ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
Қ. И. Сәтпаев атындағы Қазақ ұлттық техникалық зерттеу университеті

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Казахский национальный исследовательский технический университет им. К. И. Сатпаева

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
Kazakh national research technical university named after K. I. Satpayev

ГЕОЛОГИЯ ЖӘНЕ ТЕХНИКАЛЫҚ ҒЫЛЫМДАР СЕРИЯСЫ

♦

СЕРИЯ ГЕОЛОГИИ И ТЕХНИЧЕСКИХ НАУК

♦

SERIES OF GEOLOGY AND TECHNICAL SCIENCES

6 (432)

ҚАРАША – ЖЕЛТОҚСАН 2018 ж.
НОЯБРЬ – ДЕКАБРЬ 2018 г.
NOVEMBER – DECEMBER 2018

ЖУРНАЛ 1940 ЖЫЛДАН ШЫҒА БАСТАҒАН
ЖУРНАЛ ИЗДАЕТСЯ С 1940 г.
THE JOURNAL WAS FOUNDED IN 1940.

ЖЫЛЫНА 6 РЕТ ШЫҒАДЫ
ВЫХОДИТ 6 РАЗ В ГОД
PUBLISHED 6 TIMES A YEAR

АЛМАТЫ, ҚР ҰҒА АЛМАТЫ, НАН РК ALMATY, NAS RK

NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

«ҚР ҰҒА Хабарлары. Геология мен техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 30.04.2010 ж. берілген **№10892-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18, http://nauka-nanrk.kz /geology-technical.kz

---

Редакцияның мекенжайы: Қазақстан, 050010, Алматы қ., Қабанбай батыра көш., 69а.
Қ. И. Сәтбаев атындағы геология ғылымдар институты, 334 бөлме. Тел.: 291-59-38.

Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

«Известия НАН РК. Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан (г. Алматы)

Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан **№10892-Ж,** выданное 30.04.2010 г.

Периодичность: 6 раз в год
Тираж: 300 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел.: 272-13-19, 272-13-18, http://nauka-nanrk.kz /geology-technical.kz

Адрес редакции: Казахстан, 050010, г. Алматы, ул. Кабанбай батыра, 69а.
Институт геологических наук им. К. И. Сатпаева, комната 334. Тел.: 291-59-38.

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)
The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 10892-Ж, issued 30.04.2010

Periodicity: 6 times a year
Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
http://nauka-nanrk.kz/geology-technical.kz

Editorial address: Institute of Geological Sciences named after K.I. Satpayev
69a, Kabanbai batyr str., of. 334, Almaty, 050010, Kazakhstan, tel.: 291-59-38.

Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278 **https://doi.org/10.32014/2018.2518-170X.30**
Volume 6, Number 432 (2018), 6 – 15

UDC 664

L. A. Oganesyants[1], S. A. Khurshudyan[1], A. G. Galstyan[1], V. K. Semipyatny[1], A. E. Ryabova[1], R. R. Vafin[1], D. E. Nurmukhanbetova[2], E. K. Assembayeva[2]

[1]All-Russian Scientific Research Institute of Brewing, Non-Alcoholic and Wine Industry – a branch of the Gorbatov's Federal Scientific Center for Food Systems of RAS, Moscow, Russia,
[2]Almaty Technological University, Almaty, Kazakhstan.
E-mail: muskat@mail.ru, xca020149@rambler.ru, 9795029@mail.ru, semipyatniy@gmail.com, anryz@hotmail.com, vafin-ramil@mail.ru, dinar2080@mail.ru, elmiraasembaeva@mail.ru

BASE MATRICES – INVARIANT DIGITAL IDENTIFIERS OF FOOD PRODUCTS

Abstract. The work shows the prospects of developing a single basic product matrix (basic food semi-finished product) for the subsequent design of technologies for a group of homogeneous products. Implementation of this principle of technology engineering allows to unify many stages of production and, as a result, to stabilize the quality of products, as well as to rationalize the system of identification and control. Accordingly, the mathematical model is developed for the latter, matrices of product markers from genuine to falsified are proposed. Variants of poor-quality, and also surrogate products as possible intermediate links are considered for completeness of the information. The integration of additional thermodynamic and functional-technological indicators into the system of evaluation criteria of technology rationality and product quality is substantiated.

Keywords: food products, technologies, terms, evaluation criteria, matrices, construction.

Modern levels of technology development, including the speed of information flows, interbranch and interdisciplinary integration of scientific and practical solutions, the loyalty of the legislative framework to the organization of production and a number of other objective and subjective factors have created prerequisites for reviewing the principles of construction technology and expanding the traditional area of evaluation criteria for quality and safety of food products [1-4].

It should be noted that at present the development of food products with specified properties, including functional purpose, has become quite an ordinary process due to the applied development of the basic principles of food combinatorics [5-8]. In addition, in recent years, along with the term "food development", the notion of "food construction" has become widely used. Both concepts are legitimate in terms of the logical-conceptual essence, but require some detail and concretization. The main difference in terms is that when "constructing" a priori, the main emphasis is on creating or improving technology and/or processes, and when "developing" - on the recipe of the product being created. Undoubtedly, the technological process and the recipe of the product are interrelated, these terms complement each other and, therefore, when using them, the main thrust of the work should be taken into account. At the same time, "construction" a priori assumes the existence of a more systematic approach [9-11].

An analysis of the development of the food industry shows that over the last 15-20 years, a reorientation of production is taking place all over the world - alternative technologies are developing that involve the use of new types of raw materials and fundamentally different technological solutions [12-15]. In general, for the industry, this trend is positive, as it is aimed at increasing production volumes and expanding product lines. However, the production of alternative technologies, most of which have been obtained empirically, has been insufficiently investigated, including, in some cases, due to the lack of appropriate analysis methods and the blurring of identification features within a homogeneous group of goods [3, 12, 14]. In this perspective, a significant potential is noted in studies of thermodynamic characteristics, functional and technological indicators and further implementation of the data obtained as system criteria for determining the rationality of technological operations, the validity of production schemes, and the evaluation of product quality. The data obtained over the last decades on the indicator "water activity", inhibition of abiogenic and biogenic degradation of micro- and macro components, "barrier" conservation technologies, scientific and applied methods of designing products of functional purpose and many other directions in various food systems allow to assume the possibility of indirect adaptation most methodological approaches to various food systems and processes [14, 16-18].

The development of a new product, and to some extent, the improvement of products from the traditional range, is the result of the efforts of a large group of specialists, including dieticians, food technologists, ingredients and equipment specialists, marketers, etc., which create the basic model of a new product. This model can be described by the matrix $C_p(P, Q, O)$, where P – composition matrix, Q – matrix of physico-chemical parameters, O – matrix of organoleptic characteristics. Suppose, that the matrix C_p has dimension $m \times n$, where m – number of the rows, n – number of the columns. The matrix P includes the values of the composition components - carbohydrates, proteins, fats, amino acids, vitamins and other; the matrix Q includes the values of physical characteristics - pH, viscosity, density, solids content and other, and the matrix O – the values of the characteristics of the organoleptic profile in accordance with regulatory documentation and/or additional characteristics, arising from the task of developing a new food product with a specified property.

These matrices P, Q, O can have differentiated dimension: suppose, that the matrix P has dimension $m_1 \times n$, the matrix Q – dimention $m_2 \times n$, and the matrix O – dimention $m_3 \times n$, equality should be strictly observed:

$$m_1 + m_2 + m_3 = m. \quad (1)$$

The requirement (1) is valid in the case when the number of columns of n is the same for all matrices. The condition n = const for all matrices P, Q, O is easily realized by adding columns with zero elements.

The development of food products requires the introduction of some changes in existing production schemes and, as a consequence, the design of the technology itself. This relationship is especially clearly traced when creating not a single product, but a group of products having a significant similarity of composition (the presence of a base matrix C_p^0) and technological solutions. In this case, we can talk about the development (construction) of a food products number on the basis of a single "semi", which has a base composition of the matrix C_p^0.

To further detail the universal approach to the development of a basic semi-finished product, it seems reasonable to clarify a number of terminological definitions, which will make it possible to eliminate the discrepancies in the future.

The Basic Food Semi-Finished Product – a semi-finished product, on the basis of which a homogeneous group of food products is manufactured under industrial conditions.

The Basic Matrix of Food Semi-Finished Product – matrix of the composition of the semi-finished product, the components of which are generally preserved in the production of homogeneous products.

Homogeneous Group of Food Products – a number of food products, derived from the basic food component by changing organoleptic or other indicators (characteristics) at the last stage of technological production.

Construction of Homogeneous Goods Technology – the development of a technology that includes the production of a food semi-finished product followed by a sequential or parallel release of a homogeneous group of food products.

Taking into account the introduced terminological definitions, let us consider the problems of constructing basic food semi-finished products technologies (BFSPT). It should be noted that some examples of the use of BFSPT are known, but they are extremely rare, and the lack of proper scientific and methodological coverage in the relevant technical literature does not allow to reveal all the exceptional possibilities of the proposed method.

The overwhelming majority of food technologies are based on a sequence of operations (linear or sequential scheme) and practically no feedback schemes are widely used in instrumentation, automatic control and other industries. It is necessary to clearly distinguish the technology of food production from the devices used at certain stages of the technology. These devices themselves can have different structural schemes, but they are not objects of this article.

A generalized model of food production technology can be represented in the form of a sequence of performing a number of technological steps (figure 1). For each stage, it is assumed that there is an appropriate hardware-technological design for the production process.

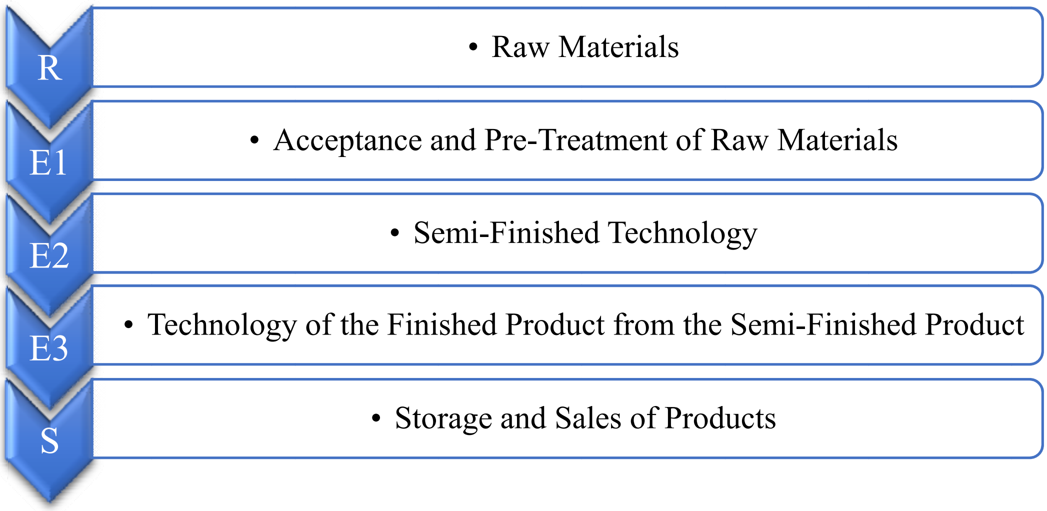


Figure 1 – Principal technology of food production according to the scheme with BFSPT

It should be noted, that the presented generalized technology is far from real production realizations. First of all, this refers to the availability of a specific semi-finished product – often in production it looks conditionally. But the high degree of generalization used in the generalized model of production technology makes it easy to formulate and explain the goals and ways of creating BFSPT. A generalized production model can be described with the help of operators:

$$C_p\left(P,Q,O\right)=W_3\cdot W_2\cdot W_1 C^0, \tag{2}$$

where W_1, W_2, W_3 – conversion operators of the corresponding stages; C^0 – generalized matrix of raw materials.

It should be noted, that the operators W_i represent the sequence of operators of all equipment used at each stage [17]. For example, if the first step (E1) uses the sequence k equipment, the operator W_1 will have the form:

$$W_1=W_{1,k}\cdot W_{1,k-1}\cdot W_{1,1}. \tag{3}$$

In the process of developing a homogeneous product group C_p^b, it is possible to define a certain matrix of the semi-finished product, which is the same for the entire group of homogeneous products C_p^b, where b = 1,2,...,s. In this case, the generalized production technology of a group of homogeneous products C_p^b when implementing the BFSPT method, it can be represented as follows figure 2.

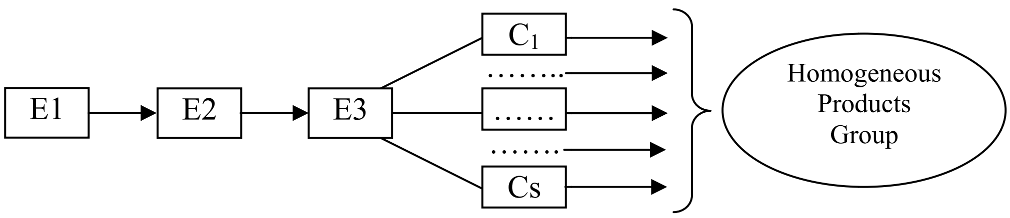


Figure 2 – Generalized Technology for the Production of a Homogeneous Food Products Group

The group of homogeneous products (figure 2), by total number s is characterized by the corresponding matrices $C_p^1, C_p^2, ..., C_p^s$. It should be noted that figure 2 shows a scheme with parallel output of homogeneous products. This scheme is preferable for large-capacity production with a sufficient production resource for the production of semi-finished products. In other cases, the parallel output scheme is replaced by a sequential-temporary scheme in accordance with the production plan.

Trends in the development of the soft drinks industry have shown that it is possible to create a new range of beverages C_p^b with distinctive organoleptics while maintaining the basic (majority) values of matrix elements P and Q.

In the practice of the Russian food industry, flour from triticale has been widely used in recent years. Studies have shown that a high-quality concentrated wort can be obtained from triticale, which can be used as a basis for obtaining a large range of new beverages. Analysis of the technological chain from the final product made it possible to determine the semi-finished product with the base matrix-concentrated wort. On the basis of the concentrated wort produced as soft drinks and kvass.

BFSPT principle is applicable in various fields of food industry, for example in dairy, when fruit yoghurt product line is formed around the base matrix – classic yogurt; glazed curds and cottage cheese mass- cottage cheese and stuff.

Today, there are quite clearly formulated points of view on possible ways to improve the quality of food products, including prolonging the shelf life and developing methods to combat falsification [19-24]. Theoretical and practical bases of physical, chemical, and biological changes that occur in food products during storage have been developed [12, 13, 17].

The level of modern knowledge, including interdisciplinary, allows us to predict the effectiveness of expanding the field of food quality assessment criteria and the rationality of technological schemes by integrating additional characteristics and predicting the economic, social and strategic effectiveness of developments, and accordingly declare the relevance of the direction [1, 12, 14, 18].

The analysis of the material made it possible to develop a mathematical model and to propose a product marker matrix from the point of quality loss from genuine to falsified. The proposed refinements and terminological definitions will eliminate the ambiguity of terminological definitions in the process of developing a set of documentation for identification of the adulterated foods.

Figure 3 shows the matrix of the genuine product.

Genuine product matrix is invariant with respect to adding null rows – y_k (dummy additionally introduced component in the product recipe) and null columns – x_l (dummy ingredients). The vector of ingredients x consists of components significant to determination of the authenticity of a particular product, and the recipe component y_j is the product sum of mass fractions a_{ij} by the corresponding ingredients x_i. The final column vector of the recipe y is equal to the mathematical product of the characteristic matrix A on the column-vector of ingredients x.

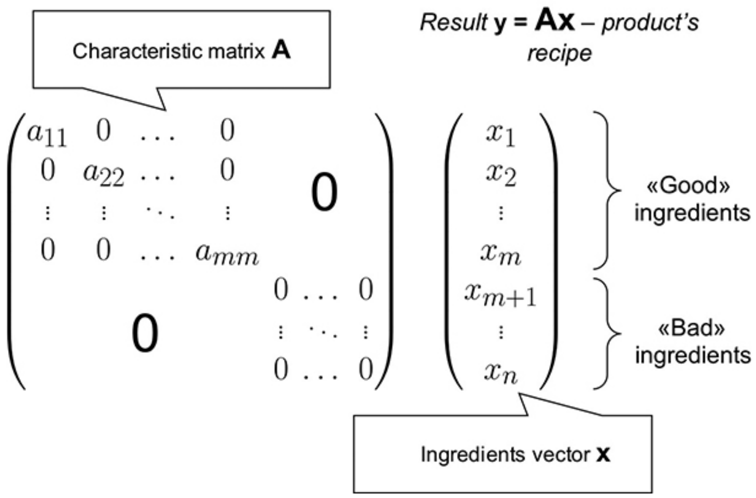


Figure 3 – Genuine Product Matrix

At the same time, it is possible to transform the original matrix into interval matrix and compare its reference range values with the actual results obtained during the analysis and presented as a numerical matrix of measurements.

Figure 4 presents a modified matrix, intrinsic to a substandard product (with violations of the mass fraction values of the components).

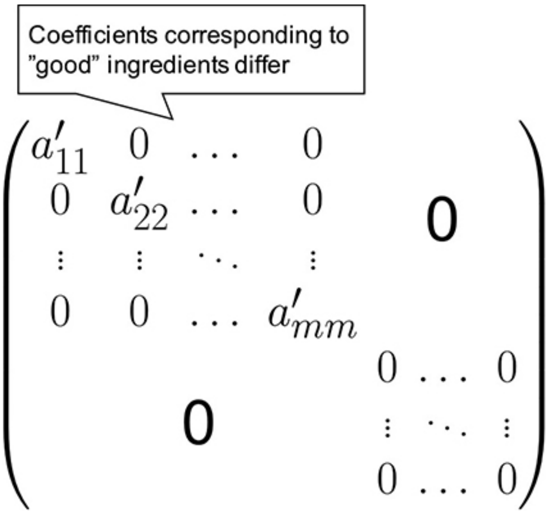


Figure 4 – Modified Product Matrix

Modified matrix { $a'_{i,j}$ }, intrinsic to a substandard product, differs from the original matrix { $a_{i,j}$ }, and while if $a'_{i,j} \neq a_{i,j}$, then with necessity $a_{i,j} \neq 0$, that is, in the modified matrix, the mass fractions of the ingredients may vary, but new ingredients can not be added to the components of the formulation.

Figure 5 shows the pseudomatrix.

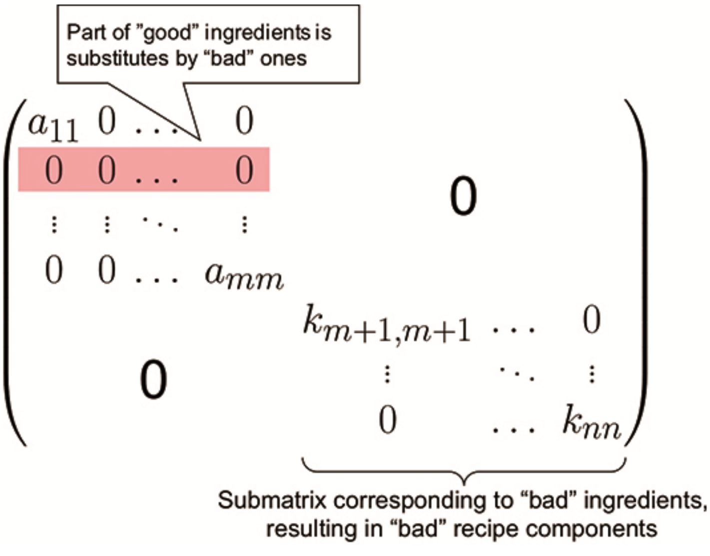


Figure 5 – Pseudomatrix

The pseudo matrix, characteristic of surrogate products, is distinguished by replacement or addition x_i ingredients, as well as by replacing or adding y_i of the recipe components, while the presence of the above components and ingredients is not hidden by the manufacturer. In this case, the added components x_i do not participate in the composition of the components of the formulation of genuine reference product.

Figure 6 shows a false matrix. A false matrix, characteristic of a falsified product, is a combination of a pseudomatrix and a modified matrix and can carry the properties of both a surrogate and a substandard

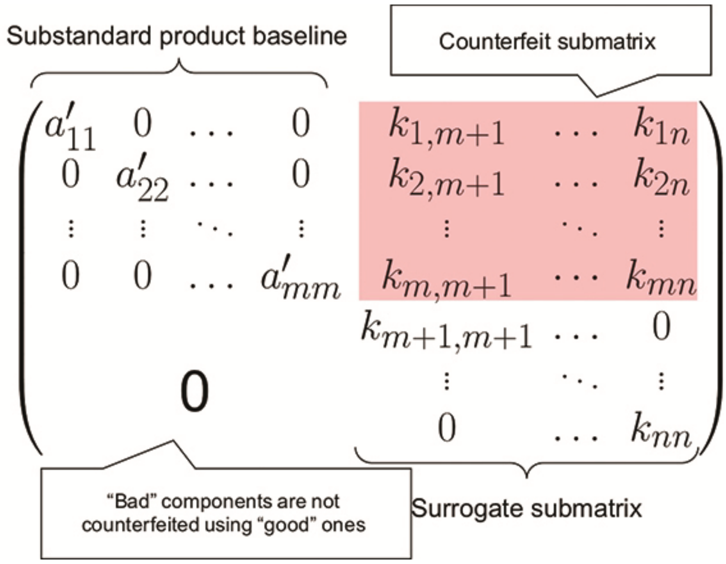


Figure 6 – False Matrix of Counterfeit

product and their various variations in terms of changing the mass fractions of the ingredients and adding additional ingredients and components. In this case, for a false matrix, the condition of the need to change only the non-zero mass fractions $a_{i,j}$ of the original matrix is not fulfilled, as in the modified version, the component of the formulation can consist of completely different ingredients and their combinations.

The resulting generalized form of the product characteristic matrix is shown in figure 7. In the case of counterfeit, the manufacturer generally does not report the relevant substitutions of the ingredients and/or their mass fractions.

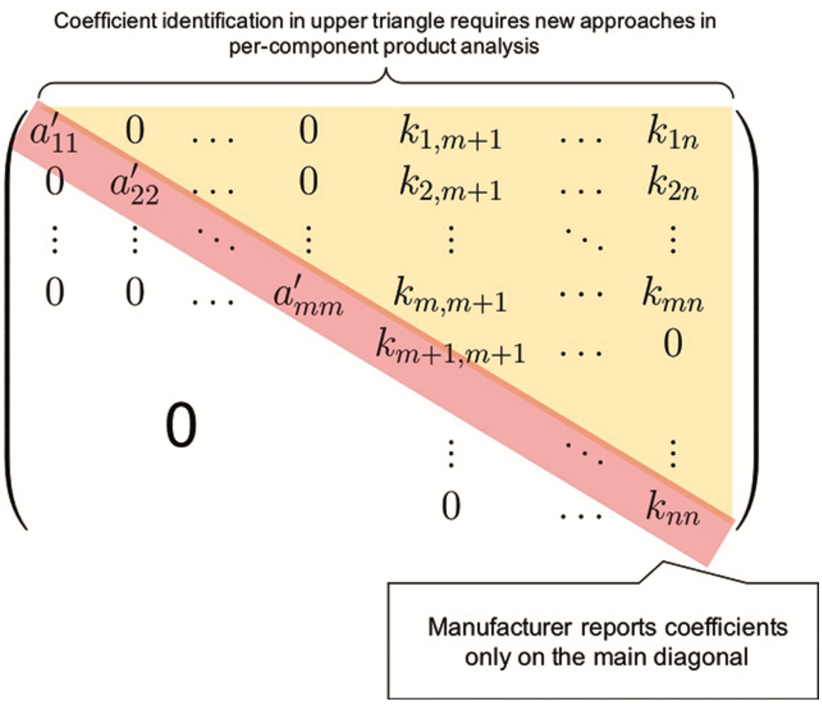


Figure 7 – Generalized Form of the Characteristic Matrix

To optimize the work with matrices, software was created – figure 8.

The operator introduces the indicators of the original matrix (standardized indicators of the product in accordance with the technical documentation) and the errors of the relevant research methods to obtain the

Figure 8 – Matrix Software Interface

interval characteristic matrix. The operator sequentially downloads the results of examining similar samples into the actual matrix. The program considers the average matrix of samples actually provided, as well as the matrix of standard deviations, presenting the received material in digital and graphical form. Deviations from the original matrix are determined by peaks on the surface deviation graph. In parallel, the program provides data on the relative novelty of the product compared to the reference product, which is in fact a new approach to assessing the novelty of technological solutions. A separate algorithm for predicting the direction of falsification has been introduced, which actually determines the quantitative ratio of samples with different deviations.

Shown the possibility of constructing a technology for the production of a group of homogeneous products based on the availability of semi-finished products from a single base matrix. The implementation of the principle of BFSPT allows us to unify two of the three stages of production, stabilize the quality of products and streamline the control system. Thus, a mathematical model has been developed, matrices of product markers and basic principles for integrating additional thermodynamic and functional-technological indicators, including water, into the system of evaluation criteria for the rationality of technologies and product quality have been proposed.

It can be assumed that the design of technologies for a complex of homogeneous food products based on BFSPT will develop taking into account the technological and economic advantages provided by BFSPT.

To identify and control the quality of products and the rationality of technological schemes, it is advisable to expand the scope of evaluation criteria. At the same time, the proposed grades of product matrices from genuine to falsified allow to fix any changes with a high degree of accuracy. Designed for ease of use with the matrix software allows you to speed up the evaluation process, create a database and identify falsification trends.

REFERENCES

[1] Lisitsyn AB. (**2010**) Introduction of High Technologies Guarantees Stable Quality. *Fleischwirtschaft International*. 1:10-12. (in Russ)

[2] Konovalova KL. and other. (**2010**) Creation of Qualitatively New Products with Specified Properties. *Food Industry*. 5:26-29. (in Russ)

[3] Churshudyan SA. (**2014**) Consumer and Food Quality. *Food Industry*. 5:16–18. (In Russ).

[4] Surkov IV, Kantere VM, Motovilov KYa, Renzyaeva TV. (**2015**) The Development of an Integrated Management System to Ensure the Quality, Stability and Food Safety. *Foods and Raw Materials.* 3(1): 111–119. doi:10.12737/11245. (in Eng)

[5] R. Wildman. (**2007**) Handbook of Nutraceuticals and Functional Foods, CRC Press, New York. ISBN 9780849364099

[6] Sokolova EN, Kurbatova EI, Rimareva LV, Davydkina VE, Borscheva YuA. (**2016**) Biotechnological Aspects of Directed Enzymatic Destruction of Cell Walls of Plant Raw Materials for Obtaining Extracts with an Increased Content of Biologically Valuable Substances as Components of Functional Drinks. *Nutrition Issues.* T. 85, 2:151-152. (in Russ)

[7] Zakharova LM, Orekhova SV, Zakharchenko MA, and Lozmanova SS. (**2012**) The study of Technological Parameters of Making a Functional Fermented Milk Product, Food Production Techniques and Technology. 37-42. (in Russ)

[8] Valdes AF and Garcia AB. (**2006**) A Study of the Evolution of the Physicochemical and Structural Characteristics of Olive and Sunflower Oils after Heating at Frying Temperatures. *Food Chemistry.* vol. 98. 2:214-219. doi:10.1016/j.foodchem.2005.05.061. (in Eng)

[9] Erl M, Erl R. (**2010**) Examples of Food Development. Case Analysis. «Professia», SPb. ISBN 978-1-84569-260-5.

[10] Erl M, Erl R, Anderson A. (**2007**) Development of Food Products. Part 1. «Professia», SPb. ISBN 1-85573-468-0.

[11] Erl M, Erl R, Anderson A. (**2007**) Development of Food Products. Part 2. «Professia», SPb. ISBN 5-93913-061-5.

[12] Rjabova AE, Kirsanov VV, Strizhko MN, Bredikhin AS, Semipyatnyi VK, Chervetsov VV, Galstyan AG. (**2013**) Lactose crystallization: current issues and promising engineering solutions, Foods and Raw Materials, 1:1:66-73. doi:10.12737/1559. (in Eng)

[13] Chernukha IM. (**2012**) Application of «-Omics» Technologies for the Analysis of Raw Meat and Products. *All about the Meat*. 6:32-36. (in Eng)

[14] Galstyan AG, Petrov AN, Semipyatniy VK. (2016) Theoretical backgrounds for enhancement of dry milk dissolution process: mathematical modeling of the system “solid particles-liquid”, *Foods and Raw Materials*, 4:1:102-109. DOI:10.21179/2308-4057-2016-1-102-109. (in Eng)

[15] Prosekov AYu, Ivanova SA. (**2016)** Providing Food Security in the Existing Tendencies of Population Growth and Political and Economic Instability in the World. *Foods and Raw Materials*, 4: 2: 201–211. doi: 10.21179/2308-4057-2016-2-201-211. (in Eng)

[16] Khurshudyan SA. (**2014**) Criterion for Assessing the Choice of Technological Equipment for the Production of Mineral Water. *Food Industry*. 2:22-23. (in Russ)

[17] Petrov AN, Galstyan AG, Radaeva IA, Turovskaya SN, Illarionova EE, Semipyatniy VK, Khurshudyan SA, DuBuske LM, Krikunova LN. (**2017**) Indicators of Canned Milk Quality: Russian and International Priorities. *Foods and Raw Materials*. 5:2:151-161. (in Eng)

[18] Rimareva LV, Sokolova EN, Serba EM, Borshchevà YA, Kurbatova EI, Krivova AY. (**2017**) Reduced Allergenicity of Foods of Plant Nature by Method of Enzymatic Hydrolysis. *Oriental Journal of Chemistry*. 33:4:2009-2015. doi:10.13005/ojc/330448. (in Eng)

[19] Petrov AN, Khanferyan RA, Galstyan AG. (**2016**) Actual Aspects of Counteraction of Food Falsification. *Nutrition Issues*. 5:86-92. (in Russ)

[20] Oseledtseva IV, Guguchkina TI, Sobolev EM. (**2010**) Practical Realization of Modern Ways for Determination Authenticity of Brandy Production. News Institutes of Higher Education. *Food Technology*. 2–3:104–107. (in Eng)

[21] Oganesyants LA, Panasyuk AL, Kuzmina EI, et al. (**2011**) Definition of authenticity of grape wines by means of isotropic mass spectrometry. *Food Proccessing Industry,* 9:30-31. (in Russ)

[22] Kalinin AV, Krasheninnikov VN, Sviridov AP, Titov VN. (**2016**) Near infrared spectrometry of clinically significant fatty acids in the near infrared range using multicomponent regression. *Journal of Applied Spectroscopy.* 83:5:773-781. doi:10.1007/s10812-016-0368-0. (in Eng)

[23] Oganesyants LA, Panasyuk AL, Kuzmina EI, Zyakun AM. (**2015**) Isotopic features of ethanol of the russian grape wine. *Winemaking and Viticulture.* 4:8-13. (in Russ)

[24] Panasyuk AL, Oganesyants LA, Kuzmina EI. (**2016**) Analysis of isotopic characteristics of wine products water component oxygen. *Winemaking and Viticulture.* 6:4-6. (in Russ)

[25] Ivashov V.I., Kapovsky B.R., Plyasheshnik P.I., Pchelkina V.A., Iskakova E.L., Nurmukhanbetova D.E. **(2018)** Mathematical simulation of one-stage grinding of products frozen in blocks. News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. Volume 5, Number 431 (2018), PP.48–65. https://doi.org/10.32014/2018.2518-170X.9 ISSN 2518-170X (Online), ISSN 2224-5278 (Print)

Л. А. Оганесянц[1], С. А. Хуршудян[1], А. Г. Галстян[1],
В. К. Семипятный[1], А. Е. Рябова[1], Р. Р. Вафин[1],
Д. Е. Нурмуханбетова[2], Э. К. Асембаева[2]

[1]Бүкілресейлік сыра қайнату, алкогольсіз және шарап өнеркәсібі ғылыми-зерттеу институты –
ФМБҒМ филиалы В. М. Горбатов атындағы «Азық-түлік өнімдерінің федералдық ғылыми орталығы»
РҒА, Мәскеу, Ресей,
[2] Алматы технологиялық университеті, Алматы, Қазақстан

БАЗАЛЫҚ МАТРИЦАЛАР – ТАҒАМ ӨНІМДЕРІНІҢ ИНВАРИАНТТЫ САНДЫҚ ИДЕНТИФИКАТОРЫ

Аннотация. Жұмыста тағам өнімдерінің бірыңғай негізгі базалық матрицасын жасаудың (негізгі азық-түлік жартылай фабрикаттарының) біртекті тағам өнімдерінің тобына арналған технологияларды кейіннен жобалау үшін келешегі көрсетілген. Құрастыру технологиясының осы принципін іске асыру өндірістің көптеген сатыларын біріктіруге және соның салдарынан өнім сапасын тұрақтандыруға, сәйкестендіру және бақылау жүйесін рационализациялауға мүмкіндік береді. Тиісінше, соңғы үшін математикалық модель әзірленді, түпнұсқалық маркерлердің матрицалары түпнұсқадан бұрмалаушылыққа дейін ұсынылады. Ақпараттың толықтығы үшін төмен сапалы, сонымен қатар суррогат өнімдердің нұсқалары аралық байланыстар ретінде қарастырылады. Қосымша термодинамикалық және функционалдық-технологиялық көрсеткіштерді технологиялар мен өнімнің сапасын бағалау критерийлеріне интеграциялау негізделген.

Түйін сөздер: тағам өнімі, технология, терминдер, бағалау критерийлері, матрицалар, құрастыру.

Л. А. Оганесянц[1], С. А. Хуршудян[1], А. Г. Галстян[1],
В. К. Семипятный[1], А. Е. Рябова[1], Р. Р. Вафин[1],
Д. Е. Нурмуханбетова[2], Э. К. Асембаева[2]

[1]Всероссийский научно-исследовательский институт пивоваренной, безалкогольной и
винодельческой промышленности – филиал ФГБНУ «ФНЦ пищевых систем им. В. М. Горбатова» РАН,
Москва, Россия,
[2]Алматинский технологический университет, Алматы, Казахстан

БАЗОВЫЕ МАТРИЦЫ – ИНВАРИАНТНЫЕ ЦИФРОВЫЕ ИДЕНТИФИКАТОРЫ ПИЩЕВЫХ ПРОДУКТОВ

Аннотация. В работе показана перспективность разработки единой базовой матрицы продукта (базового пищевого полуфабриката) для последующего проектирования технологий группы однородной продукции. Реализация данного принципа конструирования технологий позволяет унифицировать множество этапов производства и, как следствие, стабилизировать качество продуктов, а также рационализировать систему идентификации и контроля. Соответственно для последнего разработана математическая модель, предложены матрицы маркеров продукта от подлинного до фальсифицированного. Для полноты информации рассмотрены варианты некачественного, а также суррогатного продуктов как возможных промежуточных звеньев. Обоснована интеграция дополнительных термодинамических и функционально-технологических показателей в систему оценочных критериев рациональности технологий и качества продукции.

Ключевые слова: продукты питания, технологии, термины, оценочные критерии, матрицы, конструирование.

Information about authors:

Oganesyants Lev Arsenovich – All-Russian Scientific Research Institute of Brewing, Non-Alcoholic and Wine Industry – branch of the Gorbatov's Federal Scientific Center of Food Systems of RAS, Director, Doctor of Technical Science, Professor, Academician of RAS; muskat@mail.ru; https://orcid.org/0000-0001-8195-4292

Khurshudyan Sergei Azatovich – All-Russian Scientific Research Institute of Brewing, Non-Alcoholic and Wine Industry – branch of the Gorbatov's Federal Scientific Center of Food Systems of RAS, Senior Researcher of the Interbranch Scientific and Technical Center for Food Quality Monitoring, Doctor of Technical Science, Professor; xca020149@rambler.ru; https://orcid.org/0000-0001-7735-7356

Galstyan Aram Genrikhovich – All-Russian Scientific Research Institute of Brewing, Non-Alcoholic and Wine Industry – branch of the Gorbatov's Federal Scientific Center of Food Systems of RAS, Head of the Interbranch Scientific and Technical Center for Food Quality Monitoring, Doctor of Technical Science, Professor of RAS, Corresponding Member of RAS; 9795029@mail.ru; https://orcid.org/0000-0002-0786-2055

Semipyatny Vladislav Konstantinovich – All-Russian Scientific Research Institute of Brewing, Non-Alcoholic and Wine Industry – branch of the Gorbatov's Federal Scientific Center of Food Systems of RAS, Senior Researcher of the Interbranch Scientific and Technical Center for Food Quality Monitoring, Candidate of Technical Science; semipyatniy@gmail.com; https://orcid.org/0000-0003-1241-0026

Ryabova Anastasia Evgenievna – All-Russian Scientific Research Institute of Brewing, Non-Alcoholic and Wine Industry – branch of the Gorbatov's Federal Scientific Center of Food Systems of RAS, Interbranch Scientific and Technical Center for Food Quality Monitoring Researcher, Candidate of Technical Science; anryz@hotmail.com; https://orcid.org/0000-0002-5712-2020

Vafin Ramil Rishadovich – All-Russian Scientific Research Institute of Brewing, Non-Alcoholic and Wine Industry – branch of the Gorbatov's Federal Scientific Center of Food Systems of RAS, Lead Researcher of the Interbranch Scientific and Technical Center for Food Quality Monitoring, Doctor of Biological Science, Professor of RAS; vafin-ramil@mail; https://orcid.org/0000-0003-0914-0053

Nurmukhanbetova Dinara Erikovna – candidate of engineering sciences, acting associate professor, Almaty Technological University, Department of Food safety and quality; dinar2080@mail.ru

Assembayeva Elmira Kuandykovna – Almaty Technological University, Department of Food Biotechnology, Master of Technical Sciences, Senior Lecturer; elmiraasembaeva@mail.ru

N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278 **https://doi.org/10.32014/2018.2518-170X.31**
Volume 5, Number 431 (2018), 16 – 22

UDC 637.133

S. N. Turovskaya[1], A. G. Galstyan[2], I. A. Radaeva[1], A. N. Petrov[3], E. E. Illarionova[1], A. E. Ryabova[2], E. K. Assembayeva[4], D. E. Nurmukhanbetova[4]

[1]All-Russian Research Institute of Dairy Industry, Moscow, Russia,
[2]All-Russian Scientific Research Institute of Brewing, Non-Alcoholic and Wine Industry – branch of the Gorbatov's Federal Scientific Center of Food Systems of RAS, Moscow, Russia,
[3]All-Russian Scientific Research Institute of Preservation Technology – branch of the Gorbatov's Federal Scientific Center of Food Systems of RAS, Vidnoye, Russia,
[4]Almaty Technological University, Almaty, Kazakhstan.
E-mail: conservlab@mail.ru, 9795029@mail.ru, conservlab@mail.ru, vniitek@vniitek.ru, conservlab@mail.ru, anryz@hotmail.com, elmiraasembaeva@mail.ru, dinar2080@mail.ru

SCIENTIFIC AND PRACTICAL POTENTIAL OF DAIRY PRODUCTS FOR SPECIAL PURPOSES

Abstract. For many years, the All-Russian Research Institute of Dairy Industry (VNIMI) has been developing technologies for special purpose dairy products, including for on-board rations of crews of spacecraft and orbital stations. The work was carried out in complex with the Institute of Biomedical Problems, the Scientific Research Institute of the Food Concentrate Industry and Special Food Technology and a number of other industry and medical institutions. At VNIMI was created the special products shop, the scientific and production base of which allowed not only to provide research with experimental workings, but also to produce products in the required assortment and quantities. Development of technologies for astronauts products is continuing and at the present time, medical and biological requirements are being adjusted, modern technological representations are being expanded to find an applied solution, aimed at improving the quality while reducing processing intensity, introducing new packaging materials and so on.

Special requirements are imposed on the products: they must be tasty, highly nutritious, well balanced in macro- and micro-nutrient composition, have certain preventive properties, be simple in preparation and use, have increased storage stability, etc. This group of products is rightfully considered the most knowledge-intensive in terms of technological innovations and solutions.

Special purpose products on a dairy basis can in principle be divided into two main groups: sterilized (abiosis) and freeze-dried (xeranoanobiosis). To date, dozens of technologies have been created in both groups – milk, dairy drinks, soups, cereals, dairy products, cottage cheese and others. The products were tested for the duration of storage and included in the diets of astronauts. Part of the products was approved in the works of orbital stations and spacecraft, including international ones. Qualitative indicators of dairy products are highly appreciated not only by Russian, but also by foreign cosmonauts.

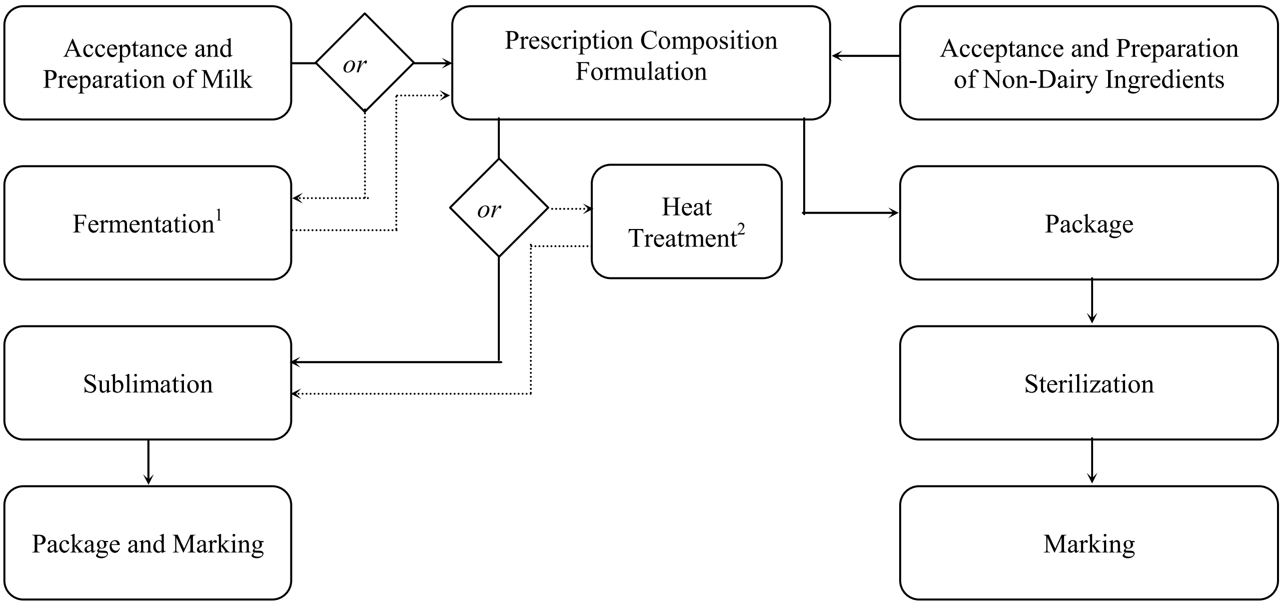
Keywords: space, nutrition, dairy products, technology, sublimation, sterilization.

With the beginning of the era of space exploration and organization of human flights into space, there was a need to provide cosmonauts with food. The everyday process of eating food in the conditions of space acquires many nuances of "everyday", medical-biological, technological and other formats [1, 2].

The peculiarities of labor and life of cosmonauts in flight, associated with the stressful effects on the body of conditions of non-trivial situation, such as speed of movement, weightlessness, emotional and mental stress, limited space of the ship's cabin and others, make special demands on the qualitative and quantitative composition of the diet, mass-volume characteristics of its constituent products and packaging [3-7].

The pioneers in the preparation and organization of food for astronauts were enthusiasts and coryphaeis in the field of food technology Frumkin M.L., Efimov V.P., Kudrova R.V. and others. They brought to the solution of this problem branch scientific research institutes, including the All-Union (now All-Russian) Research Institute of the Dairy Industry (VNIMI). In the late 60-ies in VNIMI under the guidance of Doctor of Technical Sciences, Professor Radaeva I.A. began to develop technology for special purpose products. Further research in this direction was done by Rossikhina G.A., Usacheva V.A., Dobriyan E.I., Volkova L.G., Guskova L.D., Filchakova S.A., Blinova T.E., Sokolova T.V. etc. The works were carried out in complex with the Institute of Medical and Biological Problems, the Scientific Research Institute of the Food-Concentrate Industry and Special Food Technology, and a number of other branches and medical institutes. At VNIMI the special products shop was created, the scientific and production base of which allowed not only to provide research with experimental workings, but also to produce products in the required assortment and quantities. Development of technology for astronauts products is continuing and at the present time, medical and biological requirements are being adjusted, the modern technological ideas aimed at improving the quality while reducing the processing intensity are being expanded and applied, and new packaging materials are being introduced [5-15].

Dairy products for special purposes can in principle be divided into two main groups: sterilized (abiosis) and freeze-dried (xeroboanobiosis) [16, 17]. The features and advantages of these preservation methods have long been known and widely used. They allow you to create products that retain their native properties for a long time and, at the same time, are easy to prepare and use. Principal schemes of technological processes are presented in figure.



Principal Schemes of Production of Freeze-Dried and Sterilized Special Purpose Products for Cosmonauts Nutrition (where: [1] – for sour-milk and curd products; [2] – for dairy drinks, porridges and soups; dotted line-possible technological solutions)

The group of sterilized dairy products includes: high-fat products (cream with coffee, cream with cocoa, kaimak) and high-protein products (cottage cheese with raisins, cottage cheese “Yablochko”, cottage cheese with lemon, cottage cheese with cumin, cottage cheese with dill). Sterilized dairy products have pasty, homogeneous consistency with taste and odor, characteristic of the introduced filler. Their physicochemical parameters are presented in table 1.

Sterilized dairy products are high-calorific easily digestible products, which have a high biological and energy value. These properties of products are due to their enrichment with high-grade milk proteins and the presence of fatty and fat-like substances. Due to the high content of milk fat, which is a mixture of lipids, creams can be referred to products, the need for which increases with nervous tension [18, 19].

Purposeful work on the creation of technologies for sterilized curd products and detailed studies of amino acid and fatty acid and mineral composition allow to classify them to a group of products with

Table 1 – Physico-Chemical Parameters of High-Fat and High-Protein Sterilized Dairy Products of Special Purpose

<table>
<tr><th rowspan="2">Product</th><th colspan="6">Product Indicator</th></tr>
<tr><th>Moisture Mass Fraction, %</th><th>Fat Mass Fraction, %</th><th>Protein Mass Fraction, %</th><th>Carbohydrates Mass Fraction, %</th><th>Mineral Substances (Ash) Mass Fraction, %</th><th>Energy Value, kcal/100g</th></tr>
<tr><td colspan="7">- Sterilized High-Fat Dairy Products</td></tr>
<tr><td>Cream with Coffee</td><td>32.0</td><td rowspan="2">45.0</td><td rowspan="3">5.0</td><td rowspan="2">15.0</td><td>3.0</td><td>489</td></tr>
<tr><td>Cream with Cocoa</td><td>30.0</td><td>5.0</td><td>485</td></tr>
<tr><td>Kaimak</td><td>37.0</td><td>50.0</td><td>5.0</td><td>3.0</td><td>490</td></tr>
<tr><td colspan="7">- Sterilized High-Protein Dairy Products</td></tr>
<tr><td>Cottage Cheese with Raisins</td><td rowspan="2">56.0</td><td rowspan="2">15.0</td><td rowspan="2">12.0</td><td rowspan="2">15.0</td><td rowspan="2">2.0</td><td rowspan="2">243</td></tr>
<tr><td>Cottage Cheese "Yablochko"</td></tr>
<tr><td>Cottage Cheese with Lemon</td><td>52.0</td><td rowspan="3">25.0</td><td>8.0</td><td>14.3</td><td rowspan="3">0.7</td><td>312</td></tr>
<tr><td>Cottage Cheese with Cumin</td><td rowspan="2">58.0</td><td rowspan="2">10.0</td><td rowspan="2">6.3</td><td rowspan="2">272</td></tr>
<tr><td>Cottage Cheese with Dill</td></tr>
</table>

preventive orientation. It is known that cottage cheese contains easily digestible protein, and in combination with fillers and additives, which in turn are additional sources of protein, vitamins, minerals, is a product with preventive properties. Even early studies conducted in Institute of Biomedical Problems (IBMP), found that when a person stays for a long time in conditions of weightlessness, one of the problems is the washing out of the body of potassium, which is one of the necessary macroelements that take part in metabolic processes in muscle and nerve tissues. For partial solution of this problem, curd products enriched with this macroelement were created and intended for use in the period of stress and emotional stress.

The shelf-life of sterilized dairy products is at least 12 months with unregulated room conditions and at least 20 months at a temperature of 1 to 5 °C. They consume them without prior preparation.

Sublimated dairy products developed by the Institute (www.vnimi.org) can be divided into the following subgroups: freeze-dried milk; dairy freeze-dried drinks (milk with sea buckthorn oil, milk with tea, skimmed milk with tea, milk with coffee, milk with cocoa); fermented milk products of freeze drying (acidophilic paste, acidophilus paste of increased fat content, yoghurt, sweet yogurt, fruit yoghurt, clabber Mechnikovskaya, bifidin milky-apple); cottage cheese and curd pastes freeze-dried (cottage cheese "Special", fruit cottage cheese, curd pasta with dried apricots, cottage cheese pasta with cranberry, cottage cheese pasta with black currant, cottage cheese pasta with nuts); porridge dairy freeze drying (manna porridge, rice porridge); soup with vermicelli.

Sublimated dairy products are a powder consisting of particles of different shapes, scattered by light mechanical action. The taste and smell of products is determined by their appearance and introduced fillers.

Milk, milk porridge and milk soup with vermicelli freeze-dried were developed in order to expand the range of products of increased nutritional value and long shelf life, as well as meet the desire of cosmonauts to have hot diary products in the diet. Dried freeze-dried drinks can compensate for the deficit of potassium and other macro-elements, as well as vitamin C, which occurs in cosmonauts. The physico-chemical parameters of these products are presented in table 2.

Sour-milk products of freeze-drying due to their ability to normalize the microflora in the human gastrointestinal tract are especially useful for prolonged feeding of cosmonauts with canned food. Physicochemical parameters of freeze-dried fermented milk products are presented in table 3.

Table 2 – Physicochemical Parameters of Freeze-Dried Milk, Dairy Drinks, Porreges and Special Purpose Soups

Product	Product Indicator					
	Moisture Mass Fraction, %	Fat Mass Fraction, %	Protein Mass Fraction, %	Carbohydrates Mass Fraction, %	Mineral Substances (Ash) Mass Fraction, %	Energy Value, kcal/100g
- Milk, Milk Porridges and Soup with Vermicelli of Freeze-Drying						
Milk	4.0	25.8	26.0	38.2	6.0	489
Manna Porridge		28.0	13.0	50.0	5.0	504
Rice Porridge		23.0	10.0	59.0	4.0	483
Soup with Vermicelli		20.0	17.0	53.0	6.0	460
- Milk Drinks						
Milk with Sea-Buckthorn Oil	4.0	25.0	22.0	43.0	6.0	485
Milk with Tea		18.0		55.8	4.2	457
Low-Fat Milk with Tea		---	25.0	66.0	5.0	364
Milk with Coffee		18.0	20.0	53.3	4.7	455
Milk with Cocoa		20.0	19.0	51.5	5.5	462

Table 3 – Physicochemical Parameters of Dairy Lactic Freeze-Dried Products

Product	Product Indicator					
	Moisture Mass Fraction, %	Fat Mass Fraction, %	Protein Mass Fraction, %	Carbohydrates Mass Fraction, %	Mineral Substances (Ash) Mass Fraction, %	Energy Value, kcal/100g
Acido-Filo Paste	4.0	12.5	15.0	66.5	2.0	438
Acido-Filo Paste of Increased Fat Content		19.0		60.2	1.8	472
Yogurt		36.0	16.0	39.0	5.0	544
Sweet Yoghurt		27.5		48.0	4.5	503
Fruit Yoghurt		26.0		49.6	4.4	496
Clabber Mechnikovs-kaya		40.0	18.0	33.0	5.0	564
Bifidin Milky-Apple		17.5	17.0	57.0	4.3	454

Cottage cheese and cottage pastes of freeze drying have a high biological value [20]. Milk components such as protein and calcium are present in it in much larger quantities than in milk, and therefore they can be considered as milk concentrates. One portion of reconstituted cottage cheese (100-150 g) allows you to meet half the daily requirement of the body in calcium, as well as in essential amino acids. The introduction of cottage products of herbal supplements into the formulation promoted an increase in nutritional value. The physicochemical parameters of the freeze-dried cottage products are given in table 4.

Table 4 – Physicochemical Parameters of Cottage Cheese and Cottage Pastes of Freeze-Drying

<table>
<tr><th rowspan="2">Product</th><th colspan="6">Product Indicator</th></tr>
<tr><th>Moisture Mass Fraction, %</th><th>Fat Mass Fraction, %</th><th>Protein Mass Fraction, %</th><th>Carbohydrates Mass Fraction, %</th><th>Mineral Substances (Ash) Mass Fraction, %</th><th>Energy Value, kcal/100g</th></tr>
<tr><td>Cottage Cheese "Special"</td><td rowspan="6">4.0</td><td>30.0</td><td>50.0</td><td>12.5</td><td>3.5</td><td>520</td></tr>
<tr><td>Cottage Cheese Fruit</td><td>17.0</td><td>32.0</td><td>45.0</td><td>2.0</td><td>461</td></tr>
<tr><td>Cottage Cheese Paste with Dried Apricots</td><td rowspan="3">15.0</td><td>28.0</td><td>50.7</td><td>2.3</td><td>450</td></tr>
<tr><td>Cottage Cheese Paste with Cranberries</td><td rowspan="3">30.0</td><td>49.2</td><td>1.8</td><td rowspan="2">452</td></tr>
<tr><td>Cottage Cheese Paste with Black Currant</td><td>49.3</td><td>1.7</td></tr>
<tr><td>Cottage Cheese Paste with Nuts</td><td>25.0</td><td>39.0</td><td>2.0</td><td>501</td></tr>
</table>

Shelf life of freeze-dried dairy products is at least 15 months at a temperature of (25 ± 1) °C and not less than 24 months at a temperature of 1 to 5 °C. The sublimated dairy products are packaged in multi-layer polymeric materials under vacuum. In food they are used after dissolution in water.

The intellectual component of technologies and ways of obtaining products for astronauts are registered. The products were tested for the duration of storage and included in the diets of astronauts. Qualitative indicators of dairy products are highly appreciated not only by Russian, but also by foreign cosmonauts.

REFERENCES

[1] Agureev A.N. (**2016**). Estimation of the Food Status of the Russian Crew Members of the ISS when Feeding a 16-Day Diet // In the Collection: Ideas of K.E. Tsiolkovsky in the Innovation of Science and Technology. Materials of the 51st Scientific Readings in Memory of K.E. Tsiolkovsky. P. 174-175.

[2] Agureev A.N., Kalandarov S., Vasilyeva V.F., Gurova L.A. (**2004**). Feed the Crews of Long Expeditions on the International Space Station [Pitanie ehkipazhej dlitel'nyh ehkspedicij na mezhdunarodnoj kosmicheskoj stancii] // Aerospace and Environmental Medicine [Aviakosmicheskaya i ehkologicheskaya medicina]. 38, 5:19-23. (In Rus.).

[3] Dobrovolsky V.F., Gurova L.A., Kolesnikova V.B., Pavlova L.P. (**2013**). Research Institute of Food-Concentrating Industry and Special Food Technology – The Cosmos [NII pishchekoncentratnoj promyshlennosti i special'noj pishchevoj tekhnologii – kosmosu] // Food Industry [Pishchevaya promyshlennost']. 1:48-50. (In Rus.).

[4] Dobrovolsky V.F. (**2008**). Prospects for the Organization of Space Expeditions Nutrition [Perspektivy organizacii pitaniya kosmicheskih ehkspedicij] // Food Industry [Pishchevaya promyshlennost']. 5:66-68. (In Rus.).

[5] Dobrovolsky V.F. (**2009**). "Space" Food: Yesterday, Today and Tomorrow [«Kosmicheskaya» pishcha: vchera, segodnya i zavtra] // Food Industry [Pishchevaya promyshlennost']. 8:53. (In Rus.).

[6] Dobrovolsky V.F., Shalnova N.D. (**2007**). Dairy Products in the Diet of Cosmonauts. In the Collection: Modern Technologies of Production and Processing of Agricultural Raw Materials for the Creation of Competitive Food Products. Materials of the International Scientific and Practical Conference // Volgograd Research and Technology Institute of Meat and Dairy Cattle Breeding and Processing of Livestock Products of the Russian Academy of Agricultural Sciences. P. 147-151.

[7] Pavlova L.P., Stoyanova L.I., Shakleina A.Yu., German A.D. (**2015**). Sour-Milk Products in the Cosmonauts' Food at the International Space Station [Kislomolochnye produkty v pitanii kosmonavtov na mezhdunarodnoj kosmicheskoj stancii] // Food Industry [Pishchevaya promyshlennost']. 1:12-13. (In Rus.).

[8] Rjabova A.E., Kirsanov V.V., Strizhko M.N., Bredikhin A.S., Semipyatnyi V.K., Chervetsov V.V., Galstyan A.G. (**2013**). Lactose crystallization: current issues and promising engineering solutions // Foods and Raw Materials. 1:1:66-73. DOI 10.12737/1559.

[9] Galstyan A.G., Petrov A.N., Semipyatniy V.K. (**2016**). Theoretical backgrounds for enhancement of dry milk dissolution process: mathematical modeling of the system "solid particles-liquid" // Foods and Raw Materials. 4:1:102-109. DOI 10.21179/2308-4057-2016-1-102-109.

[10] Petrov A.N., Galstyan A.G., Radaeva I.A., Turovskaya S.N., Illarionova E.E., Semipyatniy V.K., Khurshudyan S.A., DuBuske L.M., Krikunova L.N. (**2017**). Indicators of quality of canned milk: Russian and international priorities // Foods and Raw Materials. 5:2:151-161. DOI 10.21603/2308-4057-2017-2-151-161.

[11] Churshudyan S.A. (**2014**). Consumer and Food Quality // Food Industry. 5:16–18. (In Rus.).

[12] Prosekov A.Yu. (**2014**). Theory and practice of prion protein analysis in food products // Foods and Raw Materials. 2:2:106-120. DOI 10.12737/5467.

[13] Galstyan A.G., Petrov A.N., Chistovalov N.S. (**2007**). Advanced technologies of water treatment in the production of reconstituted dairy products [Peredovye tekhnologii vodopodgotovki v proizvodstve vosstanovlennyh molochnyh produktov] // Storage and processing of agricultural raw materials [Hranenie i pererabotka sel'hozsyr'ya]. 11:30-33. (In Rus.).

[14] Petrova N.A. (**2008**). Development of technology of milk liqueurs with high colloidal stability [Razrabotka tekhnologii molochnyh likerov s vysokoj kolloidnoj stabil'nost'yu] // Ph.D. thesis in Engineering Science. St. Petersburg. (In Rus.).

[15] Semipyatny V.K., Strizhko M.N., Galstyan A.G. (**2013**). Perfection of the process of dissolution of dry milk: mathematical modeling of the system "Solid particle-liquid" [Sovershenstvovanie processa rastvoreniya suhogo moloka: matematicheskoe modelirovanie sistemy «Tverdaya chastica – zhidkost'»] // Dairy industry [Molochnaya promyshlennost']. 8:28-30. (In Rus.).

[16] Strizhko M., Kuznetsova A., Galstya A., Andrey P., Prosekov A. (**2014**) Development of osmotically active compositions for milk-based products with intermediate humidity // Bulletin of the International Dairy Federation. 41-48.

[17] Galstyan A.G., Petrov A.N., Radaeva I.A., Turovskaya S.N., Chervesov V.V., Illarionova E.E., Semipyatny V.K. (**2016**). Theory and practice of milk-canning production. Publishing House "Fedotov DA", Russia. ISBN 978-5-9908238-7-7.

[18] Biryukova Z.A. (**2015**). Sterilized dairy products of functional purpose [Sterilizovannye molochnye produkty funkcional'nogo naznacheniya] // In the book: Milk. Processing and storage. Moscow, 223-251. (In Rus.)

[19] Budanina L.N., Vereshchagin A.L., Bychin N.V. (**2015**). Application of the DSC method for identification of canned dairy products [Primenenie metoda DSK dlya identifikacii konservirovannyh molochnyh produktov] // Technology and technology of food production [Tekhnika i tekhnologiya pishchevyh proizvodstv]. 2(37): 98-104. (In Rus.).

[20] Monsoor M.A., Farooq K., Haque Z.U. (**2003**). Cottage chesse whey as sn ingredient of cottage chesse dressing mixes // International Journal of Dairy Technology. 56:1:17-21. DOI 10.1046/j.1471-0307.2003.00064.x

[21] Ivashov V.I., Kapovsky B.R., Plyasheshnik P.I., Pchelkina V.A., Iskakova E.L., Nurmukhanbetova D.E. (**2018**). Mathematical simulation of one-stage grinding of products frozen in blocks // News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. Vol. 5, N 431(2018). P..48-65. https://doi.org/10.32014/2018.2518-170X.9 . ISSN 2518-170X (Online), ISSN 2224-5278 (Print).

С. Н. Туровская[1], А. Г. Галстян[2], А. Н. Петров[3], И. А. Радаева[1], Е. Е. Илларионова[1], А. Е. Рябова[2], Э. К. Асембаева[4], Д. Е. Нурмуханбетова[4]

[1]ФМБҒМ «Бүкілресейлік сүт өнеркәсібі ғылыми-зерттеу институты», Мәскеу, Ресей,
[2]Бүкілресейлік сыра қайнату, алкогольсіз және шарап өнеркәсібі ғылыми-зерттеу институты –
ФМБҒМ филиалы В. М. Горбатов атындағы «Азық-түлік өнімдерінің федералдық ғылыми орталығы» РҒА, Мәскеу, Ресей,
[3]«Бүкілресейлік консервілеу технологиясы ғылыми-зерттеу институты» ФМБҒМ
В. М. Горбатов атындағы филиал ««Азық-түлік өнімдерінің федералдық ғылыми орталығы» РҒА, Видное, Ресей,
[4] Алматы технологиялық университеті, Алматы, Қазақстан

АРНАЙЫ МАҚСАТТАРҒА АРНАЛҒАН СҮТ ӨНІМДЕРІНІҢ ҒЫЛЫМИ-ТӘЖІРИБЕЛІК ПОТЕНЦИЯЛЫ

Аннотация. Көптеген жылдар бойы Бүкілресейлік сүт өндірісінің ғылыми-зерттеу институты (БСҮҒЗИ) арнайы мақсаттағы сүт өнімдерін өндірумен, соның ішінде орбиталық станциялардың және ғарыш кемесінің экипаждары үшін борттық ас-мәзірінің технологияларын әзірлеп келеді. Жұмыстар медициналық-биологиялық мәселелер институтымен, азық-түлік өндірісі концентратының және арнайы азық-түлік технологиясы ғылыми-зерттеу институтымен, сондай-ақ бірқатар басқа салалық және медициналық институттармен бірлесіп жүргізілді. БСҮҒЗИ-да арнайы өнімдер цехы құрылды, оның ғылыми-өндірістік базасы тек эксперименталдық зерттеулермен қамтамасыз етуге ғана емес, талап етілетін ассортиментте және мөлшерде өнімді шығаруға мүмкіндік берді. Ғарышкерлерге арналған өнімдердің технологияларын дамыту жалғасуда және қазіргі уақытта медициналық және биологиялық талаптар реттелуде, өңдеу сапасын жақсартуға, жаңа орам материалдарын енгізуге және тағы басқа сапаны жақсартуға бағытталған қолданбалы шешім табу үшін заманауи технологиялық-сыныстар кеңейтілуде.

Түйінді сөздер: ғарыш, тағам, сүт өнімдері, технологиялар, сублимация, стерилдеу.

С. Н. Туровская[1], А. Г. Галстян[2], А. Н. Петров[3], И. А. Радаева[1], Е. Е. Илларионова[1], А. Е. Рябова[2], Э. К. Асембаева[4], Д. Е. Нурмуханбетова[4]

[1]ФГБНУ «Всероссийский научно-исследовательский институт молочной промышленности», Москва, Россия,
[2]Всероссийский научно-исследовательский институт пивоваренной, безалкогольной и винодельческой промышленности – филиал ФГБНУ «ФНЦ пищевых систем им. В. М. Горбатова» РАН, Москва, Россия,
[3]Всероссийский научно-исследовательский институт технологии консервирования – филиал ФГБНУ «ФНЦ пищевых систем им. В. М. Горбатова» РАН, Видное, Россия,
[4]Алматинский технологический университет, Алматы, Казахстан

НАУЧНО-ПРАКТИЧЕСКИЙ ПОТЕНЦИАЛ МОЛОЧНЫХ ПРОДУКТОВ СПЕЦИАЛЬНОГО НАЗНАЧЕНИЯ

Аннотация. На протяжении многих лет ВНИИ молочной промышленности (ВНИМИ) занимается разработкой технологий молочных продуктов спецназначения, в том числе и для бортовых рационов экипажей космических кораблей и орбитальных станций. Работы проводились комплексно с Институтом медико-биологических проблем, Научно-исследовательским институтом пищеконцентратной промышленности и специальной пищевой технологии и целым рядом других отраслевых и медицинских институтов. При ВНИМИ был создан цех спецпродуктов, научно-производственная база которого позволяла не только обеспечивать исследования экспериментальными выработками, но и осуществлять выпуск продукции в необходимом ассортименте и количествах. Разработки технологий продуктов для космонавтов продолжаются и в настоящее время, корректируются медико-биологические требования, расширяются и находят прикладное решение современные представления технологического характера, направленные на повышение качества при одновременном снижении интенсивности обработки, внедряются новые упаковочные материалы и прочее.

К продуктам предъявляются особые требования: они должны быть вкусными, высокопитательными, хорошо сбалансированными по макро- и микронутрентному составу, обладать определенными профилактическими свойствами, быть несложными в приготовлении и употреблении, иметь повышенную хранимоустойчивость и др. Эта группа продуктов по праву считается наиболее наукоемкой в части технологических новшеств и решений.

Продукты спецназначения на молочной основе принципиально можно разделить на две основные группы: стерилизованные (абиоз) и сублимированные (ксероанабиоз). На сегодняшний день созданы десятки технологий в обеих группах – это и молоко, молочные напитки, супы, каши, кисломолочные продукты, творог и прочее. Продукты прошли испытания на длительность хранения и включены в рационы питания космонавтов. Часть продуктов прошла апробацию в рамках работ орбитальных станций и космических кораблей, в том числе международных. Качественные показатели молочных продуктов высоко оценены не только российскими, но и зарубежными космонавтами.

Ключевые слова: космос, питание, молочные продукты, технологии, сублимация, стерилизация.

Information about authors:

Turovskaya Svetlana Nikolaevna – All-Russian Research Institute of Dairy Industry, Senior Researcher of the Laboratory of Dairy Preserved Foods; conservlab@mail.ru; http://orcid.org/0000-0002-5875-9875

Galstyan Aram Genrikhovich – All-Russian Scientific Research Institute of Brewing, Non-Alcoholic and Wine Industry – branch of the Gorbatov's Federal Scientific Center of Food Systems of RAS, Head of the Interbranch Scientific and Technical Center for Food Quality Monitoring, Doctor of Technical Science, Professor of RAS, Corresponding Member of RAS; 9795029@mail.ru; http://orcid.org/0000-0002-0786-2055

Petrov Andrey Nikolaevich – All-Russian Scientific Research Institute of Preservation Technology – branch of the Gorbatov's Federal Scientific Center of Food Systems of RAS, Director, Doctor of Technical Science, Academician of RAS; vniitek@vniitek.ru; http://orcid.org/0000-0001-9879-482X

Radaeva Iskra Alexandrovna – All-Russian Research Institute of Dairy Industry, Chief Researcher of the Laboratory of Dairy Preserved Foods, Doctor of Technical Science, Professor; conservlab@mail.ru; http://orcid.org/0000-0002-1920-0577

Illarionova Elena Evgenievna – All-Russian Research Institute of Dairy Industry, Preserved Milk Laboratory Researcher conservlab@mail.ru; http://orcid.org/0000-0002-9399-0984

Ryabova Anastasiya Evgenievna - All-Russian Scientific Research Institute of Brewing, Non-Alcoholic and Wine Industry – branch of the Gorbatov's Federal Scientific Center of Food Systems of RAS, Interbranch Scientific and Technical Center for Food Quality Monitoring Researcher; anryz@hotmail.com; http://orcid.org/0000-0002-5712-2020

Asembayeva Elmira Kuandykovna – PhD student at the Almaty Technological University; elmiraasembaeva@mail.ru

Nurmukhanbetova Dinara Erikovna – candidate of engineering sciences, acting associate professor, Almaty Technological University, Department of Food safety and quality; dinar2080@mail.ru; https://orcid.org/0000-0002-8939-6325

N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278 **https://doi.org/10.32014/2018.2518-170X.32**
Volume 5, Number 431 (2018), 23 – 36

UDC 658.562:621.771

**S. A. Mashekov[1], L. R. Kiyanbekova[2], A. M. Alshynova[1],
A. S. Mashekova[3], G. A. Smailova[4], R. E. Urazbaeva[2], E. A. Tussupkaliyeva[1]**

[1]Satbayev University, Almaty, Kazakhstan,
[2]Kyrgyz National Technical University named I. Razzakov, Bishkek, Kyrgyzstan,
[3]National University of Science and Technology «MISIS», Moskow, Russia,
[4]Kazakh National Agrarian University, Almaty, Kazakhstan.
E-mail: mashekov.1957@mail.ru, baulyaz11@mail.ru , aiman16@mail.ru, ms.mashekova@mail.ru ,
raushjan@mail.ru e-mail: smailova.g@kaznau.kz, elatus78@mail.ru.

THE STUDY OF THE QUALITY OF HOT THIN BEAMS OBTAINED BY ROLLING ON A LONGITUDINAL WEDGE MILL

Abstract. The article presents an analysis of the influence of temperature-deformation processing regimes on the microstructure of 08kp steel during rolling on a longitudinal-wedge mill (LWM) using the physical modeling on the plastometer STD 812; it also considers kinetics of growth and decay of austenite, as well as the conditions for the formation of a fine-grained structure. The quantitative data was obtained by the finite element method and the «MSC.SuperForge» software and the main regularities of the distribution of the stress-strain state as well as the temperature during rolling the blanks on LWM was established. The rational technology of rolling thin strips of steel 08kp has been developed and tested under laboratory conditions. Particular attention is paid to the analysis of the influence of the rolling and cooling regimes on the formation of a fine-grained structure in steel 08kp. It is established that rolling thin bands of steel 08kp on LWM leads to an increase in strength and plastic properties of sheet metal.

Key words: strip rolling, low-carbon steel 08kp, austenite, ferrite, perlite, microstructure, cold-hardening, experiment, hardening, softening, recrystallization.

Introduction. Starting from the end of the twentieth century and still now, a sheet metal with a thickness of less than 2 mm made of low-carbon steel is considered to be the most important structural material in the automotive industry and other leading branches of engineering [1, 2]. In recent years, the demand for hot-rolled thin-sheet steel has been increased and, thus, an increase in the volume of production of steel plate with a thickness of less than 2 mm has occurred. Production of hot-rolled extra-thin sheet products is planned to be carried out at the level of requirements for the quality of cold-rolled sheet. Even a partial use of hot-rolled sheet products by the consumer instead of cold-rolled sheets of the same thickness gives a significant economic effect due to its lower costs for additional redistribution (cold rolling, annealing, etc.).

Thus, the tendency of producing thin hot-rolled stripes, a part of which is independent commodity products and a part of which is used to replace cold-rolled metal, has become a reality and it still continues to grow in the world practice [2]. More than 30% of strips with a thickness of 1.0-2.5 mm and higher is contained in a typical assortment of cold-rolled structural steel. At the same time, the proportion of strips with a thickness of 1.0-3.0 mm is about 60% in the range of broadband hot rolling mills. As a prerequisite for this trend, we can note an increase in the efficiency of orders and decrease in production costs [2-5].

According to the authors of papers [2, 6], the most perspective area is using the thin hot-rolled strips to replace cold-rolled sheet products of general purpose. The analysis of the order book of metallurgical combines of the CIS countries showed that about 15-20% are cold rolled strips with the thickness of 1.0-3.0 mm, supplied in accordance with GOST 16523 with the quality of the surface finish of groups 2 and 3.

At the same time, the share of stripes of 1.5-1.8 mm thickness makes up about 30-35% of this amount (or about 6-7% of the annual production volume of the shop), and bands of 2.0-3.0 mm thickness is about 45-50% (about 8-9% of annual production). Up to 75-80% of the metal in the assortment group under consideration is supplied with the properties of the exhaust category *G* and about 14-16% with properties of the extractor category *N*.

The production of thin hot rolled products is a complex process, characterized by a large number of technological factors [7]. The mechanical properties of hot-rolled thin strips are affected by the chemical composition and structure of the metal, the formation of which is determined by the temperature-deformation modes of rolling, and the regularities of this influence have a complex character.

It should be noted that the current trend in the market of sheet steels is the expansion of the nomenclature within strengthening the quality requirements, including structure and mechanical properties [8]. The structure of hot-rolled sheets is uneven in thickness, which is primarily due to the unevenness of the deformation and the temperature gradient. Therefore, an important step is the selection of rational temperature-deformation modes of rolling.

A significant drawback of rolling extremely thin strips on continuous wide-band mills is the impossibility of meeting the optimal temperature conditions for ending the hot rolling (compression in the critical temperature range Ar_3-Ar_1 leads to the formation of an uneven grain structure that does not meet the requirements of GOST 16523) [9]. Large grain and a variety of granularity of the structure can lead to uneven deformation of the metal during stretching and cause the formation of breaks. A uniform structure is also necessary for hot-rolled strips, which can be a cost-effective sub-roll for cold rolling mills. A mixed structure with coarse grains of ferrite in the surface layers of the strip, which is unevenly deformed in cold rolling mills with a reduction ratio of 70-80%, can cause transverse cracks along the lateral edges of the strip [9]. Cold rolling does not eliminate the coarse graininess obtained during hot rolling; in non-uniform grains in a hot-rolled strip similar grains are formed in cold rolled sheets. A roll with a structure consisting of uneven or small grains is poorly deformed and the strip breaks occur [9].

It is outlined in the paper [9] that the surface heterogeneity can be associated with a different chemical composition along the section of the strip, and ferrite rolling at a temperature below the Ar1 point in the region of the single-phase ferritic structure of the metal will provide a uniform structure for the extra-thin bands. However, data on the effect of ferrite rolling on the microstructure and the mechanical properties of low-carbon steels are not enough, there is no complete idea of its effect on the quality of the metal, so it is relevant to study the features of the formation of microstructure and the mechanical properties of extremely thin low-carbon steel at low rolling-end temperatures.

It should be noted that it is possible to meet all requirements to the structure and properties of sheet steel produced in the hot rolling mill by organizing the control and controlling the formation of the structure and properties of steel in the mill's processing line [8]. Responding promptly to market demands, while significantly reducing the time and costs for the development of new types of metal products, will allow an automated design of technological modes of production of rolled products. As the first step in this direction, there should be mathematical modeling of the structure formation during rolling in different mills.

The aim of these studies is to study the distribution of accumulated deformation on the formation of the structure and properties of a metal of low-carbon steel 08kp during the rolling of thin strips on a longitudinal-wedge mill.

Materials and experimental procedure. A multifunctional longitudinal-wedge mill (LWM) of a new design (figure 1) is proposed for the rolling of sheets of steels and alloys [10]. This mill contains electric motors, reducers, gear stands, universal spindles, couplings, stands with working and supporting rolls. At the same time, in the first three stands there are two supporting rolls, and in the last two stands there are four supporting rolls. Rotation of working rolls in the decreasing rolling direction is carried out through bearing stands by five motor-reducers with an angular velocity $\omega = \upsilon \cdot R$ (where υ is the rolling speed in each mill stand, R is the radius of work rolls in each mill stand). In this case, the distances between the stands are increased by the amount of advance, and the adjustment of the distance between working rolls is made by single screw press mechanisms located at the top and bottom of the mill stand and bearing stands [19].

CONTENTS