-disciplinary learning outcomes and developing certain metacompetencies. Language is, on the one hand, a goal and, on the other hand, a means of learning, being a communicative and pragmatic tool for expressing notions from different fields of disciplinary knowledge.

Moreover, the process of foreign language learning is largely cognitive and discursive. It is through foreign language that "perception (cognition), acquisition, processing, structuring, keeping and using knowledge". Learning a foreign language offers various opportunities for meta-disciplinary integration, and the ontological connection between language and culture contributes to the humanization and humanization of the educational process in technical and technological disciplines at an engineering university.

A survey of the linguistic and didactic literature over the past few years allows us to identify the following kinds of future engineers' metacompetencies to be successfully formed and developed in the process of foreign language training at an engineering university: intercultural communicative competence (a complex combination of knowledge, skills, qualities and abilities of a personality ensuring the choice of adequate means and strategies of communicative activity and communicator's behavior in intercultural interaction), information and search competence (activities aimed at finding, structuring and storing information focusing on its comprehension, processing and transformation for further application in a particular situation), cognitive competence (readiness to constantly improve one's educational level, ability to independently acquire new knowledge and skills), critical and analytical thinking, academic reading and writing skills, self-learning competence (an integrated characteristic of personal qualities expressed in the need, general readiness and ability to engage in independent educational activities), regulatory competence (ability to self-organize), project competence, ethno-cultural tolerance and empathy, heuristic (creative) competence, etc.

Based on the analysis of scientific literature related to the research subject and practical experience of teaching foreign language at an engineering university on the basis of MOODLE educational platform (Ukrainian Engineering Pedagogics Academy, Kharkiv) we can determine the following stages of developing a certain complex of knowledge, skills and competences of future engineers:

*Monitoring* - at the beginning of the foreign language course, the teacher should define the students' skills in the MOODLE system, familiarize them with the course navigation system on the example of independent enrollment in the course, writing a short message on the topic in a foreign language in the forum, participation in a survey, performing a preliminary test, etc. If students have the necessary technical skills, the teacher focuses on the content of the course. So, the

main tasks of this stage are to identify students' expectations from the topic study, to realize the problem discussed, to identify students' readiness to process information. The group form in the forum discussing individual questions; participation in the survey and choosing the answer from the proposed options contributes to the solution of these tasks. Preliminary discussion in the forum or survey allows you to adapt the block content, take into consideration the students' interests, to consider the students' interests, to refer to their experience and available knowledge, to increase students' interest in the problem.

At the *planning stage* the following tasks are carried out: predicting the results of the students' activities in the learning process, selecting informational resources to complete a project or create a group presentation, developing an effective action program, and determining the sequence of actions. An extensive MOODLE platform toolbox allows the teachers to plan and organize both individual and group forms of students' work. At this stage students plan their mode of work on the subject block, the sequence of assignments. This is due to the technical features of MOODLE allowing the teacher to regulate access to the resources, limit the deadlines for individual assignments.

The main goals of the *organizational-executive stage* are the development of students' abilities to find and analyze information from different foreign language sources for educational purposes, the ability to navigate in the foreign-language information space, the ability to structure and process information, as well as the development of students' responsibility and creativity. Various additional services can be integrated into the MOODLE course in order to create new personal educational products, for example, to create a productive vocabulary in the form of a word cloud or a collaborative digital presentation. It should be noted that personal educational product in linguodidactics is considered as a personal innovation, new in terms of subjective experience created by students in the course of mastering and comprehending cognitive reality, both in material form (for example, information-text product of research, creative, practice-oriented, learning-reference character) and in form of non-material product (new knowledge, skills, experience of reflection activity, including mastering the methodology of learning-cognitive activity, etc.).

At the *controlling stage* the results of studying the unit (or the module as a whole) are determined. And namely - the accumulation of linguistic means, methods of communicative activity, the acquisition of linguocultural knowledge, the development of students' independence, is determined by reflexive self-assessment. Basic tools of MOODLE knowledge control are used here: quizzes, assignments, question banks, and tests. Our practical experience of developing the courses on the disciplines "Foreign language", "Foreign language", "Foreign language of professional and professional communication" on the basis of the MOODLE educational platform at the Department of Foreign Language Training, European Integration and International Cooperation of Ukrainian Engineering Pedagogics

Academy (Kharkiv) demonstrates the great possibilities of methodological organization in managing student's intellectual-personal potential. Such management forms the basis of metacompetence and includes diagnosing abilities, skills, knowledge; planning one's activity on the basis of readiness to work with new foreign-language information and abilities to orient in a stream of information; transformation of information; estimation and correction of strategies for performing activity [6]. At the same time, it should be noted that in e-courses in the MOODLE environment the controlling function mostly belongs to the teacher, determining the strategic goal of the course, structure and content, developing didactic material, etc. If the idea of metacompetence is the student's self-management of information, knowledge, personal qualities, then the next means to facilitate its development can be the students' creation of personal educational products using a foreign language. The next step in using learning tools, in our opinion, can be a joint design and development of a corporate learning and educational portal as part of the basic educational program of a particular profile. The idea of developing a corporate educational portal together with students implements such modern requirements for higher education as modularity, multi-level, variability, ensuring dynamic content, interdisciplinarity.

Based on the above methods and technologies for the development of future specialists' metacompetencies, it is advisable to highlight the organizational and pedagogical conditions for the development of students' metacompetencies in the context of teaching a foreign language at an engineering university:

- availability of a multilingual information and educational environment at an engineering university,
- application of innovative educational technologies providing conditions for meta-subject integration,
- creation of educational and methodological support for foreign language training based on the principle of meta-subjects,
- extracurricular activities aimed at creating conditions for the development of social and communication skills, tolerance, empathy, etc.

**Conclusions.** Summarizing the above, we conclude that the sequence of using foreign language teaching aids is carried out from traditional printed textbooks through electronic multimedia textbooks, educational platforms and Internet learning services to open e-textbooks, corporate learning and educational portals

as collaborative educational products. All these ultimately contribute to the independent acquisition of knowledge, its flexible application, and self-development of the student's personality. The results of our study allow us to emphasize the relevance and key areas of the program of metaconcept educational strategies and technologies in the context of foreign language training at an engineering university. The analysis of international and national educational practices shows that the development of metacompetence in higher engineering education can be effectively carried out on the basis of current educational standards both in academic disciplines based on general university modules of specialized training and in extracurricular activities in the system of lifelong learning.

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**AGRICULTURAL SCIENCES**

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Prorochenko Sergyi,***National university of life and environmental sciences of Ukraine, Kiev,***Poltoretskyi Sergyi,***Uman national university of horticulture, Ukraine***Shuvar Antin,***West Ukrainian National University, Ternopil***Kondratenko Nataliia,***Ukrainian institute for plant varieties examination, Kiev***INFLUENCE OF TECHNOLOGICAL FACTORS OF GROWING ON THE CHEMICAL COMPOSITION OF PERENNIAL LEGUME-CEREAL GRASS STATIONS****Abstract.**

The article shows the influence of agrotechnical methods of cultivation on the chemical composition of perennial leguminous and cereal grass stands. It was established that the mineral composition of alfalfa-cereal and alfalfa grass stands for all fertilization options more fully meets the physiological requirements of animals compared to cereal fodder perennial phytocenoses. Single-species crops of the leguminous component and its mixtures with cereal grasses accumulate a higher content of raw ash (9.0-9.6%), calcium (0.53-0.62%), magnesium (0.13-0.18%), phosphorus (0.40-0.45%) and slightly lower potassium – 2.36-2.58%. The type of cereal component in the mixed legume-cereal grass mixture had no significant effect on the mineral composition of the dry matter of the grass stand. The content of nitrates *himpamis* ( $N-NO_3$ ) in the dry matter of alfalfa, alfalfa-cereal and cereal stands under different fertilization backgrounds was 0.01-0.03% and did not exceed the maximum permissible concentration (0.2%).

**Key words:** legume-cereal grass mixtures, mineral fertilizer, growth regulator, chemical composition, nitrates.

**Introduction.**

An important role in the creation of a strong fodder base for animal husbandry belongs to the improvement of the efficiency of the use of natural fodder lands. They are a source of economically profitable grass fodder, well balanced in terms of protein, mineral substances and vitamins, and are also a factor in improving the ecological situation in agro-landscapes [2].

In Ukraine, the area of meadow lands is about 7.8 million hectares, of which 1 million hectares are in the Right Bank Forest-Steppe. However, today their fodder production and environmental protection capabilities are not used to their full extent, since the technological methods used in the creation and use of sown grass stands are usually too energy- and resource-consuming, including in connection with the high recommended rates of nitrogen application fertilizers. As a result, the productivity of grasslands in Ukraine remains very low, although with the implementation of effective improvement measures, natural fodder lands can ensure the collection of 54.8 million tons of green mass and 5.7 million tons of hay [4, 5, 8].

In order to solve this problem, domestic scientific institutions have developed a number of energy- and resource-efficient technologies for the creation and use of hayfields and pastures, which are based on the involvement of perennial leguminous grasses as a cheap source of symbiotically fixed nitrogen. However, until now, the theoretical aspects of the formation of high productivity, nutrition and quality of mowed grass stands of

alfalfa mixtures with different cereal components, including at different rates of mineral fertilization and the use of growth biostimulators, have not been fully elucidated [3, 7].

The relevance of scientific research on increasing the production potential of pasture lands is especially growing at the current stage of the European integration of our country into the EU countries, where the requirements for the quality and safety of fodder are very high. Under such conditions, an important scientific task is the development of effective technologies for obtaining high-quality fodder from natural fodder lands, taking into account the soil and climatic features of different regions of the country [6].

An important parameter of the quality of plant fodder is their mineral composition, which significantly affects the health of animals and their productivity. For each mineral element, its recommended (optimum, minimum, maximum) content in fodder, necessary for full feeding of cattle, was experimentally established. Based on the calculation of dry matter, the content of calcium in plant feed is considered optimal - within 0.3-0.6, phosphorus - 0.26-0.35, magnesium - 0.12-0.26, potassium - 1-3, sodium - 0.13-0.15% and the ratio of content in dry weight of calcium to phosphorus as 0.7-2.5 and potassium to calcium with magnesium as 2.2-2.4 [2, 7, 6].

It is believed that the course of the normal digestion process in the body of animals when feeding fodder from meadow grasses is possible only with a con-

tent of more than 0.4% calcium in dry matter [4, 6]. Increased rates of nitrogen fertilizers usually reduce the content of this nutrient in feed, which is caused by the loss of leguminous components from grasses and the growth of the crop of vegetative mass with the same calcium reserves in the soil [7, 10]. It is also worth noting that during the formation of sown grass stands, mineral and symbiotic nitrogen often cause significant changes in the mineral composition of feed and lead to a violation of the optimal ratio between mineral elements, which negatively affects the productivity of animals and is sometimes the cause of their diseases, for example, tympanic membrane or a decrease appetite [9].

The level of accumulation and ratio of mineral elements in the biomass of perennial grasses is mainly influenced by zonal and weather conditions, as well as mineral fertilizers and the species composition of the grass stand. The most significant deficiency of certain mineral elements in the plant mass is mainly determined by their lack in the soil and low supply with fertilizers [7, 10].

Thus, the technological methods of creating and using perennial fodder grass stands significantly affect not only their fodder productivity, but also the chemical composition of their fodder, which is an extremely important factor in the high productivity of animals and their physical condition.

The purpose of the research is to study the influence of technological methods of growing meadow phytocenoses on the chemical composition of fodder in the conditions of the right-bank Forest-steppe of Ukraine.

### Research materials and methods.

Field research was carried out during 2014-2016 at the SS NELES of Ukraine "Agronomic Research Station" [1]. Scheme of the experiment: factor A - herbageousness (types of grasses and the rate of sowing their seeds, kg/ha): 1) *Medicago sativa*, 16; 2) *Medicago sativa*, 12 + *Festuca orientalis*, 10 + *Festuca pratensis*, 8; 3) *Medicago sativa*, 10 + *Festuca orientalis*, 10 + *Dactylis glomerata*, 8; 4) *Medicago sativa*, 10 + *Bromopsis inermis*, 14 + *Lolium perenne*, 10; 5) *Medicago sativa*, 10 + *Bromopsis inermis*, 14 + *Festuca orientalis*, 8; 6) *Bromopsis inermis*, 14 + *Festuca orientalis*, 8 (cereal grass), control; factor B – fertilizers (nutrients and their norms): 1) without fertilizers, control; 2) P<sub>60</sub>K<sub>90</sub>; 3) N<sub>60</sub>P<sub>60</sub>K<sub>90</sub>; 4) N<sub>60</sub>P<sub>60</sub>K<sub>90</sub> + growth stimulant Fumar. Nitrogen fertilizers at the rate of N<sub>60</sub> were applied in three doses: N<sub>20</sub> - in the spring on frozen soil and N<sub>20</sub> - after the first and second slopes. Phosphorous and potash fertilizers in the norm of P<sub>60</sub>K<sub>90</sub> were applied according to the scheme of the experiment every year in autumn. Crops were sprayed with the Fumar growth stimulator at the beginning of grass growth in each slope at a dose of 2 l/ha with a water consumption of 200 l/ha per period. The soil of the experimental field is a typical low-humus, medium-loam chernozem.

### Results and discussion.

According to the obtained research results, it was established that, compared to cereal, alfalfa-cereal and alfalfa grass stands, regardless of fertilizer, were characterized by a mineral composition that better meets the physiological requirements of animals (Table 1).

Table 1

**The content of raw ash and macroelements and their ratio in sown meadow grass stands under different fertilization backgrounds, % in dry matter**

Fertilization	Raw ash	P	K	Ca	Mg	K:(Ca+Mg)	Ca:P
<i>Medicago sativa</i>							
Without fertilizers	9,4	0,44	2,40	0,62	0,17	3,1	1,4
P <sub>60</sub> K <sub>90</sub>	9,5	0,45	2,39	0,60	0,18	3,1	1,3
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	9,6	0,44	2,36	0,59	0,17	3,4	1,3
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	9,6	0,44	2,35	0,59	0,17	3,2	1,1
<i>Medicago sativa + Festuca orientalis + Festuca pratensis</i>							
Without fertilizers	9,2	0,40	2,45	0,60	0,15	3,3	1,4
P <sub>60</sub> K <sub>90</sub>	9,1	0,43	2,53	0,57	0,14	3,1	1,4
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	9,5	0,44	2,40	0,57	0,14	3,2	1,4
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	9,5	0,43	2,43	0,57	0,14	3,4	1,3
<i>Medicago sativa + Festuca orientalis + Dactylis glomerata</i>							
Without fertilizers	8,8	0,42	2,42	0,55	0,14	3,5	1,3
P <sub>60</sub> K <sub>90</sub>	8,9	0,41	2,48	0,54	0,13	3,7	1,3
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	8,8	0,42	2,58	0,53	0,13	3,7	1,3
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	8,7	0,41	2,48	0,53	0,13	3,8	1,5
<i>Medicago sativa + Bromopsis inermis + Lolium perenne</i>							
Without fertilizers	9,2	0,40	2,45	0,60	0,15	3,3	1,4
P <sub>60</sub> K <sub>90</sub>	9,1	0,43	2,53	0,62	0,14	3,1	1,4
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	9,5	0,44	2,40	0,61	0,14	3,2	1,4
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	9,5	0,43	2,40	0,60	0,14	3,2	1,4

<i>Medicago sativa + Bromopsis inermis + Festuca orientalis</i>							
Without fertilizers	8,8	0,43	2,50	0,58	0,15	3,4	1,3
P <sub>60</sub> K <sub>90</sub>	9,0	0,43	2,58	0,57	0,15	3,6	1,3
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	9,3	0,42	2,50	0,56	0,14	3,6	1,3
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	9,3	0,42	2,51	0,56	0,14	3,6	1,3
<i>Bromopsis inermis + Festuca orientalis</i> (злаковий травостій)							
Without fertilizers	8,4	0,35	2,57	0,41	0,12	4,7	1,2
P <sub>60</sub> K <sub>90</sub>	8,3	0,37	2,68	0,43	0,11	4,9	1,2
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	8,3	0,36	2,60	0,45	0,10	4,7	1,2
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	8,4	0,37	2,62	0,45	0,10	4,7	1,2
Animal husbandry norm	-	0,2- 0,35	1,0- 3,0	0,3- 0,6	0,12-0,26	-	0,7- 2,5
LSD <sub>05</sub>	0,4	0,02	0,12	0,03	0,01	-	-

In the dry matter of these phytocenoses, the raw ash content was 9.0-9.6%, while in the cereal grass it was 0.7-1.2% less. The advantage was also noted in the level of accumulation of calcium - by 0.12-0.17%, magnesium - by 0.02-0.07% and phosphorus - by 0.05-0.09%, relative to the content of these elements in cereal biomass cultures. At the same time, the potassium content decreased by 0.07-0.24%. Compared to alfalfa-cereal mixtures, the dry biomass of single-species alfalfa crops accumulated 0.02-0.04% more magnesium.

Fertilizers had an insignificant effect on the mineral composition of fodder, however, it was determined that, compared to P<sub>60</sub>K<sub>90</sub>, the application of N<sub>60</sub>, in grass stands with the participation of seeded alfalfa usually led to an increase in the content of raw ash, and in a cereal grass stand to a slight decrease in magnesium content.

Changes in the mineral composition of the dry matter of various types of meadow phytocenoses also

caused changes in the ratio of the content of these mineral elements. It was found that in the dry biomass of alfalfa and alfalfa-cereal stands, the ratio of potassium to the sum of calcium and magnesium decreased - from 4.6-4.8 to 3.1-3.7, and the ratio of calcium to phosphorus increased slightly - from 1.2 to 1.3-1.4. However, the obtained ratios of K:(Ca+Mg) and Ca:P did not go beyond the recommended limits of zootechnical standards for cattle, which indicates the good suitability of the obtained vegetable feed for feeding animals.

An important indicator of the quality and safety of plant feed is the content of nitrates (N-NO<sub>3</sub>). In our research, the values of this indicator in the dry matter of alfalfa, alfalfa-cereal and cereal grass stands under different fertilization backgrounds were at the level of 0.01-0.03% and did not exceed the maximum permissible limit (0.2%) (Table 2).

Table 2  
Accumulation of nitrates (N-NO<sub>3</sub>) in the dry mass of alfalfa, alfalfa-cereal and cereal grass stands under different fertilization backgrounds, %

Fertilization	Year of use			Average
	1-st	2-nd	3-rd	
<i>Medicago sativa</i>				
Without fertilizers	0,02	0,01	0,02	0,02
P <sub>60</sub> K <sub>90</sub>	0,02	0,01	0,02	0,02
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	0,03	0,02	0,03	0,03
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	0,03	0,02	0,03	0,03
<i>Medicago sativa + Festuca orientalis + Festuca pratensis</i>				
Without fertilizers	0,03	0,02	0,02	0,02
P <sub>60</sub> K <sub>90</sub>	0,03	0,03	0,02	0,02
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	0,04	0,03	0,03	0,03
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	0,04	0,03	0,03	0,03
<i>Medicago sativa + Festuca orientalis + Dactylis glomerata</i>				
Without fertilizers	0,03	0,02	0,02	0,02
P <sub>60</sub> K <sub>90</sub>	0,03	0,02	0,02	0,02
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	0,04	0,03	0,03	0,03
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	0,04	0,03	0,03	0,03
<i>Medicago sativa + Bromopsis inermis + Lolium perenne</i>				
Without fertilizers	0,02	0,02	0,02	0,02
P <sub>60</sub> K <sub>90</sub>	0,02	0,02	0,02	0,02
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	0,03	0,03	0,02	0,03
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	0,04	0,03	0,02	0,03

<i>Medicago sativa + Bromopsis inermis + Festuca orientalis</i>				
Without fertilizers	0,03	0,02	0,02	0,02
P <sub>60</sub> K <sub>90</sub>	0,03	0,02	0,02	0,02
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	0,04	0,03	0,03	0,03
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	0,04	0,03	0,03	0,03
<i>Bromopsis inermis + Festuca orientalis</i> (cereal grass)				
Without fertilizers	0,01	0,01	0,01	0,01
P <sub>60</sub> K <sub>90</sub>	0,01	0,01	0,01	0,01
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub>	0,04	0,03	0,03	0,03
N <sub>60</sub> P <sub>60</sub> K <sub>90</sub> + Fumar	0,04	0,03	0,03	0,03
LSD <sub>05</sub> , %	0,005	0,005	0,005	0,005

It was determined that the dry mass of leguminous and leguminous-cereal phytocenosis accumulated 0.01% more nitrates compared to cereal herbage. The introduction of nitrogen fertilizers in the N60 norm (variants N60P60K90ra N60P60K90+Fumar) compared to nitrogen-free backgrounds increased the nitrate content (by 0.01%) in the above-ground mass of alfalfa and alfalfa-cereal stands. Under similar fertilization conditions, the content of nitrates in the biomass of cereal grasses increased by 0.02%. The introduction of mineral nitrogen in a dose of N60 has a more significant effect on the level of N-NO<sub>3</sub> accumulation than the use of symbiotic alfalfa nitrogen both in single-species sowing and in a mixture with cereal components. Over the years of use, the content of nitrates in plant feed materials has changed little.

#### Conclusions and suggestions.

The mineral composition of alfalfa-cereal and alfalfa grass stands for all fertilizer options more fully meets the physiological requirements of animals than cereal forage perennial phytocenoses. Single-species crops of the leguminous component and its mixtures with cereal grasses accumulate a higher content of raw ash (9.0-9.6%), calcium (0.53-0.62%), magnesium (0.13-0.18%), phosphorus (0.40-0.45%) and slightly lower potassium – 2.36-2.58%. The type of cereal component in the mixed leguminous-cereal grass mixtures had no significant effect on the mineral composition of the dry matter of the grass stand. The content of nitrates (N-NO<sub>3</sub>) in the dry matter of alfalfa, alfalfa-cereal and cereal stands under different fertilization backgrounds was 0.01-0.03% and did not exceed the MPC (0.2%).

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## INFLUENCE OF ABIOTIC FACTORS ON THE FORMATION OF A COMPLEX OF VALUABLE NUTRIENTS OF STRAWBERRY BERRIES

### **Abstract.**

*Changes in weather conditions and the general deterioration of the ecological situation in Ukraine have an impact on the formation of the complex of biologically active substances of garden strawberries. The goal of our research was scientific substantiation of the impact of abiotic factors on the formation of some valuable nutrients of strawberry berries and the creation of a mathematical model for predicting the formation of some of them based on the identified stress factors. As a result of many years of research, it was established that the berries of the Red Gauntlet, Korallova 100, and Prysnyata varieties are the most valuable in terms of the set of investigated indicators, and the stability of these substances is higher in the Yasna, Tenira, and Rusanivka varieties. The formation of the components of the biochemical composition of strawberry berries is significantly influenced by growing conditions, among which the provision of moisture and the sum of active temperatures 10-15 days before harvesting are the most influential. Dispersion analysis showed that the biochemical composition of strawberry berries grown in the conditions of the Northern Forest Steppe of Ukraine depends on both varietal characteristics and growing conditions.*

**Key words:** *strawberry, berries, chemical composition, weather conditions, stability.*

### **Introduction.**

Fruit and berry products are one of the main components of a healthy diet. Experts of the Scientific Committee on Food, Agriculture, Fisheries and Biotechnology of the Commission of the European Union and leading world experts classify fruits and vegetables as functional foods due to the presence of valuable phytonutrients [2, 12, 15, 19].

The consumer value of berry crops is mainly determined by the ability to form a complex of specific biologically active compounds (vitamins, amino acids, polyphenols, aromatic substances, pectins and natural fibers). It has been scientifically proven that the biologically active substances of fruits with the properties of a redox potential modulator also contribute to the prevention of various oncological, neurodegenerative, cardiovascular diseases and stroke, as well as diabetes, asthma and viral infections [3, 13, 16-19].

Any extreme factors that can cause tension in biological systems are classified by a complex of negative factors into natural and anthropogenic. Natural factors are represented by two groups: biotic - these are stresses that have a biological nature and are caused by biological factors (microbiological, physiological and diseases; damage by insects or the action of weeds in agrocenoses); abiotic - stresses caused by non-living factors (temperature stress, water stress; stress caused by

lack of light, etc.). Anthropogenic stresses are stresses that are the consequences of human activity (production of chemical, physical and biogenic, soil compaction, actions that cause the development of diseases and weaken resistance to biotic and abiotic stresses, etc. [6, 7].

Strawberries have preventive, therapeutic and radioprotective properties due to the high content of valuable components such as ascorbic acid, phenolic and pectin substances. Therefore, the presence of strawberries in the human diet, especially in early spring, is of exceptional importance for maintaining the protective functions of the body. Modern market conditions require strawberry varieties to be early-growing, high-yielding, resistant to major diseases, and berries to have a high content of valuable biochemical substances [1, 3, 4, 11, 20].

The formation of the components of the biochemical composition of garden strawberry berries is significantly influenced by the meteorological conditions of cultivation. At the same time, the presence of correlations between the content of some biochemical components such as dry soluble substances and sugars, ascorbic acid and phenolic compounds and others has been established [1, 8, 9]. Therefore, the purpose of our research was to study the features of the formation of

some valuable components of the biochemical composition of strawberries grown in the conditions of the Northern Forest-Steppe of Ukraine.

#### Research materials and methods.

Research carried out in National University of Life and Environmental Sciences of Ukraine and Horticulture Institute of the National Academy of Agrarian Sciences of Ukraine. The objects of research were common varieties of strawberries: Yasna, Tenira, Korallova 100, Prisyvata, Red Gauntled, Romashka festivalna, Rusanovka, Istochnik. The stability of indicators of the biochemical composition of berries was determined by their deviation over the years of research (standard deviation); the most valuable varieties according to the studied indicators were determined by ranking (the variety was evaluated by the sum of the ranks). The experiments were carried out and statistical data processing was carried out according to generally accepted methods [5,10,14].

#### Results and discussion.

Analysis of the data obtained showed that the content of biochemical components in strawberries varied significantly over the years of research, both within the variety and between varieties (table). So the content of dry soluble substances (DSS) varies from 5.1% (Prisyvata) to 11.8% (Korallova 100). The Yasna variety has a high stability in terms of SRV (0.08%), while the varieties Rusanovka, Prisyvata have a lower stability, while in the berries of the Korallova 100, Istochnik and Romashka Festivalnaya varieties it was the highest (1.14-1.68%). The content of free radicals in the berries of the varieties Korallova 100, Red Gauntled, and Prisyvata was higher than in the berries of the varieties Chamomile festivalnaya, Tenira, Istochnik, on average, by 1.23 times. As a result of the research, it was revealed that the increased sums of active temperatures 5 days before harvesting strawberries contribute to a decrease in the content of DSS. The conducted correlation analysis showed that there is a feedback between them, the value

**Content of some components of biochemical composition of strawberries and their stability**

Variety	Content, %			Content, mg/100g		
	DSS	Sugar	Titrated acidity	Pectin substance	Phenolic substance	Ascorbic acid
Yasna	8,80	7,40	0,85	0,54	301,7	62,07
Yasna	8,10	7,12	0,76	0,34	284,4	69,27
Korallova 100	10,5	7,83	0,80	0,88	315,33	69,53
Prisyvata	9,80	7,91	1,08	0,85	310,4	58,33
Red Gauntled	9,90	7,50	0,96	0,95	325,5	71,37
Romashka festivalna	8,40	6,90	1,14	0,76	307,4	56,53
Rusanovka	9,20	7,97	1,11	0,81	262,4	50,03
Istochnik	8,00	7,85	1,13	0,71	333,5	58,07
Standard deviation, %						
Yasna	0,08	0,08	0,03	0,02	13,7	4,35
Yasna	0,73	0,21	0,06	0,01	37,6	1,62
Korallova 100	1,29	1,39	0,01	0,05	22,7	12,11
Prisyvata	0,66	1,27	0,07	0,08	18,6	4,91
Red Gauntled	0,78	0,98	0,03	0,06	27,5	12,08
Romashka festivalna	1,14	0,44	0,08	0,07	24,3	8,48
Rusanovka	0,52	0,38	0,14	0,06	14,6	6,50
Istochnik	1,68	0,49	0,12	0,10	33,7	8,59

The berries of the studied varieties contain 6.9-7.97% sugars. Their fluctuation on average for varieties ranged from 0.1 to 0.66%, and varietal deviations in the range of 0.2-3.1%. The high stability of this indicator was found in the berries of the Yasna variety, much lower - Korallova 100 and Prisyvata. The conducted correlation analysis showed that the formation of the amount of sugars in strawberries is significantly

affected by direct solar radiation during the growing season -  $\eta_{yx} = 0,996 \pm 0,019$ .

The amount of titratable acids in the studied varieties of strawberries was at the level of 0.98%, with fluctuations in varieties of 0.76-1.14%, and within the variety on average 0.06-31%. The high stability of this indicator was noted in the berries of the varieties Korallova 100, Yasna, Red Gauntled (0.01-0.03%), much

lower - in the berries of the Rusanovka variety. Correlation analysis between the content of titrated acids and meteorological factors showed that their level depends on the intensity of direct (for 15 days) and diffuse solar radiation (for 5 days) before harvesting berries, the value  $\eta_{yx(\text{direct solar radiation})} = 0,999 \pm 0,0035$  и  $\eta_{yx(\text{scattered solar radiation})} = 0,9994 \pm 0,0077$ .

The content of polyphenolic substances in strawberries ranged from 240.4 mg/100 g (Tenira) to 357.4 mg/100 g (Istochnik). A higher content of these substances was noted in the berries of the Istochnik, Red Gauntled, Coralova 100 varieties. The berries of these varieties had a rich and dark color. The berries of the Yasna and Prisyvata varieties were distinguished by the high stability of phenolic substances. Studies have shown that the formation of the level of polyphenolic substances is most affected by the conditions of moisture provision 10 days before harvesting, the correlation level is equal to  $\eta_{yx} = -0,9944 \pm 0,0225$ .

The content of pectin substances in strawberries averaged 0.69%. Their greatest number was noted in the berries of the Red Gauntled, Korallova 100, and Prisyvata varieties (0.95-0.85%). The berries of the Tenira and Yasnaya varieties have a high stability of this indicator (0.01-0.02%). Correlation analysis of data on the content of pectin substances in strawberries revealed an inverse relationship with the sum of active temperatures 5 days before harvesting, the value  $\eta_{yx} = -1 \pm 0,0011$ .

In the berries of the studied varieties of strawberries, the amount of ascorbic acid averaged 61.9 mg/100 g, with varietal fluctuations of 49.1-86.3. The highest content of this substance was found in the berries of the varieties Red Gauntled (86.3 mg/100 g), Coral 100 (80.0). A high rate of stability of ascorbic acid was observed in berries of the varieties Tenira, Yasnaya and Prisyvata (1.62-4.91 mg/100 g). Mathematical processing revealed a positive correlation between the amount of precipitation 10 days before harvesting and the content of ascorbic acid in berries, the value  $\eta_{yx} = 0,988 \pm 0,00325$ .

Dispersion analysis of indicators of the biochemical composition of strawberries showed that weather conditions significantly affect the content of pectin substances, and much less on the content of ascorbic acid. The interaction of factors, the conditions of the year and varietal characteristics slightly affect the formation of the content of ascorbic acid and pectin substances. At the same time, varietal characteristics significantly affect the content of free radicals and polyphenolic substances.

### Conclusions and suggestions.

As a result of the research, the following conclusions can be drawn: the berries of the varieties Red Gauntled, Korallova 100, Prisyvata are more valuable for the complex of studied indicators, and the stability of these substances is higher in the varieties Yasna, Tenira and Rusanovka. The formation of the components of the biochemical composition of strawberries is significantly influenced by the growing conditions, among which the greatest influence is provided by the

provision of moisture and the sum of active temperatures 10-15 days before harvesting. Dispersion analysis showed that the biochemical composition of strawberries grown in the conditions of the Northern Forest-Steppe of Ukraine depends on both varietal characteristics and growing conditions. The data obtained can be used in assessing the competitiveness of garden strawberries in the conditions of market relations.

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