Ministry of Education and Science of Ukraine
Sumy National Agrarian University
Department of Food Technology and Safety

Work program (syllabus) of the educational component

EC 10 INFORMATION TECHNOLOGIES AND OPTIMIZATION OF TECHNICAL AND TECHNOLOGICAL OBJECTS OF THE MANUFACTURE INDUSTRY

Specialty	G13 "Food Technologies"
Educational program	Food technology
Level of higher education	Second (Master's)

Sumy – 2025

Developer:

Anna HELIKH Candidate of Technical Sciences, Associate Professor, Department of Food Technology and Safety
(surname, initials) (academic degree and title, position)

Reviewed and approved at the meeting of the Department of Food Technology and Safety (name of department)	protocol dated 30. 05. 2025р. № 19
	Manager departments __________ Maryna SAMILYK (signature) (last name, initials)

Agreed:
Guarantor of the educational program __________ Maryna SAVCHENKO
(signature) (full name)

Dean of the faculty where the educational program is implemented __________ Nataliia BOLHOVA
(signature) (full name)

The review of the work program was provided by _________
Candidate of Agricultural Sciences,

Associate Professor __________ Nataliia BOLHOVA
(signature) (full name)

Candidate of Agricultural Sciences,

Associate Professor __________ Vasyl TYSCHCHENKO
(signature) (full name)

Methodologist of the Education Quality Department,

licensing and accreditation __________ (Надія Бердник
(signature) (full name)

Registered in the electronic database: date: 26. 06 2025 .

Information on reviewing the work program (syllabus):

Academic year in which changes are made	Number of the appendix to the work program with a description of the changes	Changes reviewed and approved		
		Date and number of the minutes of the department meeting	Head of the Department	Educational program guarantor

1. GENERAL INFORMATION ABOUT THE EDUCATIONAL COMPONENT

<table>
<tr><td>1.</td><td>Name EC</td><td colspan="3">EC 10 Information technologies and optimization of technical and technological facilities of the processing industry</td></tr>
<tr><td>2.</td><td>Faculty/department</td><td colspan="3">Food Technology / Department of Food Technology and Safety</td></tr>
<tr><td>3.</td><td>Status EC</td><td colspan="3">Mandatory</td></tr>
<tr><td>4.</td><td>Program/Specialty (programs) that include EC for (filled in for mandatory EC)</td><td colspan="3">EP "Food Technologies", G 13 Food Technologies</td></tr>
<tr><td>5.</td><td>NRC level</td><td colspan="3">7th Master's</td></tr>
<tr><td>6.</td><td>Semester and duration of study</td><td colspan="3">2nd semester, 15 weeks</td></tr>
<tr><td>7.</td><td>Number of ECTS credits</td><td colspan="3">5</td></tr>
<tr><td rowspan="2">8.</td><td rowspan="2">Total hours and their distribution</td><td colspan="2">Contact work (classes)</td><td>Independent work</td></tr>
<tr><td>Lectures
2</td><td>Laboratory
-</td><td>148</td></tr>
<tr><td>9.</td><td>Language of instruction</td><td colspan="3">Ukrainian</td></tr>
<tr><td>10.</td><td>Teacher/Educational Component Coordinator</td><td colspan="3">Ph.D., associate professor Helikh A.O.</td></tr>
<tr><td>11.1</td><td>Contact information</td><td colspan="3">Anna Helikh, Associate Professor of the Department of Technology and Safety, 317a,
e - mail: anna.helikh@snau.edu.ua</td></tr>
<tr><td>11.</td><td>General description of the educational component</td><td colspan="3">formation of competencies in the use of modern information technologies for system analysis, modeling and optimization of technical and technological objects of the processing industry. Applicants will learn to reasonably select equipment and optimize its operating modes, including time, temperature and pressure parameters. Mastering methods for modeling the recipe composition, heat treatment methods and calculating production costs. Using specialized software to perform accurate calculations and make effective decisions. Training of specialists capable of increasing the efficiency and competitiveness of processing industry enterprises using information technologies.</td></tr>
<tr><td>12.</td><td>Purpose of the educational component</td><td colspan="3">Study of the principles of building mathematical models of food technology as objects of design, control and optimization. Verification of the validity and reliability of computer models of technological processes, among which two types can be distinguished: physicochemical (deterministic) models and empirical models based on the processing of experimental data.</td></tr>
<tr><td>13.</td><td>Prerequisites for studying EC, connection with other educational components of EP</td><td colspan="3">1. The educational component is the basis for the OPP "Food Technologies": EC 7 Qualification work (performance and defense).</td></tr>
<tr><td>14.</td><td>Academic Integrity Policy</td><td colspan="3">It is not allowed to copy the conclusions of the laboratory work protocols from each other, in such a case the laboratory work will be considered unprotected and will require re-revision. In case of re-revision, the work will not be evaluated for the maximum score.</td></tr>
<tr><td>15.</td><td>Key words</td><td colspan="3">optimization, statistics, big data, computer software, interpretation</td></tr>
<tr><td>16.</td><td>Course link</td><td colspan="3">https://cdn.snau.edu.ua/moodle/course/view.php?id=4755</td></tr>
</table>

2. LEARNING OUTCOMES BY EDUCATIONAL COMPONENT AND THEIR RELATIONSHIP WITH PROGRAM LEARNING OUTCOMES

Learning outcomes for EC: After studying the educational component, the student is expected to be able to...	Program learning outcomes that the OK aims to achieve			How is RND assessed?
	PLO 1	**PLO 3**	**PLO 4**	
DLO 1 Formulate, analyze, and decompose problems of mathematical modeling of technological processes in the processing industry, developing algorithmic solutions for their computer implementation.	**X**	**X**		Oral defense of laboratory work Multiple-choice final test (modular assessment) Public presentation of the results of one's own calculations Exam – multiple choice test
DLO 2 Apply modern software (MS Office Excel, MathCAD, STATISTICA) and computational intelligence methods to solve optimization problems in food technology engineering, performing critical analysis and visualization of results.	**X**	**X**	**X**	Oral defense of laboratory work Multiple-choice final test (modular assessment) Public presentation of the results of one's own calculations Exam – multiple choice test
DLO 3. Assess the adequacy, validity and reliability of developed computer models (deterministic and stochastic) of technological processes, using empirical data and statistical criteria.	**X**	**X**	**X**	Oral defense of laboratory work Multiple-choice final test (modular assessment) Public presentation of the results of one's own calculations Exam – multiple choice test

LIST OF COMPETENCES THAT WILL BE IMPROVED/ACQUIRED IN THE PROCESS OF NON-FORMAL EDUCATION	
Data analysis and statistical inference in R	
General: Ability to think analytically and solve problems in food processes based on data. Includes identifying patterns in technological data, selecting adequate analysis methods, and mastering R tools for optimizing and controlling food processes. **Professional:** proficiency in statistical methods and R language for data analysis in the food industry. It involves performing key stages of analysis (from collecting and preparing data on raw materials, process parameters, product quality indicators to building models and interpreting results) for the purpose of quality control, optimizing recipes, improving technological regimes, and formulating substantiated conclusions for improving food processes.	**Form for confirming learning results:** A certificate of successful completion of training with the number of hours. The authenticity of the certificate can be verified by using the link on it.

3. CONTENT OF THE EDUCATIONAL COMPONENT (COURSE PROGRAM)

Topic. List of issues to be addressed within the topic	Distribution within the overall time budget			Recommended reading[1]
	Classroom work		Independent work	
	Lecture	Labs		
Module 1				
***Lecture 1.* Content, purpose and main objectives of the discipline. General information about modeling. General concepts of optimization of technological processes.** 1. The main objectives of the course, its relationship with the disciplines of special training. 2. Formulation of modeling tasks. 3. The essence and stages of mathematical modeling. 4. Modeling objects. Generalized algorithm for developing mathematical models of technological processes. 5. Hierarchical structure of the modern food industry enterprises. General idea of the technological system. 6. General concepts of optimization of technological processes.	2			[1-3], [7], [8], [10], [14], [15], [16], [17], [23]
***Laboratory lesson 1.* (part 1)** *Description of experimental data, their functional relationship. regression equation*				[9], [1-3], [4], [8], [10], [11], [12]
Independent work *Topic 1. Linear programming problems* 1.1. Examples of linear modeling problems 1.2. General and basic linear programming problems 1.3. Geometric method for solving linear programming problems			10	[1-3], [7], [8], [1 1], [14], [15], [18], [17], [24]
***Lecture class* 2. MS Workspace Software Features Office Excel, MathCAD and STATISTICA used to solve practical problems of modeling food technologies.** 1. Application of mathematical models and software functions of the MS working environment in engineering practice Office Excel, MathCAD, STATISTICA – as modern methods for solving optimization problems and their graphical interpretation for presentation and visual understanding.				[1-3], [7], [8], [10], [14], [15], [16], [17], [23]

[1] Specific source from the main or additionally recommended literature

2. Processing the results of the implementation of plans for full and fractional multifactorial experiments. Analysis of the results and their presentation.				
Laboratory lesson 2 **(part 2)** *Description of experimental data, their functional relationship. Regression equation.*				[1-3], [7], [8], [10], [14], [5], [16], [17], [24]
Independent work Topic 1. Linear programming problems 1.4 Methods for solving linear programming problems using modern computer technologies			10	[9], [3], [4], [8], [10], [11], [12]
Lecture **3. GENERAL information about the theoretical prediction of the experiment.** 1. Basic concepts and definitions of experimental factors. 2. Verification of the reproducibility of experiments. 3. Calculation of the experimental error.				[1-3], [7], [8], [10], [14], [15], [16], [17], [23]
Laboratory lesson 3 *Application of the least squares method to approximate experimental data*				[8], [3], [4], [8], [10], [16], [17]
Independent work Topic 1. Linear programming problems 1.5. Simplex method of finding a solution linear programming problems 1.6. Artificial basis method			10	[1-3], [7], [8], [10], [14], [15], [16], [17], [20]
Lecture 4. **Nonlinear programming methods and their application in optimizing processes in the processing industry. (Part 1)** 1. Fundamentals of nonlinear optimization. 2. Classification of methods.				[6], [8], [9], [11], [15], [16], [17], [21]
Laboratory lesson 4. Solving nonlinear optimization problems using MathCAD or Python (SciPy) packages. (Part 1)				[1-3], [7], [9], [13], [14], [15], [16], [17], [23]
Independent work. Topic 2. Nonlinear programming in food technology. 2.1. Overview of modern software tools for solving nonlinear programming problems.			10	[6], [8], [9], [11], [15], [16], [17], [21]
Lecture 5. **Nonlinear programming methods and their application in optimizing processes in the processing industry. (Part 2)** 1. Gradient methods.				[1-3], [7], [8], [10], [14], [15], [16], [17], [24]

2. Search methods without restrictions and with restrictions.				
Laboratory lesson 5. Solving nonlinear optimization problems using MathCAD or Python (SciPy) packages. (Part 2)				[9], [3], [4], [8], [10], [11], [12]
Independent work. Topic 2. Nonlinear programming in food technology. 2.1. Analytical review of applications of nonlinear programming in specific technologies of the food industry.			10	[1-3], [7], [8], [10], [14], [15], [16], [17], [23]
***Lecture 6.* Introduction to Data Mining and Machine Learning in Processing Industry Problems. (Part 1)** 1. Basic concepts of Data Mining. 2. Classification, clustering, regression problems.				[1-3], [7], [9], [13], [14], [15), [16], [17], [23]
Laboratory lesson 6. Introduction to Data Mining tools using STATISTICA or Weka/Orange as an example.				[6], [8], [9], [11], [15], [16], [17], [21]
Independent work. Topic 3. Data Mining and Machine Learning.			10	[1-3], [7], [9], [13], [14], [15], [16], [17], [23]
***Lecture 7.* Introduction to Data Mining and Machine Learning in Processing Industry Problems. (Part 2)** 1. Machine learning algorithms (decision trees, neural networks – overview).				[1-3], [7], [8], [10], [14], [15], [16], [17], [24]
Laboratory lesson 7. Building a simple classification or clustering model for technological data.		2		[9], [3], [4], [8], [10], [11], [12]
Independent work. Topic 3. Data Mining and Machine Learning. 3.1. Examples of successful application of Data Mining and machine learning for optimization of technological processes, quality control, and demand forecasting in the food industry.			10	[1-3], [7], [8], [10], [14], [15], [16], [17], [23]
***Lecture 8.* Decision support systems (DSS) in the management of technological facilities in the processing industry.** 1. DSS architecture. 2. DSS components: databases, knowledge bases, model block. 3. Expert systems as a component of DSS .				[8], [3], [4], [8], [10], [1 6], [17]

Laboratory lesson 8. Analysis of DSS application cases. Design of a DSS conceptual model for a specific optimization problem in food technology.				[1-3], [7], [9], [13], [14], [15], [16], [17], [23]
Independent work. Topic 4. Decision support systems. 4.1. Market research for commercial DSS and expert systems for the processing industry. 4.2. Development of a knowledge base for a simple expert system (if-then rules).			10	[9], [3], [4], [8], [10], [11], [12]
Total for module 1	**2**	**-**	**80**	
Module 2				
Lecture class **9. Mathematical description and planning of the experiment.** 1. Mathematical description 2. Planning an extreme experiment				[1-3], [6], [7], [9], [11], [15], [16], [17], [23]
Laboratory lesson **9** Method of planning multivariate experiments				[1-3], [6], [7], [9], [11], [15], [16], [17], [22]
Independent work Topic 5. Linear programming problems 5.1 The concept of a degenerate solution 5.2 Modified simplex method			8	[6], [8], [9], [11], [15], [16], [17], [21]
Lecture class **10. Basics of working with a full factorial experiment. (Part 1)** 1. Steep climb method 2. Simplex method 3.Orthogonal central compositional planning 4.Rotatable planning 5. Contour-graphic analysis				[3], [5], [8], [12], [14], [15], [16], [19], [23]
Laboratory lesson **10** Regression Equation Analysis. Part 1				[1-3], [8], [9], [11], [15], [16], [17], [24]
Independent work Topic 6. Conceptual principles for modeling functional food compositions and culinary products			8	[6], [8], [9], [11], [15], [16], [17], [22]
Lecture class **11. Basics of working with a full factorial experiment. (Part 2)**				[3], [5], [8], [12], [14], [15], [16], [19], [23]

1. Examples of linear modeling problems 2. General and basic linear programming problems 3. Geometric method for solving linear programming problems 4 Methods for solving linear programming problems using modern computer technologies				
***Laboratory lesson* 11** Regression Equation Analysis. Part 2				[1-3], [8], [9], [11], [15] , [16], [17], [24]
Independent work Topic 6. Conceptual principles for modeling functional food compositions and culinary products 6.1 Theoretical justification production culinary products 6.2 Practical principles creation culinary products functionalappointment			8	[6] , [8], [9], [11], [15], [16], [17], [2 2]
***Lecture 12.* Optimization of multi-stage technological processes and management of material flows at food industry enterprises. (Part 1)** 1. Dynamic programming methods for optimizing sequential operations (e.g., multi-stage extraction, heat treatment, fermentation). 2. Models for managing inventories of raw materials, semi-finished products and finished products under conditions of limited shelf life (EOQ, JIT, MRP for food products).	2			[1-3], [6] [7], [9], [11], [15], [16], [17], [23]
***Laboratory lesson* 12.** Solving the problem of optimal planning of food production (for example, assortment) on a multi-stage line. Calculation of the optimal batch size of raw materials taking into account expiration dates**.**				[1-3], [6], [7], [9], [11], [15] , [16], [17], [23]
Independent work. Topic 7. Optimization of logistics and production cycles in the food industry. 7.1. Analysis of the application of dynamic programming methods for the optimization of specific food technologies (for example, the production of juices, canned food, dairy products). (Part 1)			8	[6], [8], [9], [1 1], [15], [16], [17], [2 1]
***Lecture 13.* Optimization of multi-stage technological processes and management of material flows at food industry enterprises. (Part 2)** 1. Integration of process line optimization with logistics of raw material supply and				[1-3], [7], [8], [10], [14], [15], [16], [17], [2 4]

finished product sales (cold chains, production planning to order).				
***Laboratory lesson* 13.** Solving the problem of optimal planning of food production (for example, assortment) on a multi-stage line. Calculation of the optimal batch size of raw materials taking into account shelf life **.**				[9], [3], [4], [8], [10], [11], [12]
Independent work. 7.2. Analysis of the application of dynamic programming methods for optimizing specific food technologies (for example, the production of juices, canned food, dairy products). (Part 2)			8	[1-3], [7], [8], [10], [14], [15], [16], [17], [23]
***Lecture 14.* Application of simulation modeling methods for analysis and optimization of technological processes and systems in the food industry. (Part 1)** 1. Principles of simulation modeling of food production (for example, bottling, packaging, heat treatment lines). 2. Discrete-event modeling for analyzing line performance, bottlenecks, and equipment queues in food production.				[6], [8], [9], [1 1], [15], [16], [17], [2 1]
Laboratory lesson 14. Development of a simple simulation model of a food production area (e.g., filling and packaging line, raw material receiving process) using specialized software. Analysis of "what-if" scenarios.		6		[1-3], [6] , [7], [9], [11], [15] , [16], [17], [23]
Independent work. Topic 8. Simulation modeling to improve the efficiency of food production.			14	[6], [8], [9], [11], [15] , [16], [17], [21]
***Lecture 15.* Application of simulation modeling methods for analysis and optimization of technological processes and systems in the food industry. (Part 2)** 1. Software tools for simulation modeling (AnyLogic, FlexSim, Arena – with examples for the food industry).				[1-3], [7], [8], [10], [14], [15], [16], [17], [24]
Laboratory lesson 15. Development of a simple simulation model of a food production area (e.g., filling and packaging line, raw material receiving process) using specialized software. Analysis of "what-if" scenarios.				[9], [3], [4], [8], [10], [11], [12]

Independent work. 8.1. Examples of using simulation modeling to optimize production lines of specific food products (bakery, meat, confectionery), logistics flows in the warehouse, and assessment of contamination risks.			14	[1-3], [7], [8], [10], [14], [15], [16], [17], [23]
Total for 2 modules	**-**	**-**	**68**	
Non-formal education (Prometheus)				
Data analysis and statistical inference in R **Course program:** Data analysis Statistics Data types Central tendency Visual data analysis Interpretation of results	5			https :// prometheus . org . ua / prometheus - free / data - analysis - statistics /
Total	**2**	**-**	**148**	

4. TEACHING AND LEARNING METHODS

<u>**DLO**</u>	**Teaching methods** (work that will be carried out by the teacher <u>during classroom lessons</u> , consultations)	**Number of hours**	**Teaching methods** (what types of learning activities should <u>the student perform independently</u>)	**Number of hours**
<u>**DLO 1**</u> Formulate, analyze, and decompose problems of mathematical modeling of technological processes in the processing industry, developing algorithmic solutions for their computer implementation.	**Problem lectures** (questions are raised regarding the material covered by the teacher, but the lecturer answers them himself, to focus students' attention on the main point) **Presentations** (demonstration of information on the topic of lectures)	2	**Laboratory classes** (performing tasks according to methodological instructions) **Brainstorming** during practical work **Individual tasks** (independent processing of the information proposed by the teacher)	48

DLO 2 Apply modern software (MS Office Excel, MathCAD, STATISTICA) and computational intelligence methods to solve optimization problems in food technology engineering, performing critical analysis and visualization of results.	**Problem lectures** (questions are raised regarding the material covered by the teacher, but the lecturer answers them himself, to focus students' attention on the main point) **Presentations** (demonstration of information on the topic of lectures)	-	**Laboratory classes** (performing tasks according to methodological instructions) **Brainstorming** during practical work **Individual tasks** (independent processing of the information proposed by the teacher)	- 40
DLO 3. Assess the adequacy, validity and reliability of developed computer models (deterministic and stochastic) of technological processes, using empirical data and statistical criteria.	**Problem lectures** (questions are raised regarding the material covered by the teacher, but the lecturer answers them himself, to focus students' attention on the main point) **Presentations** (demonstration of information on the topic of lectures)	-	**Laboratory classes** (completion of tasks in accordance with methodological instructions) **Brainstorming** during practical work **Individual tasks** (independent processing of the information proposed by the teacher)	- 60

5. EVALUATION BY EDUCATIONAL COMPONENT

5.1.Diagnostic assessment (indicated as needed)

5.2.Summative assessment

5.2.1. To assess the expected learning outcomes, there are

No.	Summative assessment methods	Points / Weight in the overall score	Date of compilation
	Module 1 (35 points):		
1	Laboratory work protection	*16 points / 16%*	within 5 days after class
2	Midterm testing (multiple choice test)	*19 points / 19%*	By week 15
	Module 2 (35 points):		
3	Laboratory work protection	*14 points / 14%*	within 5 days after class
4	Midterm testing (multiple choice test)	*21 points / 21%*	By week 15
5	Exam (multiple choice test)	*30 points / 30%*	By week 15
Informal education			
6	Completion of training on Prometheus	*5 points / 5%*	By week 15

5.2.2. Evaluation criteria

Component	***Unsatisfactorily***	***Satisfactorily***	***Good***	***Perfectly***
	< 0 points	*0.5 points*	*1 point*	*2 points*
Defense of laboratory works	*Task requirements not met*	*Most requirements are met, but individual components are missing or insufficiently disclosed, there is no analysis of other approaches to the issue*	*All task requirements met*	*Fulfilled all the requirements of the task, demonstrated creativity, thoughtfulness, proposed their own solution to the problem*
Module 1				
1	Laboratory work protection	*8 laboratory works, each is rated at a maximum of 2 points (16 points for a total of 8* laboratory works *)*		within 5 days after class
2	Midterm testing (multiple choice test) for Module 1	*19 test questions, each worth 1 point*		By week 7
Module 2				
3	Defense of practical works	*7 laboratory works, each is rated at a maximum of 2 points (a total of 7* laboratory works *are worth 14 points)*		within 5 days after class
4	Midterm testing (multiple choice test) for Module 2	*21 test questions, each worth 1 point*		By week 15
5	Exam (multiple choice test)	*30 test questions, each worth 1 point*		By week 15
Informal education				
5	Completion of training on Prometheus	*Obtaining a certificate and identifying it with a trusted link (total 5 points)*		By week 15

5.3.Formative assessment:

To assess current progress in learning and understand areas for further improvement,

No.	Elements of formative assessment	Date
1	Oral survey after studying the topic, during laboratory classes	within 5 days after class
2	Feedback in the form of a discussion of the final testing	7, 15 weeks
3	Feedback in the form of a discussion of the non-formal education course	after listening to the course up to week 15
4	Feedback in the form of a discussion of exam testing	Up to 15 weeks

6. LEARNING RESOURCES (LITERATURE)

Methodological support

1. **Helikh A.O.** Information technologies and optimization of technical and technological facilities in the processing industry. Textbook for master's students of specialty 181 "Food Technologies" of full-time and part-time forms of study // Sumy: SNAU, 2024, 104 p.

2. **Helikh A.O.** Information technologies and optimization of technical and technological facilities in the processing industry. Course of lectures for master's students in specialty 181 "Food Technologies" of full-time and part-time forms of study // Sumy: SNAU, 2021, 45 p.

3. **Helikh A.O.** Information technologies and optimization of technical and technological facilities in the processing industry Methodological recommendations for laboratory classes for master's students of specialty 181 "Food Technologies" of full-time and part-time forms of study // Sumy: SNAU, 2021, 42 p.

Recommended reading

Basic

4. Helikh, A ., & Filon, A. (2025). Study of the amino acid profile of alternative proteins (Helix pomatia, Lissachatina fulica, Helix aspersa) and their potential application in a healthy diet: optimization of a modern brandade recipe. Technology Audit and Production Reserves, 2(3(82), 71–79. https://doi.org/10.15587/2706-5448.2025.326896 (Scopus)

5. Helikh A. (2025). Low-allergenic shortbread cookies enriched with cassava powder and alternative protein for military nutrition. Biota. Human. Technology. 2025. No. 1. P. 148-160. DOI: 10.58407/bht.1.25.9

6. Helikh, A. O. (2025). Research on the quality indicators of sauces using alternative proteins for military food. *Tavria Scientific Bulletin. Series: Technical Sciences* , (1), 294-303. https://doi.org/10.32782/tnv-tech.2025.1.29

7. Helikh, A., Yunfen, P. **(2025).** Modeling the technology of cooked minced meat products using alternative proteins. Innovations and technologies in the field of services and food, (1 (15), 10-15. https://doi.org/10.32782/2708-4949.1(15).2025.2

8. Liu, Y., *Helikh, A.,* **Filon, A.,** & Duan, Z. (2023). Sausage technology for food sustainability: recipe, color, nutrition, structure. *Eastern-European Journal of Enterprise Technologies, 4* (11(124), 47-58. **(Scopus) Q3**

9. Liu, Y., *Helikh, A.O.,* **Filon, AM,** Tang, X.-X., Duan, Z.-H., Ren, A.-Q. (2024). Beetroot (Beta vulgaris L. var. conditiva Alef.) pretreated by freeze-thaw: influence of drying methods on the quality characteristics. *CYTA-Journal of Food, 22* (1), 1-12. **(Scopus) Q2**

10. Ostapchuk M.V., Stankevych G.M. Mathematical modeling on a computer: Textbook. — Odessa: Druk, 2022.-313 p.

11. Gao, D., **Helikh, A.,** Duan, Z., Shang, F., Liu, Y. (2022). Development of pumpkin seed meal biscuits. Eastern-European Journal of Enterprise Technologiesthis, 2 (11-116), 36–42. https://doi.org/10.15587/1729-4061.2022.254940

12. **Helikh, A. ,** Gao D. , Zhenhua D. (2022). Study on application of pumpkin seed protein isolate in sausage production process. Technology audit and production reserves — No. 2/3(64). p. 19-23. https://doi.org/10.15587/2706-5448.2022.255785

13. **Gelikh A. O.,** Kryzhska T. A., Danylenko S. G., Semernya O. V. (2022). Optimization of rheological parameters of yogurt structure with the addition of hemp seed protein isolate. Food Resources. Issue No. 18. pp. 51-60. https://doi.org/10.31073/foodresources2022-18-05

14. **Helikh A. ,** Kryzhskaya T. , Girichenko S. (2021). Optimization of emulsion-type sauces with the addition of plant-based protein isolates **.** Food Resources. Issue No. 17. pp. 54-64. https://doi.org/10.31073/foodresources2021-17-06

15. Bondar, A.G. Mathematical modeling in chemical technology / A.G. Bondar- K.: Higher School, 2021. – 289 p.

16. Ladieva, L.R. Optimization of technological processes./ L.R. Ladieva. - K.: IVC "Publishing house "Polytechnica", 2023. - 192 p.

17. L. Sztangret, L. Rauch, J. Kusiak, P. Jarosz, and S. Małecki, "Modeling of the oxidizing roasting process of zinc sulphide concentrates using the artificial neural networks," *Computer Methods in Materials Science* , vol. 11, no. 1, pp. 122–127, 20 23 .

18. A. Stanisławczyk, J. Gawad, and J. Kusiak, "Multi scale modeling and optimization of production chains based on metal forming," in *Proceedings of the 8th Conference World Congress on Computational Mechanics (WCCM '08)* , Venice, Italy, 20 23 .

19. M. Pietrzyk, L. Madej, and R. Kuziak, "Optimal design of manufacturing chain based on forging for copper alloys, with product properties being the objective function," *CIRP Annals—Manufacturing Technology* , vol. 59, no. 1, pp. 319–322, 20 23 .

20. J. Kusiak, A. Danielewska-Tu lecka, and P. Oprocha, *Optimization. Selected Methods with Examples of Applications* , Polish Scientific Publishers, Warszawa, Poland, 20 23 , (Polish).

21. K. Miettinen, *Nonlinear Multiobjective Optimization* , Springer, Berlin, Germany, 20 23 .

Auxiliary

22. Optimization of technological processes of the industry: Method, instructions for studying the discipline and performing control work for students of special. 7.091713 "Technology of sugar substances" correspondence form of study / Compiled by: V.O. Miroshnyk. - Kyiv: UDUHT, 2023. - 48 p.

23. AE Shiel, D. Weis, and KJ Orians, "Evaluation of zinc, cadmium and lead isotope fractionation during smelting and refining," *Science of the Total Environment* , vol. 408, no. 11, pp. 2357–2368, 20 23 .

Information resources

https :// cdn. snau.edu. ua / moodle / course / view . php ? ID = 4351