

ANNOTATION

of the dissertation work by
Yessembek Madina Zhanibekkyzy
on the topic: «**Improving the technology of bakery products using secondary raw materials processing of grain crops**»,
submitted for the degree of Doctor of Philosophy (PhD)
in the educational program 8D07201 – «Food Technology»

1. Relevance of the Study. At present, the rational use of raw material resources and the development of technologies for producing food products with high nutritional value are of particular relevance. The President of the Republic of Kazakhstan, Kassym-Jomart Tokayev, in his Address to the Nation «Kazakhstan in a New Reality: Time for Action» (2020), emphasized the importance of developing new food products to ensure the strategic self-sufficiency of the national economy.

In addition, within the framework of Sustainable Development Goal 12 «Responsible Consumption and Production», special attention is paid to reducing food waste and ensuring the efficient use of resources. In this regard, one of the priority tasks of the food industry is to reduce waste volumes and to efficiently utilize secondary raw materials generated during the processing of grain crops.

In the grain-processing industry, a significant portion of by-products such as milling fractions, bran, husk, and germ remains underutilized despite their high content of proteins, dietary fiber, vitamins, and minerals. At the same time, during processing, valuable anatomical parts of the grain are transferred into secondary products, which reduces the overall efficiency of raw material utilization.

Particular interest is associated with rice and buckwheat processing products, which possess high nutritional value. Rice and buckwheat milling fractions contain significant amounts of dietary fiber, B vitamins, as well as macro- and microelements, making them promising raw materials for the enrichment of bakery products.

The use of secondary raw materials in the baking industry makes it possible to increase the nutritional value of products, expand the product range, and ensure more rational use of resources. Considering that bakery products occupy a significant place in the human diet, they represent a convenient object for enrichment.

An important direction for improving the quality of bakery products is the application of sourdough technologies. The use of complex starter cultures based on rice and buckwheat milling fractions contributes to improving the microbiological quality of products, enhancing their safety, and promoting the formation of favorable organoleptic properties.

Thus, the improvement of the technology for producing bakery products from first-grade wheat baking flour using a complex starter culture based on rice and buckwheat milling fractions, aimed at increasing the nutritional value and microbiological safety of products, is a relevant scientific and practical task.

2. Objects of the Study. The objects of the study included rice milling fraction produced at the dynamically developing enterprise PT «Abzal and

Company» (Kyzylorda), buckwheat milling fraction manufactured by LLP «Eger» (Pavlodar), as well as a complex starter culture, dough, and wheat bread.

3. Aim of the Study. The aim of the study is to improve the technology of bakery products made from first-grade wheat baking flour, aimed at increasing their nutritional value and microbiological safety through the use of a complex starter culture based on rice and buckwheat milling fractions.

To achieve this aim, the following objectives were set:

- to substantiate the feasibility of using secondary raw materials of grain crops – rice and buckwheat milling fractions – for the production of bakery products;
- to determine the effect of rice and buckwheat milling fractions on the rheological properties of dough and to establish their optimal ratio to ensure the best quality characteristics of the final product;
- to develop a technology for a complex starter culture based on rice and buckwheat milling fractions and to determine its effect on the quality and microbiological stability of bread during storage;
- to develop a formulation, production technology, and regulatory and technical documentation for wheat bread using rice and buckwheat milling fractions;
- to evaluate the nutritional value and sanitary-hygienic indicators of the developed bread, to test the new technology under industrial conditions, and to assess the economic efficiency of bread production.

4. Methods and Methodologies. The study employed standard and specialized methods for the analysis of raw materials, semi-finished products, and finished products. Physicochemical, rheological, organoleptic, and microbiological methods of analysis were applied. The formulation was optimized using methods of mathematical experimental design, and statistical data processing was carried out using analysis of variance (ANOVA) at a significance level of $p \leq 0.05$.

5. Scientific Novelty of the Study:

- the technology of bakery products has been improved through the use of secondary raw materials from grain processing – rice and buckwheat milling fractions – as an additional component to first-grade wheat baking flour, ensuring an increase in the nutritional value of the finished products;
- based on mathematical modeling and experimental design, the optimal dosage of rice milling fraction (5%) and buckwheat milling fraction (10%) has been established, providing improved water absorption capacity of the dough, its structural-mechanical and rheological properties, as well as the quality of bakery products;
- for the first time, a technology for producing a complex starter culture based on rice and buckwheat milling fractions has been developed, and its positive effect on the properties of dough and bread has been scientifically substantiated: an increase in dough acidity by 3.3 times, an increase in volatile acid content by 2.9 times, and a decrease in sugar content by 29% were established. It has been proven that the use of the complex starter culture enhances the microbiological stability of bread, suppresses the development of mold microflora, and completely inhibits the development of rope spoilage;

- the technology and formulation of wheat bread with enhanced nutritional value using a complex starter culture based on rice and buckwheat milling fractions have been developed, ensuring coverage of the daily physiological requirements of an adult: protein – 31.2%, fats – 15%, dietary fiber – 18.4%, iron – 54.8%, magnesium – 47.4%, potassium – 26.9%, phosphorus – 54.7%.

6. Field of Application. The developed technology of scalded bread «Bereke» can be used in the baking industry for the production of bakery products with the use of secondary raw materials from grain processing, in particular rice and buckwheat milling fractions, as well as for expanding the range of widely consumed bakery products. The technology can be recommended for implementation at bakery enterprises.

7. Practical Significance of the Study. A technology for the production of scalded bread «Bereke» using secondary raw materials from grain processing – rice and buckwheat milling fractions – has been developed, ensuring increased nutritional value and microbiological safety of the product.

The technology has been tested and implemented under industrial conditions at LLP «Master Bakery» (Astana), as confirmed by an implementation certificate.

Based on the research results, an organizational standard «Bereke Scalded Bread. Technical Specifications» has been developed.

The scientific novelty of the work is confirmed by patents of the Republic of Kazakhstan for utility models: No. 7716 dated 06.01.2023 «Method for Preparing a Starter Culture for Bread Production» and No. 7736 dated 13.01.2023 «Method for Producing Scalded Wheat Bread».

8. Author's Contribution. The author's contribution includes conducting theoretical and experimental research, processing and analyzing the obtained data, establishing the optimal ratio of rice and buckwheat milling fractions, developing the formulation and technology of scalded bread «Bereke», carrying out industrial testing, developing regulatory and technical documentation, and preparing scientific publications.

9. Approbation of the Study. The main results of the dissertation were presented at the following international scientific and practical conferences: «Economics and Education of Kazakhstan: New Challenges and Realities» (Semey, 2021), «Seifullin Readings – 18(2): «Science of the XXI Century – The Era of Transformation» (Astana, 2022), and «Modern Trends in the Development of Chemical Technology and Engineering in the Food and Light Industries» (Almaty, 2023).

The developed technology has been tested under industrial conditions at LLP «Master Bakery» (Astana).

10. Publications. Based on the research results, 7 scientific papers have been published, including 1 article in a journal indexed in the Scopus database (Q1, percentile 87), 3 articles in journals recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan, and 3 articles in the proceedings of international scientific and practical conferences.

Two patents of the Republic of Kazakhstan for utility models have been obtained on the topic of the dissertation.

11. Scope and Structure of the Dissertation. The dissertation consists of an introduction, literature review, materials and research methods, experimental part, practical application of the results, conclusion, list of references, and appendices. The total length of the dissertation is 146 pages, including 25 tables, 23 figures, 10 equations, 165 references, and 6 appendices.

12. Conclusions of the Dissertation.

Based on the results of the study, the following conclusions were drawn:

1. The feasibility of using secondary by-products of cereal processing – rice and buckwheat milling fractions – has been substantiated in the technology of bakery products. Theoretical and experimental studies confirmed the possibility of their use as an additional component to first-grade wheat flour in order to enhance the nutritional value of finished products and ensure the rational use of grain resources.

2. It was established that the incorporation of rice and buckwheat milling fractions into the formulation improves the rheological properties of the dough: water absorption capacity increases, as well as dough development time and resistance to deformation. The optimal ratio of secondary cereal processing products was determined to be 5% rice milling fraction and 10% buckwheat milling fraction.

3. A technology of a complex starter culture based on rice and buckwheat milling fractions was developed, and it was experimentally confirmed that:

- when producing wheat bread using rice and buckwheat milling fractions by the straight-dough method, dough acidity increases by 1.5 times and volume by 16%, whereas with the use of a complex starter culture, acidity increases by 3.5 times and volume by 29%;

- when producing wheat bread using rice and buckwheat milling fractions with a complex starter culture, physicochemical properties are improved: volatile acid content increases by 1.4 times, acidity by 3.3 times, while sugar content decreases by 29%; organoleptic properties (taste, aroma, crumb porosity) and structural-mechanical quality indicators of the finished products are also improved. The reduced sugar content is explained by the activity of biochemical processes during fermentation, as well as by the complete assimilation of carbohydrates by enzymatic microflora.

A positive effect of the improved technology for wheat bread production using a complex starter culture on microbiological safety was established. It was shown that this technology completely inhibits the development of rope spoilage (potato disease) and increases resistance to mold.

4. The technology and formulation of scalded bread «Bereke» were developed. An increase in its nutritional value was established. It was shown that average daily bread consumption by an adult provides 31.2% of protein requirements, 15% of fats, 18.4% of dietary fiber, vitamins: B5 – 2%, B6 – 5%, and minerals: Fe – 54.8%, Mg – 44.7%, Ca – 7.9%, K – 26.9%, P – 54.7%.

5. The economic efficiency of producing scalded bread «Bereke» was calculated. Based on the research results, production trials were conducted. A

regulatory and technical document – the organization standard «Scalded Bread «Bereke». Technical Specifications» – was developed and approved.

In addition, two utility model patents of the Republic of Kazakhstan were obtained based on the research results: No. 7716 «Method for preparing a starter culture for bread baking» dated January 6, 2023, and No. 7736 «Method for producing scalded wheat bread» dated January 13, 2023. This confirms the scientific novelty and practical significance of the study.