MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

SUMS NATIONAL AGRICULTURAL UNIVERSITY

TECHNOLOGY OF NUTRITION DEPARTMENT

METHODOLOGICAL RECOMMENDATIONS FOR THE FORMATION OF DISSERTATIONS BY DOCTOR OF PHILOSOPHY DEGREE

methodical recommendations were compiled taking into account the Requirements for the preparation of the dissertation, approved by the Order of the Ministry of Education and Science of Ukraine No. 40 of 12.01.2017 "On the approval of the Requirements for the preparation of the dissertation", effective from 03.10.2017.

SUMY- 2022

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М 54

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М 54 Methodological recommendations for the preparation of dissertations by candidates for the scientific degree of Doctor of Philosophy (candidate of sciences) / Sumy 2022. - 31 p.

The methodical recommendations present the requirements for the design of dissertations by the recipients of the scientific degree of Doctor of Philosophy, the preparation procedure and rules for design of the structural elements of the dissertation, examples of components for the independent work of the recipient.

Recommended for publication by the methodical board of SNAU.

Protocol No 1 of 22.11. 2022.

CONTENT

REQUIREMENTS

before completing the dissertation

1 General provisions

The dissertation for obtaining the scientific degree of Doctor of Philosophy (candidate of sciences) is prepared in the official language in the form of a specially prepared scientific work with manuscript rights in hard or paperback and in electronic form (for foreign applicants, the dissertation is prepared in English).

The thesis is submitted to the specialized scientific councils of the Sumy National Agrarian University in hardcover and in electronic form in pdf format with an electronic signature. The number of copies for doctors of philosophy is 3 copies with a signature. Upon agreement, an electronic version of the dissertation can be sent to opponents.

The dissertation is printed on one side of a sheet of white A4 paper (210x297 mm) with 1.5 line spacing. Kegel–broom (14 typographic points), Times New Roman font. The text of the dissertation must be printed, leaving the fields of the following sizes: left–not less than 20 - 25 mm, right–not less than 10 mm, upper–not less than 20 mm, lower–not less than 20 mm.

The volume of the main text of the dissertation is calculated by the author's sheets.

The volume of the main text for the dissertation of the **Doctor of Philosophy** (candidate's dissertation) is 4.5-7 author's sheets - **108-168 pages**. The main text of the dissertation includes the following structural parts of the dissertation: title page, abstracts, table of contents, literature review, main part, conclusions, excluding pages that are completely occupied by figures, diagrams or tables.

The total volume of the literature review should not exceed 20% of the volume of the main part of the dissertation.

A literature review for dissertation of the **Doctor of Philosophy** (candidate's dissertation) is approximately **18-20 pages long**.

Calculation of the volume of the main text:

The total volume of the dissertation - appendices - the list of used sources - tables and illustrations that completely occupy the space of the page = **Volume of the main text.**

2 Structure of the thesis

The dissertation must have the following main (**mandatory**) structural elements:

title page;

annotation;

content;

a list of conditional designations (if necessary);

main part;

references;

applications

Each of these elements, as well as the main body and appendices sections, must start on a new page.

3 Requirements for structural elements

3.1 Layout of the title page

The title page of the dissertation is drawn up according to the approved form.

The title page indicates the institution where the dissertation work was completed and the institution where the dissertation work will be defended. If it is the same institution, it is repeated on the title page twice.

The title page contains the dissertation's handwritten signature, which certifies the independent performance of research by the author and the absence of borrowings without properly issued references.

SAMPLE design of the title page is given below.

SAMPLE

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
SUMY NATIONAL AGRARIAN UNIVERSITY

Qualifying scientific work on the rights of the manuscript

IVANOV IVAN IVANOVYCH

UDC 644.78

DISSERTATION
TECHNOLOGY OF MODIFIED STARCH AND ITS USE IN THE PRODUCTION OF QUICK COOKING FOOD CONCENTRATES

Specialty 181 - Food technologies

Field of knowledge 18 – Production and Technologies

Submitted for a scientific degree of Doctor of Philosophy

The dissertation contains the results of own research. The use of ideas, results, and texts of other authors have references to the relevant source

I.I. Ivanov

signature Initials and surname of the dissertation student

Scientific supervisor

Petrov Petro Petrovych,

doctor of technical sciences, professor

Sumy - 2022

3.2 Design of the abstract

To familiarize yourself with the content and results of the dissertation, a summarized summary of its main content - an abstract - is provided in accordance with the established model. The abstract is provided in the national and English languages. The abstract of the dissertation should briefly present the main results of the research, indicating the scientific novelty and the presence of practical significance.

The abstract also states:

surname and initials of the recipient;

thesis title;

the type of dissertation and scientific degree for which the applicant is applying;

specialty (code and name);

the name of the higher educational institution or the name of the scientific institution in which (which) the training was carried out;

the name of the scientific institution or the name of the higher educational institution in whose specialized academic council the defense will take place;

city, year

The volume of the annotation is 0.2 - 0.3 author's sheets **(5-7 pages).**

At the end of the abstract, keywords are given in the appropriate language. The set of keywords should correspond to the main content of the scientific work, reflect the topic of the research and ensure the thematic search of the work. The number of keywords is from five to fifteen. Keywords are presented in the nominative case, printed on a line separated by a comma.

After the keywords, a list of the applicant's publications by the topic of the dissertation is given. Scientific works are indicated:

in which the main scientific results of the dissertation are published;

which certify the approval of the dissertation materials;

which additionally reflect the scientific results of the dissertation.

The list of publications is given in the following order*:*

1.Monographs indicating personal contribution.

2.Articles with an indication of personal contribution.

3.Patents with indication of personal contribution.

4.Abstracts of reports.

5. Information letters, methodical recommendations, etc.

Design of the abstract in Ukrainian

АНОТАЦІЯ

Іванов І.І. Технологія модифікованого крохмалю та його використання у виробництві харчових концентратів швидкого приготування. – Кваліфікаційна наукова праця на правах рукопису.

Дисертація на здобуття наукового ступеня кандидата технічних наук за спеціальністю 181 «Харчові технології». – Сумський національний аграрний університет, Суми, 2022.

Дисертаційна робота присвячена…

***Ключові слова*:**

Список публікацій здобувача

Design of the abstract in English

ABSTRACT

Ivan I.I. Modified starch technology and its use in the production of instant food concentrates. – Qualifying scientific work on manuscript rights.

Dissertation for obtaining the scientific degree of candidate of technical sciences in specialty 181 "Food technologies". – Sumy National Agrarian University, Sumy, 2022.

The dissertation is devoted to...

Keywords:

***THE CONTENT OF THE ABSTRACT* 5-7 pages (according to the Ukrainian version).**

3.3 Designing the content of the dissertation

The content is presented at the beginning of the dissertation after the abstract. Page numbering begins with the title page, but the title page is not numbered. The content should contain the names of all structural elements, headings and sub-headings (if any) indicating the numbering and numbers of their initial pages.

SAMPLE

CONTENT

3.4 List of conventional designations

The list of conventional designations, symbols, units of measurement, abbreviations is provided as a separate list if necessary. Additionally, their explanation is provided in the text at the first mention. Abbreviations are listed in alphabetical order. Abbreviations, symbols, designations that are repeated no more than twice are not included in the list. **Common abbreviations (g, m, cm, kg, etc.) should also not be given.**

SAMPLE

LIST OF CONDITIONAL DESIGNATIONS

BAS - biologically active substances;

HPLC – high performance liquid chromatography;

MTT - moisture-thermal treatment;

MRA - moisture-retaining ability;

GA - gelatinizing ability;

MS – modified starch;

MQK - methods of quality control;

LQD - the limit of quantitative determination;

SS – sanitary standards;

TI - technological instruction.

3.5 Designing the main part of the dissertation

The main part of the dissertation should contain:

introduction;

literature review;

thesis sections;

conclusions

3.5.1 Introduction

The introduction provides a general description of the dissertation in accordance with the structural parts presented below.

Justification of the choice of research topic(the connection between the topic of the dissertation and modern research in the relevant field of knowledge is highlighted through a critical analysis with the definition of the essence of the scientific problem or task).

Pay attention! This item used to be called **topic relevance**.

If available, the following may also be indicated in the introduction:

Connection of work with scientific programs, plans, topics, grants - it is indicated within the framework of which programs, thematic plans, scientific topics and grants, in particular sectoral, state and/or international, the dissertation research

was carried out, indicating the state registration numbers of scientific research works and the name of the organization where the work was carried out.

SAMPLE

Connection of work with scientific programs, plans, topics, grants

The dissertation work was carried out in accordance with the scientific work plan of the department and is a fragment of the complex research work "Scientific substantiation and development of technologies of food and culinary products using innovative types of raw materials" (state registration number 0119U103484). The research was carried out in accordance with the budgetary theme of the scientific research work of the PNDL "Investigation of the physical and chemical properties of starch", which was approved by the order of the Ministry of Education and Science of Ukraine No. 633 of November 5, 2022 (0103U001125), code KPKV 2201020 - "Fundamental research in higher education institutions".

The author personally participated in the development of technology of a new type of modified starch, conducting laboratory research on the properties of modified starch, processing and summarizing the obtained results.

The purpose and tasks of the researchaccording to the subject and object of research.

The purpose of the research practically repeats the name of the work with the designation of the final target setting, includes the object of research and the method or methodology that helped the applicant to perform a certain scientific task or solve a certain problem.

SAMPLE

The purpose and tasks of the research. The purpose of the work is to develop the technology of modified starch and study the possibilities of using it as a structure former in the composition of food concentrates (first dinner dishes, sweet dishes and culinary sauces). The work is aimed at solving the following tasks.

-conduct an analysis and summarize modern literature data on obtaining various types of modified starches and methods of their production;

- to develop a technology for obtaining a new type of modified starch;

-to investigate the physico-chemical and structural-mechanical properties of modified starch and to determine the expediency of using new raw materials in the production of food products;

- to establish the dependence of the properties of modified starch and its dispersions on technological factors (starch concentration, environmental reaction, influence of various additives);

- develop formulations of food concentrates using modified starch, determine quality indicators of new products;

- to carry out a set of studies of organoleptic and microbiological indicators of the proposed groups of food concentrates in order to establish their shelf life, to investigate the influence of some food additives on the properties of finished products;

- develop and approve regulatory and technical documentation (recipes, TI, TU), give recommendations on improving technological schemes for the production of selected products.

Object of study–modified starch technology.

Subject of study– modified starch, model starch-water systems with the addition of sugar, salt, acid, instant food concentrates using modified starch.

Research methods (the used scientific methods of research are listed and what exactly was studied by each method is meaningfully noted; the choice of methods that ensure the reliability of the results and conclusions is justified).

SAMPLE

Research methods - physical, physicochemical, microbiological, organoleptic, methods of system analysis, experiment planning, mathematical modeling, mathematical processing of results.

If necessary, the programs with the help of which the statistical processing of the results was carried out are given. The results of experimental studies were processed using the Microsoft Excel 12.0 program (**STATISTICA 6.1**, etc.).

Scientific novelty obtained results (argued, briefly and clearly presents the main scientific propositions that are put forward for defense, with an indication of the difference between the obtained results and the previously known ones).

The degree of scientific novelty indicates the difference between the obtained results and those known in the literature. It is indicated by the words "for the first time", "expanded scientific concepts...", "specified scientific data", "improved", "further developed". Moreover, the degree "for the first time" should reflect novelty on a global scale. Scientific novelty should not only contain information about established scientific results (facts), but also specific confirmation of these results with absolute or relative figures reflecting changes in the studied indicators.

ABSENCE of scientific novelty in the work is grounds for withdrawing the dissertation from defense.

SAMPLE

A new type of modified starch with specified properties was developed, the properties of the raw material were investigated, and the relationship between the structure of the starch molecule and the functional properties of the corresponding type of starch was established.

Changes in the structure of the starch molecule were experimentally investigated and theoretically substantiated. It was established that the physical modification of starch affects the crystallinity of the raw material and the ability of the modified starch to be assimilated, the fractional composition, quantitative and qualitative ratio of different fractions changes.

For the first time, the optimal concentration of the solvent in the starch-water system for obtaining a product of the required structure was established experimentally. A new physical method of determining the optimal starch-water hydromodule was developed: the method of free torsional oscillations of a pendulum.

The parameters for the production of new products using modified starch, which lead to the formation of high-quality food concentrate products, have been established. The dependence of these parameters on the formulation of the created products was studied.

Practical significance of the obtained results - information on the use of research results or recommendations on their practical use are provided.

SAMPLE

Practical significance of the obtained results

On the basis of the conducted theoretical and experimental studies, the technology of modified starch was developed and scientifically substantiated, the use of which will allow to expand the assortment and improve the quality of food concentrates for quick preparation.

A new method has been developed for determining the optimal concentration of starch in a starch-water dispersion for the formation of a paste of the required viscosity.

The regulatory documentation for the production of instant food concentrates (TU U 15.8 – 19492247 – 034 – 2005), recipe and technological instruction (TI U 15.8 – 19492247 – 034 -2005), which regulates the technical requirements and technological process of production, was developed and approved in the established order.

The technology of quick-cooking food concentrates (first lunch dishes) has been implemented in the production process of food enterprises and in the educational process of the university. A research and industrial batch of food concentrates was released in the production conditions of the FOP "Zoryanyi I.O. (act dated 06/07/2021), Shvydko LLC (act dated 08/30/2021), Kyiv.

The obtained research results are used in the educational process of SNAU (act dated 03.09.2021).

Personal contribution of the acquirer (if the dissertation uses ideas or developments belonging to co-authors, together with which the acquirer has published scientific works, the specific personal contribution of the acquirer to such works or developments must be indicated; the acquirer must also add references to dissertations of co-authors in which the results of joint works).

SAMPLE

Personal contribution of the acquirer

The author directly carried out:

– information search and analysis of literary data on the topic of the dissertation;

– formulation of research goals and objectives,

– personal conduct of experimental research in laboratory conditions, analysis and generalization of scientific results,

– formulation of conclusions, development of regulatory documentation,

– publication of the results of theoretical and practical research.

Scientific works published in co-authorship with Petrovy P.P., Lazarenko M.V., Ivanovy V.M.

Co-authors of scientific papers are the scientific supervisor and scientists with whom the research was conducted. In scientific works published in co-authorship, the dissertation belongs to the factual material and the main creative work.

Setting the goal and tasks, discussing the results were carried out together with the scientific supervisor - for candidate theses.

Approbation of dissertation materials (indicate the names of the conference, congress, symposium, seminar, school, place and date).

SAMPLE

Approbation of the results of the dissertation

The main provisions of the dissertation work were reported, discussed and received a positive evaluation at scientific and practical conferences of various levels:…

The structure and scope of the dissertation (the structure of the dissertation is announced, its total scope is indicated).

Scope and structure of the dissertation

The dissertation consists of 167 pages of typewritten text, consists of an introduction, 5 chapters, general conclusions, a list of used sources and 5 appendices. The volume of the main text of the dissertation is 118 pages of printed text. The work is illustrated with 25 tables, 36 figures and 2 diagrams. The list of used sources contains 171 names, 81 of them in Cyrillic and 90 in Latin.

GENERAL VIEW OF THE INTRODUCTORY PART

INTRODUCTION

Justification of the choice of research topic

The problem of finding effective methods of processing natural raw materials to obtain a product with given functional and technological properties ……

Connection of work with scientific programs, plans, topics, grants

The work is a fragment of scientific research ....

The purpose and tasks of the research

The aim of the dissertation research was to identify …..

In order to achieve the set goal, it was necessary to solve the following tasks:

- analyze scientific primary sources to identify approaches....

Object of study -technology…..

Subject of study -raw materials, semi-finished products, finished products …….

Research methods

physical, physico-chemical, microbiological, ……

Scientific novelty of the obtained results

In the dissertation work ……

Practical significance of the obtained results

Conducted in the dissertation work ……

Personal contribution of the acquirer

The author directly carried out:

Approbation of the results of the dissertation

The main content of the dissertation is presented ……

Scope and structure of the dissertation

The dissertation is presented on _ pages of typewritten text, ...

3.5.2 Literature review

In the review of the literature, other authors' information about the state and prospects of the research of the selected object is given. In the text of the dissertation, there must be references to the publications of these authors and sources from which materials or specific results were borrowed. References are given in square brackets, and the number must correspond to the numbering of the source in the list of sources used. It is allowed to give footnotes at the bottom of the page, but even in this case, a reference is made to the source number in the bibliography.

3.5.3 Dissertation sections

In the sections of the dissertation, the content of the recipient's own research must be comprehensively and fully explained, and references to all scientific works of the recipient given in the abstract must be made. A list of these works should also be included in the list of used sources.

In the case of using scientific results, ideas, publications and other materials of other authors, the text of the dissertation must necessarily contain references to the publications of these authors. Fragments of publicized (published) texts of other authors (citations) can be included in the dissertation only with a reference to the source (except for fragments that do not carry an independent content load).

Dissertation sections can be divided into subsections (numbering consists of the section number and serial number of the subsection, separated by a dot), clauses (numbering - from the section number, serial number of the subsection and serial number of the clause, separated by a dot), subsections (numbering - from the section number, serial number numbers of the subdivision, serial number of the item and serial number of the sub-item, separated by a dot). Chapters, subdivisions, clauses and subsections are numbered with Arabic numerals.

SAMPLE

SECTION 1

ANALYSIS OF THE MODIFIED STARCH MARKET

(Literature review)

1.1 Characteristics of the main additives used in the food industry, features of their functioning

Analysis of modern literary data shows [6,7,12,48,74,118,139] that as food additives starch, cellulose, hemicellulose, pectin, dietary fibers, gums and mucus, carrageenans, alginates, agar, xanthan are used in all branches of the food industry , as functional ingredients. Their use contributes to the formation of the necessary viscosity and texture of finished products and shapes their consumer properties. Some of the functional additives have a health-prophylactic value [16,47].

After each chapter, they make conclusions to it.

SAMPLE conclusions

Conclusions to section 1

The conducted literature review allows us to draw the following conclusions:

1. The use of modified starches in food technology of structure-forming additives allows creating a wide range of structured and textured products with given technological properties.

2. According to literature, the production of modified food starches is allowed in world practice and ...

According to these rules, all sections of the dissertation are drawn up.

3.5.3.1 Formulas and figures

When numbering formulas and figures, if there are references to them in the text of the dissertation, the section number and the number of the formula (figure) are placed after a dot. The numbered formula is placed in the middle of a new line (numbering is on the right side in parentheses). The figure number and title are given below/to the right of the figure.

SAMPLE design of drawings

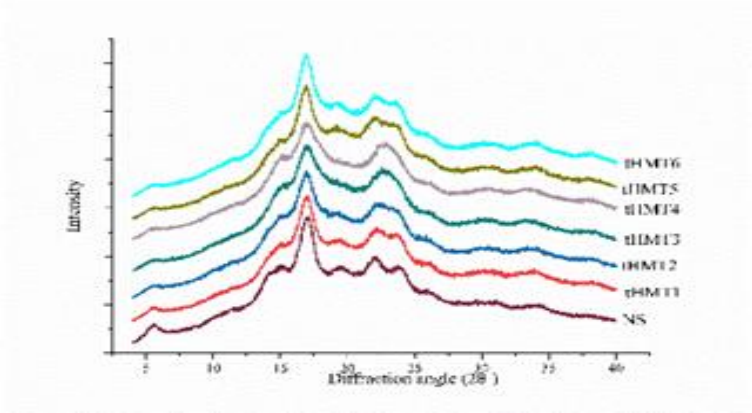

Fig. 3.2 – Diffractograms of native starch and modified starch of different degrees of processing.

SAMPLE of form design

$$M_{сч} = \frac{180 \times 100}{X}, \qquad (2.2)$$

where $M_{сч}$ is the number-average molecular weight,

180 is the molecular weight of glucose,

X - glucose content in the sample, %.

3.5.3.2 Tables

SAMPLE

Table 1.4

Indicators of wavelengths

	Extracts			Extracts			Extracts		
	Water	Vodn. -sp.	Sp.	Water	Vodn. -sp.	Sp.	Water	Vodn. -sp.	Sp.
λ, nm	417	418	418	418	417	419	418	420	419

<u>If the table is placed on several pages (i.e. breaks)</u>

Table 1.5

Metrological characteristics of the technique

LRS	Hser	S2	Sep	Hser±Δx	ε, %
1	2	3	4	5	6
Extracts					
Water	0.018	0.001·10-2	0.017	0.018±0.005	27,674
Water-alcohol	0.022	0.001·10-2	0.001	0.022±0.004	21,881
Spirituous	0.031	0.001·10-1	0.004	0.031±0.011	38,173

From the next page

Continuation of table 1.5

1	2	3	4	5	6
Extracts					
Water	0.021	0.002·10-1	0.002	0.021±0.006	22,682
Water-alcohol	0.033	0.005·10-2	0.003	0.033±0.008	27,035
Spirituous	0.046	0.006·10-1	0.004	0.046±0.009	21,873

3.5.3.3 Notes

One note is not numbered. The word "Note" is capitalized letters from the paragraph indentation are not underlined, after the word "Note" a period is placed and the text of the note is given with a capital letter in the same line.

Sample

Note * – starch-water systems.

Several notes are numbered consecutively with Arabic numerals with a period. After the word "Notes" put a colon and from a new line of the paragraph after the number of the note with a capital letter the text of the note is given.

Sample

Notes:

1. MK – modified starch;
2. EL - native starch.

OR

Notes:

1. * –deviation is reliable with respect to the control sample, $p<0.05$;
2. ** –deviation is reliable with respect to the comparison sample, $p<0.05$.

3.5.4 Conclusions

The conclusions state the most important scientific and practical results of the dissertation, indicate scientific problems for the solution of which the results of the research can be applied, as well as possible directions for continuing research on the subject of the dissertation.

In the presence of practical significance of the obtained results, information on the use of research results or recommendations on their use are provided. If the research results are implemented, the information is provided with the names of the organizations in which the implementation was carried out. In this case, the attachments may contain copies of relevant documents.

In the conclusions of the dissertation, the conclusions made based on the results of the entire work are given. This part is small in volume (about 5...7 pages), but it is of particular importance, since here the final results of the work performed must be presented to the scientific community in a complete and logically flawless form.

In the conclusions, it is necessary to correlate the obtained conclusions with the goals and objectives set in the introduction. The main scientific and practical results of the research should be summarized here, the essence of the solved problem should be formulated, competent and clear proposals should be given regarding the scientific and practical use of the obtained results.

Conclusions at the end of the dissertation are usually drawn up in the form of consecutively numbered paragraphs. At the same time, each numbered paragraph should contain a logically completed and specific conclusion. It should be emphasized separately that the goals of the research were achieved, and all the tasks were solved.

3.6 List of used sources

The list of used sources is formed by the recipient of a scientific degree in one of the following ways:

in the order of appearance of links in the text;

in alphabetical order of the surnames of the first authors or titles;

in chronological order.

The bibliographic description of the list of sources used in the dissertation is drawn up by the degree holder according to the rules of the National Standard of Ukraine DSTU 8302:2015 "Information and documentation. Bibliographic reference. General provisions and rules of drafting".

Those sources that were not referenced in the text of the dissertation should not be included in the list. In addition, it is not recommended to include encyclopedic dictionaries, newspapers, popular science books and textbooks for students.

3.7 Attachments

Appendices may include **recommended** supporting material necessary for a complete understanding of the dissertation:

intermediate formulas and calculations;

tables of auxiliary digital data;

data on optimization and mathematical modeling of technological processes;

protocols and acts of tests, implementation, calculations of the economic effect, letters of support for the results of the dissertation work;

developed normative and technological documentation (technical conditions of TU, technical instructions of TI, recipes of P, technological cards of TC);

instructions and methods, description of algorithms that are not the main results of the dissertation, descriptions and texts of computer programs for solving problems with the help of electronic computing tools, which were developed in the course of the dissertation;

illustrations of an auxiliary nature;

other data and materials.

Mandatory an appendix to the dissertation is a list of the applicant's publications on the subject of the dissertation and information on the approval of the dissertation results (the names of the conference, congress, symposium, seminar, school, venue and date, and the form of participation are indicated).

Appendices can be provided as a separate part (volume, book).

Appendices should be marked consecutively with capital letters of the Ukrainian alphabet, with the exception of the letters Г, Э, З, И, Й, Й, О, Ч, б, for example, appendix A, appendix B, etc. In the case of writing a dissertation in English, appendices are marked with letters of the English alphabet.

Appendices must have the same page numbering as the rest of the dissertation.

If necessary, the text of the appendices can be divided into sections, subsections, clauses and subsections, which should be numbered within each annex. In this case, each number is preceded by a designation of the appendix (letter) and a period, for example, A.2 - the second section of appendix A; D.3.1 – subsection 3.1 of Appendix D.

Illustrations, tables, formulas and equations contained in the text of the appendix should be numbered within each appendix, for example, Figure D.3 is the third figure of Appendix D; table A.2 is the second table of appendix A: formula (A.1) is the first formula of appendix A.

SAMPLE

Appendix A

EXAMPLE OF OPTIMIZATION OF THE RECIPE COMPOSITION

The purpose of the study is to optimize the recipe composition of "Anodonta" rolls according to the content of proteins, fats and carbohydrates at one of the maximum organoleptic values and to create a universal model for other recipes that use the pulp of Anodonta molluscs.

To achieve the goal, the following tasks were performed:

1. Development of an orthogonal central-compositional plan with four (n) factors of optimization of the formulation of "Anodonta" roles with fixation of each of the factors at five levels, taking into account the minimum and maximum number of recipe ingredients with unchanged main characteristics of the dish.

2. Evaluation of the organoleptic properties of each prescription composition determined during the experiment.

3. Present the obtained results in the form of a 3D model to determine the best prescription composition.

4. Determination of the near-optimal ratio of proteins, fats and carbohydrates in the dish to the norm in the diet of an average adult by interpreting the obtained mathematical data into the language of the experiment, taking into account organoleptic indicators.

5. Determine the content of mineral substances in the dish with quantitative indicators of the optimal composition of recipe ingredients.

Research materials and methods

The organoleptic assessment of the quality of the finished product was carried out by analytical methods - qualitative and profile analysis. The essence of the profile method is that the complex concept of one of the organoleptic indicators (consistency, taste and smell, color) was presented in the form of a set of components (descriptors), which were evaluated by experts according to indicators of quality, intensity and order of manifestation.

For optimization, the response function is formed in the form of a complete quadratic polynomial of the second order for n=4, which is given in formula 1. To determine the coefficients of the polynomial, an orthogonal central-composite plan of the second order (OCCP) is used.

$$Y=b0+b1x1+b2x2+b3x3+b4x4+b12x1x2+b13x1x3+b14x1x4+b23x2x3+b24x2x4+b34x3x4 +b123x1x2x3+b124x1x2x4+b234x2x3x4+b1234x1x2x3x4+b_{11}x_1^2+b_{22}x_2^2+b_{33}x_3^2+b_{44}x_4^2 \quad (1)$$

An orthogonal central-composite plan is a plan in which the planning matrix X is constructed so that the matrix C = XtX turns out to be diagonal. We also use this approach when building second-order plans. the plan is called central if all points are located symmetrically about the center of the plan. OCKSKP - a central symmetrical rectangular compositional plan.

3 criteria are used to determine the OCCP that can be used in research, the data on which are generally known:

1. Student t-test— a general name for a class of methods for statistical testing of hypotheses (statistical criteria) based on comparison with by the Student's distribution. The most frequent cases of using the t-criterion are related to checking the equality of mean values in two samples[1].

2. The Cochrane criterion— used to compare three or more sample of the same volume

3. F-testor Fisher's criterion (F-criterion, φ*-criterion) - they call any statistical criterion, the test statistics of which during execution null hypothesis has Fisher distribution (F-distribution).

Main part. The optimization parameter is the optimal ratio in the formulation of proteins, fats and carbohydrates at one of the maximum organoleptic values. According to established rational standards of daily consumption of basic nutrients, the optimal daily ratio of protein, fat and carbohydrates for an average adult is 1:1:4, respectively.In the OCCP, each factor is fixed at five levels, taking into account the maximum and minimum number of ingredients while leaving unchanged the main properties of the dish, which are given in the table. 1. The plan of the experiment, the results of direct measurements and their initial analysis are presented in table. 2 and table. 3 respectively.

Table 1 – Prescription components and levels of fixation of factors affecting the optimization of the formulation of "Anodonta" rolls

Factors affecting optimization (formulation components)		Factor fixation levels and their natural values, g					Content per 100g of product, g		
		-1,414	-1	0	1	1,414	Squirrels	Fats	Carbohydrates
1	Fig	7.93	0	5	0	2.07	7.5	2.6	56.1
2	Clams	5.86	0	0	0	4,14	8,17	1.15	0.1
3	Cream cheese	.93	0	5	0	2.07	5.9	32.4	4.1
4	Avocado (pulp)	7.93	10	15	20	22.07	2	15.3	2
Formulation components that are not factors in the mathematical model		Content in 1 portion net, g					Squirrels	Fats	Carbohydrates
Seaweed "Nori"		2					46.1	41	0.1
Salt		2					0	0	0
Sugar		8					0	0	99.8
Wine vinegar		5					0	0	0.3

Table 2- Orthogonal central-composite plan with four (n) optimization factors of the "Anodonta" role formulation (planning matrix)

No	x0	x1	x2	x3	x4	x_1^2	x_2^2	x_3^2	x_4^2
1	1	1	1	1	1	0.20	0.20	0.20	0.20
2	1	-1	1	1	-1	0.20	0.20	0.20	0.20
3	1	1	-1	1	-1	0.20	0.20	0.20	0.20
4	1	-1	-1	1	1	0.20	0.20	0.20	0.20
5	1	1	1	-1	-1	0.20	0.20	0.20	0.20
6	1	-1	1	-1	1	0.20	0.20	0.20	0.20
7	1	1	-1	-1	1	0.20	0.20	0.20	0.20
8	1	-1	-1	-1	-1	0.20	0.20	0.20	0.20
9	1	1	-1	1	1	0.20	0.20	0.20	0.20
10	1	-1	-1	1	-1	0.20	0.20	0.20	0.20
11	1	1	1	1	-1	0.20	0.20	0.20	0.20
12	1	-1	1	1	1	0.20	0.20	0.20	0.20
thirteen	1	1	-1	-1	-1	0.20	0.20	0.20	0.20
14	1	-1	-1	-1	1	0.20	0.20	0.20	0.20
15	1	1	1	-1	1	0.20	0.20	0.20	0.20
16	1	-1	1	-1	-1	0.20	0.20	0.20	0.20
17	1	-1,414	0	0	0	-0.80	-0.80	-0.80	1.20
18	1	1,414	0	0	0	-0.80	-0.80	-0.80	1.20
19	1	0	-1,414	0	0	-0.80	-0.80	1.20	-0.80
20	1	0	1,414	0	0	-0.80	-0.80	1.20	-0.80
21	1	0	0	-1,414	0	1.20	-0.80	-0.80	-0.80
22	1	0	0	1,414	0	1.20	-0.80	-0.80	-0.80
23	1	0	0	0	-,414	-0.80	1.20	-0.80	-0.80

24	1	0	0	0	1,414	-0.80	1.20	-0.80	-0.80
25	1	0	0	0	0	-0.80	-0.80	-0.80	-0.80

Table 3 – Results of direct measurements

No	y1	y2	y3	y4	$\bar{y}_j$	s_j^2	$\hat{y}$	$\hat{y}$	s
1	8.8	11.9	31.7	12.41	16.2	109.56	16.2	16.3	0.017
2	7,8	10.1	25.9	10.56	13.6	68.73	13.6	13.7	0.005
3	6.9	10.1	31.5	13.71	15.6	120.36	15.6	15.4	0.037
4	6.4	11.4	26.1	11.67	13.9	71.99	13.9	13.7	0.038
5	8.0	7.1	31.1	14,16	15.1	123.82	15.1	15.3	0.034
6	7.4	8.4	25.7	11.02	13.1	72.41	13.1	13.3	0.033
7	6.5	8.4	31.3	12.75	14.7	128.23	14.7	14.7	0.007
8	5,6	6.6	25.5	13,26	12.7	83.61	12.7	12.6	0.019
9	7.1	11.6	31.7	11.64	15.5	120.55	15.5	15.6	0.006
10	6.2	9.8	25.9	10,20	13.0	76.64	13.0	13.0	0.000
11	8.6	10.3	31.5	14,22	16.2	110.24	16.2	16.0	0.020
12	8.0	11.6	26.1	11.61	14.3	64.33	14.3	14.2	0.020
thirteen	6.3	6.9	31.1	12.53	14.2	134.33	14.2	14.3	0.017
14	5.8	8.1	25.7	12,26	13.0	78,82	13.0	13.1	0.017
15	8.2	8.6	31.3	14.01	15.5	117.50	15.5	15.5	0.001
16	7.2	6.8	25.5	11.26	12.7	76.60	12.7	12.6	0.007
17	6,7	9.0	24.6	10.25	12.6	65,96	12.6	12.7	0.010
18	7.7	9.4	32.5	13.49	15.8	130.66	15.8	15.7	0.005
19	6.0	9.1	28.6	12.34	14.0	100.95	14.0	14.2	0.027
20	8.3	9.4	28.6	14.05	15.1	87.17	15.1	15.0	0.018
21	6.8	6.9	28.3	14.25	14.1	102.16	14.1	13.8	0.049
22	7.6	11.5	28.9	10.96	14.7	91.77	14.7	15.0	0.064
23	7.0	8.1	28.4	11.83	13.9	98.60	13.9	14.0	0.009
24	7.3	10.3	28.7	12,18	14.6	92.21	14.6	14.6	0.004
25	7.2	9.2	28.6	12.84	14.5	94.11	14.5	14.4	0.002

As a result of the research, the coefficients of the regression equation were obtained. A statistical analysis of the model as a whole and its coefficients separately was carried out. The results are summarized in the table. 4.

Table 4 – Results of statistical analysis of the experiment

	x0	x1	x2	x3	x4	$x_1^2 -$	$x_2^2 -$		
∑xi* ycp	358.6	21.1	5,6	8.1	4.3	0.0	-0.6	0.6	-0.7
∑xi^2	25	0.0	0.0	0.0 ^{2}	0.0 ^{2}	8.0	8.0	8.0	8.0
bi	14.34	1.05	0.28	0.41	0.22	0.00	-0.07	.08	0.09
S2	15,13	1.61	1.61	1.61	1.61	4.04	4.04	4.04	4.04
S{bi}	3.89	1.27	1.27	1.27	1.27	2.01	2.01	2.01	2.01
you	3.69	0.83	0.22	0.32	0.17	0.00	0.04	0.04	0.04
ti–tkr	1.63	-1.23	-1.84	-1.74	-1.89	-2.06	-2.02	-2.02	-2.02

	x1x2	x1x3	x1x4	x2x3	x2x4	x3x4	x1x2x3	x1x2x4	x2x3x4	x1x2x3x4
∑xi* ycp	1.8	0.6	-1.3	0.5	0.1	0.0	-1.3	-0.1	-0.1	0.5
∑xi^2	16	16	16	16	16	16	16	16	16	16
bi	0.11	0.04	-0.08	0.03	0.00	0.00	-0.08	-0.01	-0.01	0.03
S2	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02
S{bi}	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
you	0.08	0.03	0.06	0.02	0.00	0.00	0.06	0.00	0.01	0.02
i–tkr	-1.98	-2.03	-2.00	-2.04	-2.06	-2.06	-2.00	-2.06	-2.05	-2.04

∑Sj2	242 1.28	∑ Garden	0.466	Sy2	96.85
Sj2max	134.33	Garden^2	0.0233		
G	0.06	F	0.000240	a	0.05
m-1	3.00	k1	4		
N	25.00	k2	20	f1	24.00
Greek	0.19	Fkp (table)	2.87		
G– Gkr=	-0.13	F-Fkp=	-2.86975952	tT	2.06
(G<Gkr) the variance is		F<Fkp the statistical model is significant,			

uniform	the regression equation is reliable

After building the OCCP, carrying out all the necessary calculations and determining the regression equation to be reliable, the coefficients in formula 1 are replaced by those determined in the studies, which makes it possible to determine the interdependence of the recipe components and their influence on the optimization indicators. As a result, the obtained regression model in coded units has the form:

$$Y=14.34+1.05x1+0.28x2+0.41x3+0.22x4+0.11x1x2+0.04x1x3-0.08x1x4+0.03x2x3-0.08x1x2x3-0.01x1x2x4-0.01x2x3x4+ 0.03x1x2x3x4-0.07x_2^2+0,08x_3^2-0.09x_4^2 \quad (1)$$

To determine the optimal prescription composition according to the given parameters, a 3D model was built using the method of least squares smoothing using the software package for statistical analysis Statistica, which is shown in Fig. 1. After studying the graphic data, the results of direct measurements and the regression equation, 21 samples were determined as the optimal prescription composition (tables 1, 2, 3).

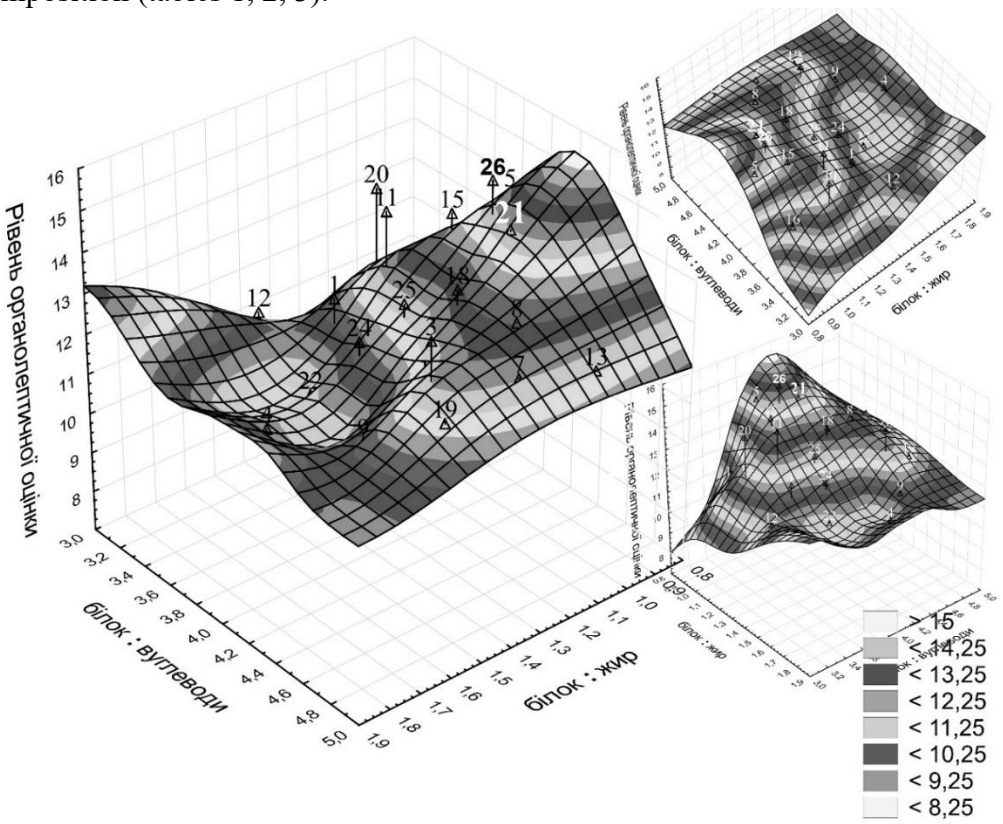

Figure 1 – 3D model of optimization of prescription composition of "Anodonta" roles

According to the conducted research and as shown by the 3D model, the optimal prescription composition is the indicators of experiment No. 21. In the table 5 shows the amount of mineral substances with the optimal recipe composition determined by research.

Table 5 – Amount of mineral substances in the optimal prescription composition

Recipe ingredients	Net mass, g	Mineral composition, mg									
		Sa mg/100 g	Sa mg/mass ingr.	P mg/100 g	P mg/mass ingr.	Mg mg/100 g	Mg mg/mass ingr.	Fe mg/100 g	Fe mg/mass ingr.	I2 mg/100 g	I2 mg/mass ingr.
Fig	35	40	14	328	114.8	116	40.6	2.1	0.735	0.0023	0.0008
Clams	30	453	135.9	403	120.9	30	9	3.91	1,173	0.2530	0.0759
Cream	8	98	7.84	106	8.48	9	0.7	0.38	0.030	0	0

cheese									4		
Avocado (pulp)	15	2	1.8	52	7,8	29	4.35	0.55	0.0825	0.0020	0.0003
Seaweed "Nori"	2	100	2	50	1	0	0	0.5	0.01	0.009	0.0002
Salt	2	368	7.36	75	1.5	22	0.44	2.9	0.058	0	0
Sugar	8	3	0.24	0	0		0	0.3	0.024	0	0
Wine vinegar	5	6	0.3	8	0.4		0.2	0.45	0.0225	0	0
Content in portions	-	-	169.44	-	254.88		55,31		2.1354		0.0772

Results and their discussion. The translation of the model into the language of the experimenter is called the interpretation of the model. The influence of the factor on the optimization parameter is equal to the value of the regression coefficient. Since Y tends to the maximum, increasing the coefficients with a + sign is favorable for the optimization parameter. Factors whose coefficients are insignificant (from the point of view of an experimenter with experience in the field under study) are not interpreted and do not exert a significant influence on the optimization parameter.

The most important in the research of the response function is the interaction of two or more factors. Based on the regression equation, the greatest influence on the optimization parameter is exerted by the interaction of factors x1 and x2, which corresponds to the largest coefficient of 0.11. This conclusion comes from the regression equation, and is also explained by the fact that the unit optimization parameter y1(protein) mainly increases due to the increase in factors x1 and x2, and the unit optimization parameter y3(carbohydrate) due to the increase in the factor x1. An increase in the unit optimization parameter y2(fat) is provided by factors x3 and x4, which contain a significant amount of fat in their composition, but have almost no effect on the optimization of protein and carbohydrate content, therefore their influence on the overall optimization parameter is insignificant, which is confirmed by the insignificant value of the coefficients in the equation regressions

The even, three, and four-factor relationship is reduced to a lower level if there are factors in it that do not have a significant impact on the optimization parameter, so the most important thing in the recipe of the dish is the content of rice and freshwater shellfish, which exert the greatest influence on the optimization of the recipe composition. Interpreting a regression equation that is reliable (the variance is homogeneous and the statistical model is significant) is the main way to make good decisions in optimization. Therefore, after the study of graphic data, the results of direct measurements and the interpretation of the regression equation, 21 samples were determined as the optimal recipe composition, which has the closest to the optimal ratio of proteins, fats and carbohydrates, which is 1:1.03:4.18 with organoleptic evaluation 14 ,25. An important condition in the research of the prescription composition is the factor

Conclusions

In the course of the conducted research, the goal was achieved, namely, the prescription composition of "Anodonta" roles was optimized, and the set tasks were solved:

1. An orthogonal central-composite plan was developed with four (n) factors of optimization of the "Anodonta" role formulation and the homogeneity of variance was confirmed using G-criteria (Cochren) at the significance level x (0.05), the significance of the statistical model and the reliability of the regression equation , using Fisher's F-test (Table 4).

2. The organoleptic evaluation of each prescription composition determined during the experiment was carried out using analytical methods - qualitative and profile analysis.

3. To determine the optimal recipe composition, the obtained results were presented in the form of a 3D model (Fig. 1), built by the method of least squares smoothing.

4. After the study of graphic data, the results of direct measurements and the interpretation of the regression equation, 21 samples (tables 1, 2, 3) were determined as the optimal recipe

composition, which has the closest to the optimal (1:1:4) ratio of proteins, fats and carbohydrates , which is 1:1.03:4.18 with an organoleptic evaluation of 14.25.

5. Guided by prescription composition No. 21, the content of mineral substances was determined, namely:Ca, P, Mg, Fe, I2, in one portion (Table 5).