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COMPARATIVE EVALUATION OF SOFT WHEAT VARIETIES FOR THEIR APPLICATION IN HEALTHY NUTRITION PRODUCTS

Abstract. The chemical structure of grain of four varieties of soft wheat of Kazakhstan selection is considered: Shortandinskaya, Novosibirskaya-31, Trizo and Tobolskaya. The content of proteins, carbohydrates, fats, ash, as well as macroelements: potassium, phosphorus and magnesium is determined. It is established that the Novosibirskaya-31 variety is characterized by the highest content of protein and minerals. It is revealed that the Trizo variety is characterized by minimal ash content, which increases its technological value for the flour-milling industry. Statistical processing of the results is carried out by the method of variance analysis, as well as the principal component analysis (PCA). The main parameters influencing the nutritional value of the varieties are determined. Recommendations for the use of the studied varieties in the production of healthy and dietary food products are formulated.

Keywords: soft wheat, grain varieties, chemical composition, nutritional value, potassium, phosphorus, protein, ash content, PCA analysis, healthy nutrition.

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Introduction. Common wheat (*Triticum aestivum L.*) traditionally occupies a leading place in the production of grain crops and serves as the main raw material for the manufacture of bakery and flour products. In recent years, scientific and consumer interest in wheat varieties with high nutritional and biological value has increased, especially in the context of creating healthy and functional food products [1,2].

It has been proven at the international level that whole-grain soft wheat flour with a high content of protein, fiber and macronutrients can reduce the level of

inflammatory markers, have a positive effect on the intestinal microbiota, and also help normalize body weight and prevent metabolic disorders [3-5]. At the same time, the nutritional value of wheat is determined not only by its botanical species, but also by varietal characteristics, agroclimatic growing conditions and the processing technologies used [6,7].

In the conditions of Kazakhstan, soft wheat forms the basis of agricultural exports and domestic consumption. However, to date there has been no comprehensive comparative assessment of locally bred varieties by key indicators of chemical composition (proteins, carbohydrates, fats, ash) and the content of vital macronutrients (potassium, phosphorus, magnesium). Such an assessment is especially important in terms of their suitability for the production of dietary, baby and preventive nutrition products.

Thus, the purpose of this study was to identify the most promising varieties of soft wheat of Kazakhstani selection by a set of nutritional and technological indicators. The work is aimed at forming scientifically sound recommendations for the use of individual varieties as raw materials for healthy nutrition, taking into account modern requirements of nutrition and food technology.

Materials and methods. The study was conducted in laboratory conditions of the Department of Agrochemistry and Soil Science of the Research Institute of Food Safety of the ATU, using standard methods for assessing the chemical composition of grain. The objects of the study were four varieties of soft wheat of Kazakh selection: Shortandinskaya, Novosibirskaya-31, Trizo and Tobolskaya, grown in the same agroclimatic conditions on experimental plots of the North Kazakhstan region in 2023.

Methods of analysis. Determination of the mass fraction of protein – by the Kjeldahl method (GOST 10846-91). Fat content – by Soxhlet extraction (GOST 10857-64). Ash content – by the calcination method; Mass fraction of carbohydrates - by the calculation method: 100% – (% protein + % fat + % ash + % moisture). The content of potassium, magnesium and phosphorus – by the photometric method with preliminary mineralization of the sample (GOST 26657-97, GOST 30538-97).

Statistical processing. All measurements were carried out in triplicate. The results were processed using the Statistica 12.0 package. To assess the reliability of differences, variance analysis (ANOVA) was used, as well as the Newman-Keuls test for paired comparisons between varieties. Principal component analysis (PCA) was used to visualize the relationships between variables and identify varieties with the most balanced composition.

Research results. The conducted assessment of the chemical composition of grain of four varieties of soft wheat revealed significant differences in the main indicators of nutritional value. Table 1 shows the average values of the content of proteins, carbohydrates, fats, ash, as well as potassium, phosphorus and magnesium.

Table 1

Chemical composition of soft wheat grain of different varieties, % and mg/100 g

Indicator	Shortandinskaya	Novosibirskaya-31	Trizo	Tobolskaya
1	2	3	4	5
Proteins, %	13.98	16.90	14.78	15.12
Carbohydrates, %	58.39	55.87	56.42	57.20
Fats, %	2.39	2.15	1.79	2.03
Ash, %	1.88	1.72	1.65	1.73

Table 1 (continued)

1	2	3	4	5
Potassium, mg/100 g	322.70	334.40	328.10	330.05
Phosphorus, mg/100 g	363.28	368.70	365.10	364.90
Magnesium, mg/100 g	109.30	114.03	110.56	112.87

The analysis showed that Novosibirskaya-31 has the highest content of protein (16.9%) and macronutrients (potassium, phosphorus, magnesium), which indicates its high biological value and the feasibility of using it in the production of dietary and preventive nutrition products.

The Trizo variety had the lowest ash content (1.65%), which can be a positive indicator for milling, since ash content directly affects the yield and quality of premium flour.

According to the results of the analysis of variance (ANOVA), the differences in most indicators were statistically significant ($p < 0.05$), which was confirmed by the Newman-Keuls test (Table 2).

Table 2

Newman-Keuls test results

Indicator	The statistically superior variety
Proteins, %	Novosibirskaya-31
Carbohydrates, %	Shortandinskaya
Fats, %	Shortandinskaya
Ash, %	Trizo
Potassium, mg/100 g	Novosibirskaya-31
Phosphorus, mg/100 g	Novosibirskaya-31
Magnesium, mg/100 g	Novosibirskaya-31

Principal Component Analysis (PCA). The principal component analysis revealed clustering of varieties by complex chemical composition. In the PCA diagram, Novosibirskaya-31 and Tobolskaya varieties form one group characterized by high protein and mineral content, while Triso and Shortandinskaya are shifted to the axes associated with carbohydrates and ash content, respectively. The diagram in Figure 1 visualizes the distribution of varieties according to the factors that most strongly influence nutritional value.

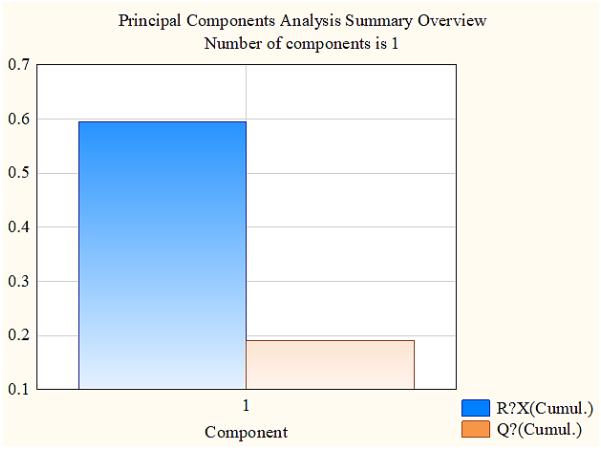

Fig. 1. PCA diagram: spatial distribution of soft wheat varieties by nutritional value components

The diagram shows the cumulative share of explained variance of the first principal component (R^2X(Cumul.)) – approximately 60%, which indicates that one component explains the main variation in the data; the Q^2 value (the predictive ability of the model) is moderate, but acceptable for interpretation.

Discussion. The results of the analysis showed significant variability in the chemical composition of grain between soft wheat varieties grown under the same conditions. The Novosibirskaya-31 variety has the highest content of protein (16.9%) and macronutrients (potassium, phosphorus, magnesium), which meets the criteria of increased nutritional value. Similar characteristics were previously identified as the most significant in the selection of grain for the production of baby and dietary foods [8].

The Trizo variety, despite its moderate protein content, has the lowest ash content (1.65%), which indicates a high level of grain purification, which is especially important in the production of premium flour. According to the work of Litvinenko et al. [9], ash content can be considered as an indicator of the suitability of grain for deep processing, affecting the quality of the finished product.

The results of the analysis of variance (ANOVA) and the Newman-Keuls test confirmed statistically significant differences between varieties for most indicators. The data obtained are in agreement with the findings of Stupakova et al. [10], who emphasize the importance of a representative sample and the reliability of chemical-analytical data in the varietal differentiation of grain crops.

The principal component analysis (PCA), visualized in Figure 1, showed that one principal component accumulates more than 60% of the total variance. This indicates the high information content of the main indicators (protein, ash, macronutrients) for a comprehensive varietal assessment. A similar statistical approach was previously used in assessing the functional properties of grain raw materials [2,8]. Thus, the studied varieties demonstrate various nutritional and technological advantages, allowing them to be recommended for differentiated use depending on production tasks – from obtaining high-grade flour to developing preventive nutrition products.

Conclusion. Based on a comprehensive analysis of the chemical composition of four varieties of soft wheat (Shortandinskaya, Novosibirskaya-31, Trizo, Tobolskaya), it was found that:

– The Novosibirskaya-31 variety has the highest nutritional value due to its increased protein content (16.9%) and macronutrients (potassium, phosphorus, magnesium), which makes it preferable for use in the production of healthy food products;

– The Trizo variety is characterized by the lowest ash content, which can be useful when grinding grain and obtaining premium flour;

– The principal component analysis (PCA) confirmed the possibility of grouping varieties by chemical and nutritional characteristics, explaining up to 60% of the total variability;

– The results obtained are consistent with literary sources and expand our understanding of the breeding and technological value of soft wheat varieties grown in Northern Kazakhstan.

The results can be used to develop varietal recommendations for the selection of grain raw materials for dietary, baby and functional nutrition.

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ДЕНСАУЛЫҚҚА ПАЙДАЛЫ ТАМАҚ ӨНІМДЕРІН ӨНДІРУДЕ ҚОЛДАНУҒА АРНАЛҒАН ЖҰМСАҚ БИДАЙ СҰРЫПТАРЫНЫҢ ХИМИЯЛЫҚ ҚҰРАМЫНЫҢ САЛЫСТЫРМАЛЫ ТАЛДАУЫ

Аңдатпа. Қазақстан селекциясы бойынша төрт жұмсақ бидай сұрыптарының дәндерінің химиялық құрылысы қарастырылды: Шортандинская, Новосибирская-31, Тризо және Тобольская. Ақуыз, көмірсу, май, күл құрамымен қатар, макроэлементтер: калий, фосфор және магний анықталды. Новосибирская-31

сұрыпы ең жоғары ақуыз және минералдық заттар құрамымен ерекшеленетіні анықталды. Тризо сұрыпының күл мөлшері ең төмен болып, бұл оны ұн өндірісінде технологиялық мәнін арттырады. Нәтижелерді статистикалық өңдеу дисперсиялық талдау әдісі және негізгі компоненттерді талдау (PCA) арқылы жүргізілді. Сұрыптардың тағамдық құндылығына әсер ететін негізгі параметрлер анықталды. Зерттелген сұрыптарды денсаулыққа пайдалы және диеталық тамақ өнімдерін өндіруде қолдану бойынша ұсыныстар берілді.

Тірек сөздер: жұмсақ бидай, дән сұрыптары, химиялық құрамы, тағамдық құндылығы, калий, фосфор, ақуыз, күл құрамы, PCA талдау, денсаулыққа пайдалы тамақ.

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СРАВНИТЕЛЬНЫЙ АНАЛИЗ ХИМИЧЕСКОГО СОСТАВА СОРТОВ МЯГКОЙ ПШЕНИЦЫ ДЛЯ ОБОСНОВАНИЯ ИХ ИСПОЛЬЗОВАНИЯ В ПРОИЗВОДСТВЕ ПРОДУКТОВ ЗДОРОВОГО ПИТАНИЯ

Аннотация. Рассмотрено химическое строение зерна четырёх сортов мягкой пшеницы казахстанской селекции: Шортандинская, Новосибирская-31, Тризо и Тобольская. Определено содержание белков, углеводов, жиров, золы, а также макроэлементов: калия, фосфора и магния. Установлено, что сорт Новосибирская-31 характеризуется наибольшим содержанием белка и минеральных веществ. Выявлено, что сорт Тризо отличается минимальной зольностью, что повышает его технологическую ценность для мукомольной промышленности. Проведена статистическая обработка результатов методом дисперсионного анализа, а также методом главных компонент (PCA). Определены основные параметры, оказывающие влияние на пищевую ценность сортов. Сформулированы рекомендации по применению изученных сортов в производстве продуктов здорового и диетического питания.

Ключевые слова: мягкая пшеница, сорта зерна, химический состав, пищевая ценность, калий, фосфор, белок, зольность, PCA-анализ, здоровое питание.