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COMPARATIVE ANALYSIS OF THE TECHNOLOGICAL PROPERTIES OF FLOUR FROM NEW DURUM WHEAT VARIETIES

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Abstract. The article presents the results of a study of the technological properties of flour obtained from the grain of the new durum wheat variety Spadshchyna and the dual-purpose wheat varieties Demira and Chado, characterized by protein contents of 12.20%, 11.55%, and 13.56% and kernel hardness values of 186, 165, and 183 N, respectively. It was found that the flour from *Spadshchyna* and *Demira* contained 30.7% crude gluten, while *Chado* contained 33.8%. According to the gluten quality characteristics, the gluten of *Spadshchyna* wheat flour was rated as satisfactorily weak, *Demira* as good, and *Chado* as satisfactorily strong. The evaluation of the physical properties of dough from the experimental flour samples using a Chopin alveograph showed that the wheat flours of all varieties can be classified as strong, with flour strength values of 249, 268, and 360 alveograph units. All flour samples met the requirements of the regulatory documentation by the falling number parameter; however, the falling number of *Chado* flour was 3.2% and 16.2% higher compared with *Demira* and *Spadshchyna*, respectively. The most intensive maturation processes, as indicated by changes in titratable and active acidity as well as CO_2 evolution, were observed in dough made from *Spadshchyna* flour. The total volume of CO_2 released during 240 min of maturation was 1435, 1323, and 1099 cm³ for *Spadshchyna*, *Demira*, and *Chado* dough samples, respectively. The maximum dough volume during maturation was achieved by *Demira* flour dough, exceeding *Spadshchyna* by 27.9%. The difference between *Demira* and *Chado* dough volumes was insignificant (4.8%). Experimental baking tests showed that bread made from *Demira* flour had the most favorable sensory characteristics, including a regular shape, smooth crack-free surface, light crust color, uniform and well-developed porosity, and elastic crumb. Bread made from *Chado* flour also showed high quality but slightly lower loaf volume compared with *Demira*. In contrast, *Spadshchyna* flour produced loaves with lower volume and coarse, unevenly distributed pores, which worsened product quality. Based on the obtained results, *Demira* and *Chado* flours are recommended for bakery applications, while *Spadshchyna* wheat is more suitable for groat or possibly pasta production.

Keywords: durum wheat, dual-purpose wheat, gluten, flour quality, bread quality.

Introduction. Formulation of the problem

An important direction in grain breeding both in Ukraine and worldwide is the search for opportunities to improve the quality traits of durum wheat grain. Compared with common (soft) wheat, durum wheat typically contains more protein with a superior amino acid profile, has higher levels of minerals, β-carotene, and B-vitamins, and exhibits greater tolerance to drought and pests. Durum wheat is primarily used for the production of pasta and wheat groats. However, a major factor limiting the broader use of durum wheat in the food industry, especially in bread production, is its high kernel hardness, which results in increased energy consumption during milling, extensive starch damage when attempting to produce finer flour, and consequently inferior gluten properties that impede the production of high-quality bread from durum flour. In response, current approaches to improving durum wheat traits focus on reducing kernel hardness, enhancing gluten quality, and managing starch characteristics along with the nutritional value of the grain [1–7]. One of the leading objectives of the Laboratory of Wheat Breeding at the Yuriev Plant Production Institute of the National Academy of Agrarian Sciences of Ukraine (Kharkiv) is to breed wheat cultivars that concurrently exhibit good pasta and breadmaking qualities. The breeding lines developed through long-term selection trace their pedigree to an interspecific hybrid F6 (*T. turgidum x Dicoccum 147*), an accession from VIR No. 12950 (*Melanopus falcatum* from Palestine), and a local form *T. durum Desf. var. hordeiforme*. Since 1965, comprehensive studies have been conducted on the line with universal quality, designated 59-204, and compared with standards of durum and common wheat. This line combines the typical strong wheat protein characteristics with the carbohydrate complex of durum wheat. It is characterized by exceptional dough resilience during mixing, a high ratio of disulfide to sulfhydryl groups (SS/SH), and low gluten hydration. Classified as a strong wheat line, it makes bread with good crumb quality and pleasant taste. Line 59-204 was evaluated in competitive variety trials from 1974 to 1976 and entered State trials under the name Kharkivska 5 [8]. This cultivar provided the basis for a series of original dual-purpose wheat cultivars, including Kharkivska 13, Kharkivska 15, Kharkivska 29, Kharkivska 31, Chado, and Demira, which were entered into the State Register of Plant Varieties of Ukraine between 1992 and 2019. Further scientific and practical interest lies in studying and comparing the technological properties of these newly developed wheat cultivars with a view to their application in the technologies of flour-based culinary products, baked goods, and pasta

Analysis of recent research and publications

A substantial body of research worldwide is focused on developing dual-purpose wheat cultivars. Lafiandra D. et al. note that modification of durum wheat protein via introgression of the Glu-D1 locus, alteration of grain texture through introduction of puroindoline genes, and adjustment of starch fractional composition regarding the amylose-amylopectin ratio may theoretically yield lines that combine desirable pasta quality (color, firmness, and low cooking losses) with satisfactory breadmaking properties [1].

Many researchers are working on improving the technological characteristics of the *Soft Svevo* durum wheat cultivar through introgression of puroindoline genes into its genome [1, 9–12]. Heinze K. and co-authors investigated the feasibility of introducing functional puroindoline protein genes into the genome of durum wheat in order to enhance milling performance and broaden technological applications. They found that the presence of puroindoline genes alters kernel texture from very hard to softer, significantly reduces milling energy requirements, increases flour yield, and is associated with low starch damage during milling, thereby enabling the production of flour with improved baking quality [9]. Boehm J. D. et al. compared several soft durum-derived breeding lines for kernel hardness, flour yield, starch damage, protein content, and breadmaking properties, finding that final bread quality depended on the background glutenin allele composition [10–11]. Additionally, Morris C. F. et al. reported that selection of *Soft Svevo* lines with improved gluten properties through specific Glu-D1 allele combinations increased the specific loaf volume by approximately 16.9% relative to control flours [12].

Pasqualone A. et al. compared a new Italian dual-purpose wheat cultivar, *Faridur*, with traditional *Svevo*. Although *Faridur* exhibited higher protein and wet gluten contents, its gluten quality, evaluated by alveograph and farinograph, was inferior in strength and stability. Consequently, bread baked from *Faridur* showed a decreased specific loaf volume, highlighting the need for specialized technological adjustments when using this wheat in bread production [13].

Ruan Y. et al. investigated lines of durum wheat with enhanced gluten properties and found that genetic loci controlling gluten strength are distributed across several chromosomes, suggesting potential targets for marker-assisted selection to optimize flour properties for both pasta and bread products [14].

Sissons M. et al. focused on dual-purpose lines derived from *Svevo* and *Lira* through introgression of various Glu-D1 alleles aimed at improving breadmaking quality. They observed that products made from these new lines exhibited reduced stickiness and cooking losses compared with controls, demonstrating an improved pasta performance [15]. Cecchini C. et al. provide an analytical review of rheological methods used to evaluate durum wheat flour, emphasizing the need for alternative assessment techniques because the rheological behavior of pasta and bread doughs differs substantially and thus standard tests do not always adequately capture pasta quality [16]. Along with other authors, the researchers agree that successful breeding of dual-purpose wheat requires simultaneous improvement of gluten quality as well as control of particle size distribution and the degree of starch damage after milling.

The wheat cultivars developed at the Yuriev Plant Production Institute of the National Academy of Agrarian Sciences of Ukraine (Kharkiv) are distinguished among other dual-purpose wheats by high protein and gluten content, good flour strength parameters, and a bright yellow grain color due to elevated carotenoid levels. The cultivar *Demira* has a potential yield of about 7.1 t/ha (with an average yield of about 4.5 t/ha in trials), grain protein of 13.5…15.5%, and gluten content of 31…34%, producing strong flour (312 a.u.) with good bread volume, confirming its versatility. *Chado* is a medium-maturing durum wheat with high pasta quality and good bread-making potential, with 34…36% wet gluten and 14.5…16.5% protein content, and displays good stability and yield performance [17, 18]. *Spadshchyna* is characterized by a favorable fatty acid profile in the kernel oil and high carotenoid levels, which are important for attractive pasta color [19].

Thus, there is scientific and practical interest in justifying the use of flour from these new wheat cultivars in the production of both flour-based and pasta products. The present study examines the potential of using these cultivars specifically for breadmaking.

The purpose of the research presented in this article is to conduct a comparative analysis of the technological properties of grain from the durum wheat variety *Spadshchyna* and dual-purpose durum wheat varieties *Demira* and *Chado*, as well as to identify the most promising variety for further use in the production of bread and flour-based products. To achieve this goal, the following objectives were set:

– to determine the technological properties of flour obtained from experimental grain samples by assessing gluten content and quality, dough rheological properties, and falling number;

– to investigate the specific features of dough maturation processes prepared from the experimental flour samples by evaluating acidity parameters, carbon dioxide production dynamics, and dough volume;

– to assess the quality of bread produced from the experimental flour samples based on organoleptic characteristics.

Materials and methods.

The study used grain of durum wheat cultivars *Spadshchyna*, *Demira*, and *Chado* harvested in 2024, whose characteristics are presented in Table 1.

Flour was produced from the grain of these cultivars by single-grade milling with a 70% extraction rate using an MLU-202 laboratory mill (Bühler, Switzerland). Grain moisture before the first break system was 17%, and conditioning time was 24 h. Experimental studies were conducted at the Laboratory of Immunity, Biotechnology and Grain Quality of the Yuriev Plant Production Institute of the National Academy of Agrarian Sciences of Ukraine (Kharkiv) and at the Department of Restaurant, Hotel and Touristic Business of V. N. Karazin Kharkiv National University

Table 1 – Properties of experimental grain batches (n=3; P≥0.95)

Indicator	Experimental grain samples		
	Spadshchyna	Demira	Chado
Kernel hardness, N	186±3	165±2	183±3
Test weight (hectolitre weight), g/L	844±15	808±10	828±12
Total vitreousness, %	82±2	69±2	63±2
Protein content, g	12.20±0.4	11.55±0.3	13.56±0.3

Gluten content and properties were determined according to standard methods [20]. Dough physical properties were evaluated using a Chopin alveograph. Flour amylolytic activity was assessed by the falling number method. Titrated acidity of dough was determined using standard titration procedures [20]. Active acidity (pH) was measured potentiometrically with a pH-meter (model 150-M). The intensity of alcoholic fermentation in model dough systems was evaluated based on the amount of released carbon dioxide and the gas production rate [21]. Gas-retention capacity was assessed indirectly through dough volume changes during fermentation: 50 g of dough was placed in a 250 cm³ graduated cylinder and incubated at 30°C [21]. Trial baking was performed according to standard methodology [20]. Product quality was evaluated organoleptically and compared with the requirements for wheat bread specified in DSTU 7517:2024. Sensory evaluation used a 10-point scale [22]. Experimental data were processed using the MS Office Excel package.

Results of the research and their discussion

One of the most important quality indicators of wheat flour, for both pasta and breadmaking, is the content and properties of gluten, which largely determine its technological application. Therefore, at the first stage of the study these parameters were determined for the experimental flour samples (Table 2).

All flour samples met regulatory requirements for wet gluten content and exceeded the minimum value for premium wheat flour (24.0%) by 6.7…9.8 percentage points. The highest gluten content was observed in cultivar *Chado*. However, elasticity and extensibility differed significantly among samples. The best gluten properties were found in *Demira*, which could be classified as Quality Group I, whereas gluten from *Spadshchyna* and *Chado* flours was characterized as satisfactorily weak and satisfactorily strong, respectively, corresponding to Quality Group II. Notably, gluten from *Demira* flour showed advantages not only among the tested samples but also compared with other European dual-purpose wheat cultivars [13].

At the next stage, dough physical properties were evaluated using a Chopin alveograph (Table 3).

Table 2 – Gluten content and properties of experimental flour samples

(n=3; P≥0.95)

Indicator	Experimental flour samples		
	Spadshchyna	Demira	Chado
Wet gluten content, %	30.7±0,4	30.7±0,5	33.8±0,5
Gluten elasticity, units	85±1	70±1	50±1
Gluten extensibility, cm	22±1	15±1	10±1
Color	light	light	light
Quality group	II	I	II

Table 3 – Dough physical properties

(n=3; P≥0.95)

Indicator	Experimental flour samples		
	Spadshchyna	Demira	Chado
P (tenacity), mm	147	105	150
L (extensibility), mm	35	53	57
P/L ratio	4.2	2.0	2.6
W (flour strength), a.u.	249	268	360
Le (elasticity index), %	55	60	60

Analysis of Table 3 shows that cultivar *Chado* exhibited the highest flour strength, exceeding that of *Spadshchyna* and *Demira* by 1.4 and 1.3 times respectively. Overall, according to flour strength, all three cultivars may be classified as strong flours. Interestingly, based on tenacity, extensibility, and balance ratio, *Demira* and *Chado* lie at the boundary between strong and very strong flour categories, whereas *Spadshchyna* shows low extensibility values typical of weak flour, which shifts its balance ratio toward values characteristic of pasta-type wheat with coarser flour particle size. The high P/L ratio of *Spadshchyna* indicates increased dough elasticity combined with limited extensibility, typical of samples with a rigid gluten network and high resistance to deformation. The low L value (35 mm) combined with high P (147 mm) suggests insufficient capacity for plastic expansion, which may adversely affect crumb structure formation. Such rheological behavior is usually associated with a higher proportion of polymerized glutenins relative to gliadins, resulting in a rigid protein matrix. By contrast, P/L values of 2.0…2.6 for *Demira* and *Chado* correspond to the upper range of strong flour with a more balanced elasticity-to-extensibility ratio, facilitating more efficient gas retention and improved crumb structure. In this context, the high P/L value of *Spadshchyna* can be considered an indicator of primarily pasta-type technological suitability, consistent with trial baking results (Fig. 6). Thus, according to dough rheology, dual-purpose cultivars *Demira* and *Chado* differ clearly from the typical pasta cultivar *Spadshchyna*. Notably, *Demira* flour exhibited significantly better dough properties than both *Spadshchyna* and *Chado*, as well as compared with published data for the Italian dual-purpose cultivar *Faridur* [13].

Overall, these results correlate with gluten content and property data (Table 2), although certain discrepancies were observed between gluten extensibility and dough extensibility for *Spadshchyna*. These differences may be related to starch structural characteristics typical of pasta-type cultivars, as well as to grain chemical composition, including elevated levels of polyunsaturated fatty acids and endogenous enzyme activity, which requires further investigation.

To assess autolytic activity, the falling number was measured (Figure 1).

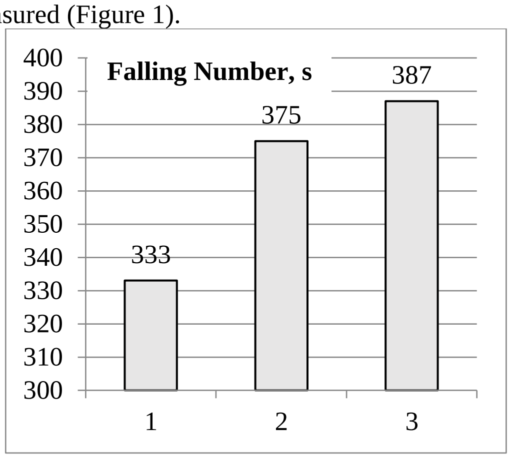


Fig. 1. Falling number: 1 – Spadshchyna; 2 – Demira; 3 – Chado

All grain samples met regulatory standards for wheat grain and flour. The highest falling number was observed for *Chado*, exceeding those of *Demira* and *Spadshchyna* by 3.2% and 16.2% respectively, suggesting lower enzymatic activity. This may indicate slower dough maturation processes in samples made from *Chado* and *Demira* flour compared with *Spadshchyna*. However, since falling number is an indirect indicator of enzyme activity, these results may also be related to starch structure [22] and therefore require further study.

Fermentation behavior was evaluated by monitoring dough acidity, gas production dynamics, and dough volume changes (Figures 2–5).

The most intensive fermentation processes were observed in dough made from *Spadshchyna* flour. Initial acidity was slightly higher in this sample, probably due to grain composition differences. Throughout fermentation, acidity increased somewhat more rapidly in *Spadshchyna* dough than in *Demira* or *Chado*, consistent with falling-number data (Fig. 1). Overall, it should be noted that the acidity of dough prepared from all experimental flour samples was within the typical range for wheat yeast dough. Final titrated acidity of *Spadshchyna* dough exceeded that of *Demira* and *Chado* by 13.3% and 21.4%, respectively, while pH values differed only slightly among samples.

The obtained data correlate with the results of the study on the fermentation intensity of yeast dough made from the experimental flour samples (Figs. 3–4).

Gas-production analysis showed that dough from *Spadshchyna* and *Demira* released 30.6% and 20.4% more carbon dioxide respectively than dough from *Chado* (Fig. 4). Maximum gas-release rates occurred after 60 min of fermentation for *Spadshchyna* and *Demira* and after 70 min for *Chado* (Fig. 3).

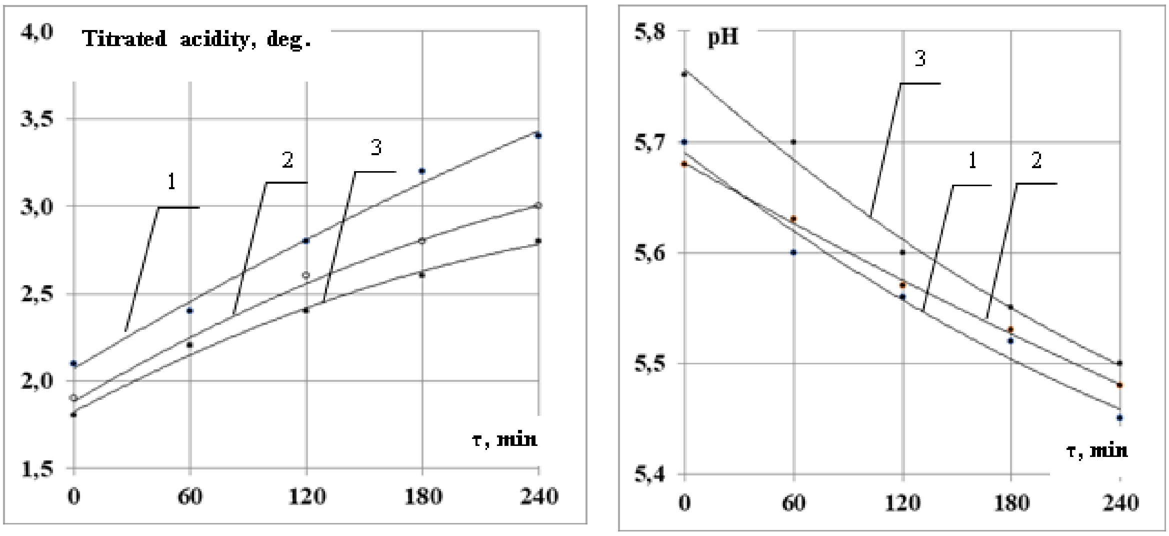


Fig. 2. Titrated (a) and active (b) acidity during the fermentation of dough made from wheat flour: 1 – Spadshchyna; 2 – Demira; 3 – Chado

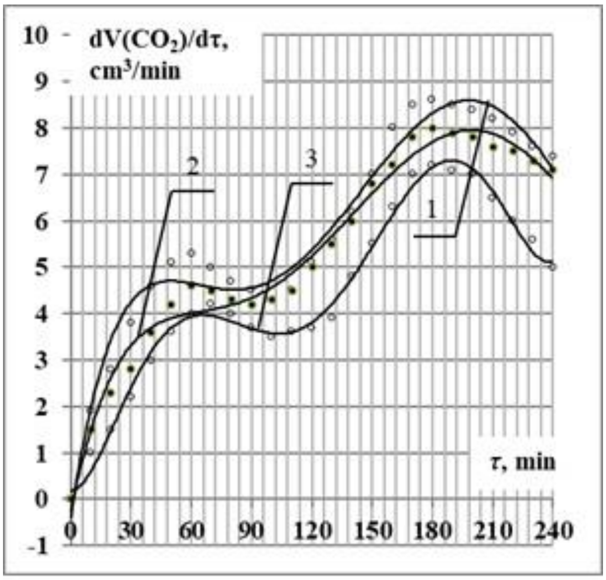


Fig. 3. The rate of gas formation during the fermentation of the dough made from wheat flour: 1 – Spadshchyna; 2 – Demira; 3 – Chado

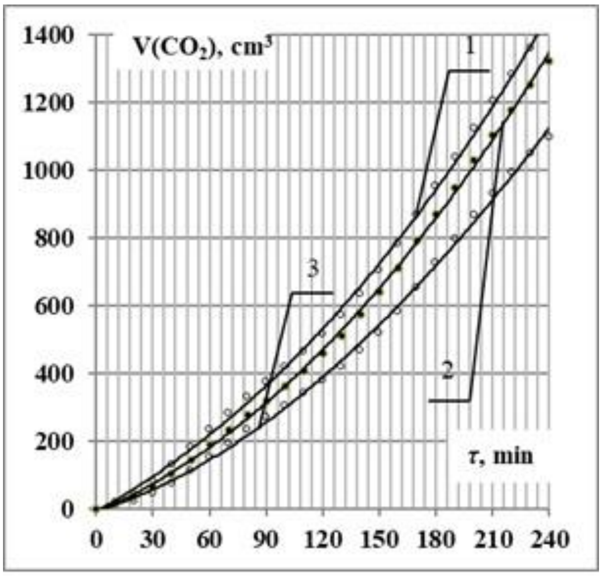


Fig. 4. The amount of gas released during the fermentation of the dough made from wheat flour: 1 – Spadshchyna; 2 – Demira; 3 – Chado

After this period, gas-production intensity decreased, probably due to depletion of simple sugars and yeast adaptation to maltose fermentation. Gas-production rates increased again after 100–110 min and reached maxima at 180 min. These findings indicate more intensive fermentation processes in dough made from *Spadshchyna* grain, likely due to higher levels of fermentable sugars and nitrogenous compounds (Table 1) as well as greater amylolytic enzyme activity (Fig. 1). The obtained data are also consistent with the results of the study on changes in dough acidity during fermentation (Fig. 3).

According to the investigation of dough volume changes during fermentation (Fig. 5), the dough made from *Demira* wheat flour reached the highest maximum volume, which was 27.9% greater than that of dough made from *Spadshchyna* wheat flour. The difference in maximum volume between dough samples produced from Demira and Chado wheat flours was insignificant, amounting to 4.8%. It is worth noting that the changes in dough acidity during maturation, as well as the intensity of carbon dioxide evolution, followed a somewhat different pattern than the changes in dough volume. The results indicate more intensive sugar fermentation in dough prepared from Spadshchyna wheat flour, whereas the greatest volume was achieved by samples produced from *Demira* and *Chado* flours. This is likely due to the fact that although the starch of *Spadshchyna* flour is more susceptible to amylolysis and ensures intensive carbon dioxide release during fermentation, the insufficient gluten quality of *Spadshchyna*, particularly the signs of a poorly elastic protein network identified during alveograph analysis (Table 3), does not allow effective retention of the released gas, resulting in lower dough and final product volumes.

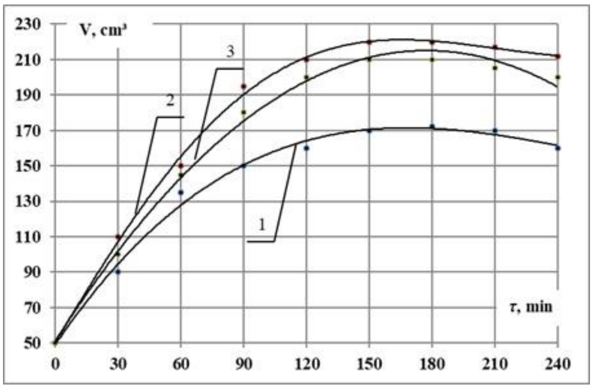


Fig. 5. Change in volume during the fermentation of the dough made from wheat flour: 1 – Spadshchyna; 2 – Demira; 3 – Chado

The most comprehensive assessment of the suitability of flour from new wheat varieties can be obtained from the analysis of product quality indicators based on trial baking results (Figs. 6–7, Table 4).

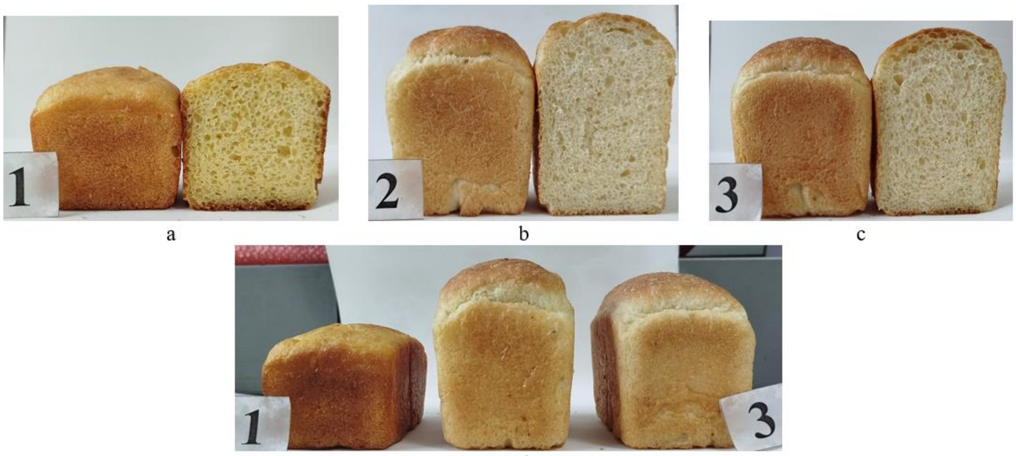
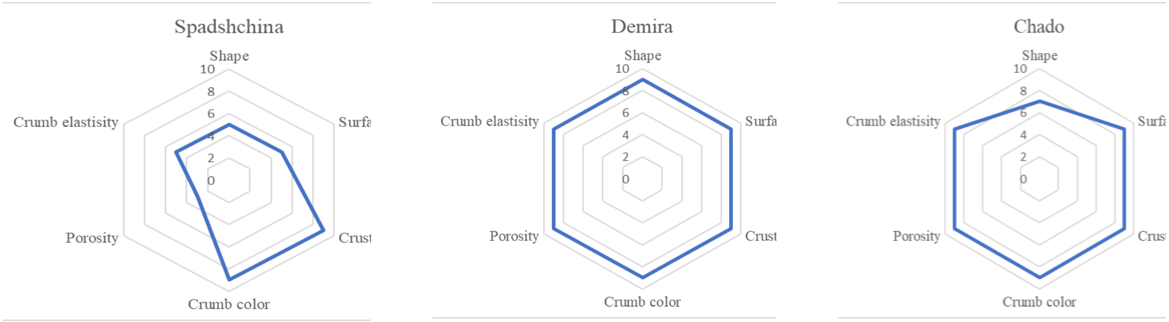


Fig. 6. Appearance of bread made from flour of wheat grain varieties: 1 – Spadshchyna; 2 – Demira; 3 – Chado

Table 4 – Organoleptic quality characteristics of bread samples

Indicator	Experimental samples of bread made from flour of wheat grain varieties		
	Spadshchyna	Demira	Chado
External appearance: Shape	Regular, consistent with the baking mold		
Surface	Clean, smooth, free of cracks and ruptures	Clean, smooth, convex, without cracks or ruptures	
Crust color	Light brown	Golden	
Crumb condition	Soft, elastic, with uniform medium porosity	Soft, elastic, with uniform fine porosity	
Taste and aroma	Characteristic of wheat bread, without foreign flavors or odors		



a b c

Fig. 7. Profilograms of organoleptic quality indicators of bread produced from flour of wheat grain varieties:
1 – Spadshchyna; 2 – Demira; 3 – Chado

It was established that, according to organoleptic characteristics, particularly external appearance and crumb condition, the products made from *Demira* wheat flour were the most advantageous. This is consistent with the results of determining gluten content and properties in flour (Table 2), dough physical properties (Table 3), and dough volume changes during fermentation (Fig. 5). Bread made from *Demira* wheat flour exhibited a regular shape, smooth crack-free surface, light crust color, and a uniform, well-developed porous structure with an elastic crumb. Bread samples produced from *Chado* wheat flour were also characterized by high quality indicators, although they were inferior to products made from *Demira* flour in terms of volume. This may be associated with excessively strong gluten (Table 2) and slightly reduced dough maturation intensity (Figs. 2–5), which can be corrected through technological approaches such as blending different flour batches, incorporating proteolytic enzymes into formulations, or adding ingredients exhibiting such activity. Based on the results of carbon dioxide release during fermentation, it can be hypothesized that slight supplementation with sugars or amylolytic enzymes may enhance dough fermentation and improve the specific volume of the products.

Thus, the conducted research demonstrated that grain of the *Demira* and *Chado* wheat varieties may be considered promising raw materials for the production of bakery and flour-based culinary products, whereas grain of the *Spadshchyna* variety is more appropriately regarded as raw material for pasta and groat production. The use of flour derived from *Chado* grain may be advisable when combined with weaker flour or with enzyme preparations exhibiting proteolytic and amylolytic activity. Further research interest lies in investigating the potential application of new wheat varieties in pasta production.

Conclusion

As a result of the conducted research, a comparative analysis of the technological properties of grain from dual-purpose durum wheat varieties *Demira* and *Chado* was performed in comparison with the standard pasta-type variety *Spadshchyna*, and the feasibility of using *Demira* and *Chado* grain in flour-based product technologies was substantiated. It was established that *Demira* and *Chado* contain 30.7% and 33.8% wet gluten of quality groups I and II, respectively, and are characterized by favorable flour strength indicators, while the falling number of all studied grain samples complied with regulatory standards. It was found that yeast dough maturation processes, assessed by changes in titrated and active acidity as well as carbon dioxide evolution intensity, proceeded more intensively in samples prepared from *Spadshchyna* wheat flour than in those made from *Demira* and *Chado* wheat. At the same time, the substantial advantages of *Demira* grain in terms of gluten quality compared with the other samples resulted in the highest dough volume during fermentation, exceeding that of *Spadshchyna* by 27.9%. According to trial baking results, bread produced from *Demira* and *Chado* flours exhibited high organoleptic quality and can be recommended for industrial application..

References

1. Lafiandra D, Sestili F, Sissons M, Kiszonas A, Morris CF. Increasing the Versatility of Durum Wheat through Modifications of Protein and Starch Composition and Grain Hardness. *Foods.* 2022;11:1532. doi:10.3390/foods11111532.
2. Guzman C., Autrique J.E., Mondal S., Singh R.P., Govindan V., Morales-Dorantes A., Pena R.J. Response to drought and heat stress on wheat quality, with special emphasis on breadmaking quality, in durum wheat. Field Crops Res. 2016;186:157–165. doi: 10.1016/j.fcr.2015.12.002.
3. Ceoloni C., Forte P., Gennaro A., Micali S., Carozza R., Bitti A. Recent developments in durum wheat chromosome engineering. Cytogenet. Genome Res. 2005;109:328–334. doi: 10.1159/000082416.
4. Ruiz M., Giraldo P. The influence of allelic variability of prolamins on gluten quality in durum wheat: An overview. J. Cereal Sci. 2021;101:103304. doi: 10.1016/j.jcs.2021.103304.
5. McCallum C.M., Comai L., Greene E.A., Henikoff S. Targeting induced local lesions in genomes (TILLING) for plant functional genomics. Plant Physiol. 2000;123:439–442. doi: 10.1104/pp.123.2.439.
6. Slade A.J., McGuire C., Loeffler D., Mullenberg J., Skinner W., Fazio G., Holm A., Brandt K.M., Steine M.N., Goodstal J.F., et al. Development of high amylose wheat through TILLING. BMC Plant Biol. 2012;12:69. doi: 10.1186/1471-2229-12-69.

7. Gazza L., Sgrulletta D., Cammerata A., Gazzelloni G., Perenzin M., Pogna N.E. Pastamaking and breadmaking quality of soft-textured durum wheat lines. J. Cereal Sci. 2011;54:481–487. doi: 10.1016/j.jcs.2011.09.003.
8. Kyrychenko VV, Petrenkova VP, Kobyzieva LN, Riabchun VK, editors. *Teoretychni doslidzhennia ta praktychni dosiahnennia Instytutu roslynnytstva imeni V. Ya. Yurieva NAAN: istoriia ta sohodennia (1908–2018 rr.)* [Theoretical studies and practical achievements of the Plant Production Institute named after V.Ya. Yuriev of NAAS: history and present (1908–2018)]. Kharkiv: Plant Production Institute nd. a. V.Ya. Yuriev NAAS; 2018. p. 448–49. Available from: https://yuriev.com.ua/assets/files/knigi/teoretichni-ta-peraktichni-dosyagnennya.pdf
9. Heinze K, Kiszonas AM, Murray JC, Morris CF, Lullien-Pellerin V. Puroindoline genes introduced into durum wheat reduce milling energy and change milling behavior similar to soft common wheats. *Journal of Cereal Science*. 2016;71:183–189. doi:10.1016/j.jcs.2016.08.016.
10. Boehm JD Jr, Ibba MI, Kiszonas AM, Morris CF. End-use quality of CIMMYT-derived soft-kernel durum wheat germplasm: I. Grain, milling, and soft wheat quality. *Crop Science*. 2017;57:1475–1484. doi:10.2135/cropsci2016.09.0774.
11. Boehm JD Jr, Ibba MI, Kiszonas AM, Morris CF. End-use quality of CIMMYT-derived soft-kernel durum wheat germplasm: II. Dough strength and pan bread quality. *Crop Science*. 2017;57:1485–1494. doi:10.2135/cropsci2016.09.0775.
12. Morris CF. Re-evolution of durum wheat by introducing the Hardness locus and other D-genome traits; implications for milling and end-use. *Frontiers in Sustainable Food Systems*. 2019;(article). doi:10.3389/fsufs.2019.00103.
13. Pasqualone A, Palombieri S, Koksel H, Summo C, De Vita P, Sestili F. Milling performance and bread-making aptitude of the new soft kernel durum wheat variety *Faridur*. *International Journal of Food Science & Technology* (IJFST). 2023;58:268–278. doi:10.1111/ijfs.16200.
14. Ruan Y, Yu B, Knox RE, et al. High density mapping of quantitative trait loci conferring gluten strength in Canadian durum wheat. *Frontiers in Plant Science*. 2020;11:170. doi:10.3389/fpls.2020.00170.
15. Sissons M, Sestili F, Lafiandra D. Effect of Glu-D1 introgression on dough- and pasta-making quality of durum wheat lines with different glutenin composition and amylose content. *Cereal Chemistry*. 2019. doi:10.1002/cche.10137.
16. Cecchini C, et al. Assessing the Rheological Properties of Durum Wheat Semolina: a review of methods and interpretation for pasta/bread quality. *Foods*. 2021;10:2947. doi:10.3390/foods10122947.
17. Ministry of Agrarian Policy and Food of Ukraine. *Derzhavnyi reiestr sortiv roslyn, prydatnykh dlia poshyrennia v Ukraini* [State register of plant varieties suitable for dissemination in Ukraine] [Internet]. Available from: https://minagro.gov.ua/file-storage/reyestr-sortiv-roslin.
18. STOV «Peremoha». *Semena pshenitsy tverdoi Chado, elita* [Seeds of durum wheat Chado, elite] [Internet]. Available from: https://stovperemoga.com.ua/p/92381640-semena-pshenicy-tverdoy-chado-elita/
19. Instytut roslynnytstva im. V. Ya. Yurieva NAAN. *Sort "Spadshchyna" (Pshenitsia yara tverda Triticum durum Desf.)* [Variety "Spadshchyna" (Spring durum wheat Triticum durum Desf.)]. Kharkiv: Instytut roslynnytstva im. V. Ya. Yurieva NAAN; 2006 [Internet]. Available from: https://yuriev.com.ua/ua/katalog-produkcii/katalog/pshenicya-yara/spadshhina/
20. Drobot VI. Laboratornyi praktykum z tekhnologii khlibopekarskoho ta makaronnoho vyrobnytstv. Kyiv: Tsentr navchalnoyi literatury; 2006.
21. Investigation of the technological properties of emmer flour / A. Zaparenko, S. Didenko, O. Holyk, Y. Goloventsov // Food Science and Technology. – 2020. – Vol. 14. – Issue 2. – P. 119–127. DOI: https://doi.org/10.15673/fst.v14i2.1717
22. Kyienko ZB, Prysiazhniuk LM, Shovhun OO, Ivanytska AP, Pavliuk NV, Tkachyk SO. Methodology for conducting qualification examination of plant varieties for suitability for distribution in Ukraine. Methods for determining quality indicators of crop production (3rd ed., rev. and enl.) [Metodyka provedennia kvalifikatsiinoi ekspertyzy sortiv roslyn na prydatnist do poshyrennia v Ukraini. Metody vyznachennia pokaznykiv yakosti produktsii roslynnytstva (3-tie vyd., vypr. i dop.)]. Kyiv (Ukraine): Digital Publishing House of the Ukrainian Institute for Plant Variety Examination; 2016. p. 34–37. doi:10.21498/978-966-924-578-6. [In Ukrainian]

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ПОРІВНЯЛЬНИЙ АНАЛІЗ ТЕХНОЛОГІЧНИХ ВЛАСТИВОСТЕЙ БОРОШНА НОВИХ СОРТІВ ТВЕРДОЇ ПШЕНИЦІ

Анотація. Подано результати досліджень технологічних властивостей борошна, отриманого із зерна нових сортів твердої пшениці подвійного використання *Деміра* та *Чадо* у порівнянні зі стандартним сортом *Спадщина*, що характеризуються вмістом білка 13.56, 12.20 і 11.55 % відповідно, а також твердозерністю 183, 186 і 165 Н відповідно. Виявлено, що борошно пшениці сортів *Спадщина* та *Деміра* містить 30,7% сирої клейковини, у той час як *Чадо* – 33,8%. За показниками пружності та розтяжності клейковина борошна пшениці *Спадщина* виявилася задовільно слабкою, *Деміра* – хорошою, *Чадо* – задовільно міцною. Результати оцінювання фізичних властивостей тіста дослідних зразків борошна на альвеографі за методом Шопена дозволили віднести борошно пшениці всіх сортів до сильного з показниками сили борошна 249, 268 і 360 о.а. За показниками числа падіння всі дослідні зразки борошна відповідали вимогам нормативної документації, при цьому значення показника числа падіння для борошна пшениці сорту *Чадо* було на 3,2% та 16,2% вищим порівняно з *Деміpою* та *Спадщиною* відповідно. Встановлено, що найбільш інтенсивно процеси бродіння за показниками зміни титрованої та активної кислотності, а також інтенсивності виділення вуглекислого газу перебігають в тісті, приготовленому на основі борошна пшениці сорту *Спадщина*. Загальна кількість виділеного вуглекислого газу протягом 240 хв бродіння для зразків тіста із борошна *Спадщина*, *Деміра* та *Чадо* становила 1435, 1323 і 1099 см^3 відповідно. За результатами дослідження зміни об'єму тіста під час бродіння встановлено, що найбільшого максимального об'єму досягає тісто, приготовлене із борошна пшениці *Деміра*, що на 27,9% більше, ніж для тіста, приготовленого із борошна пшениці *Спадщина*. Різниця в максимальному об'ємі тіста, приготовленого із борошна пшениці *Деміра* та *Чадо* є несуттєвою та становить 4,8%. За результатами пробного випікання хліба встановлено, що за органолептичними показниками, зокрема зовнішнім виглядом і станом м'якушки, найвигідніше відрізняються вироби, отримані із борошна пшениці сорту *Деміра*, Вироби, отримані із борошна пшениці сорту *Деміра* мали правильну форму, рівну без тріщин поверхню, світлий колір скоринки, вироби мали рівномірну добре розвинену пористість з еластичною м'якушкою. Зразки хліба, отримані із борошна пшениці сорту *Чадо* також характеризувалися високими показниками якості, хоча і поступалися виробам, отриманим із борошна пшениці сорту *Деміра* за показником об'єму. Вироби, отримані із пшениці сорту *Спадщина*, мали недостатній об'єм та завеликі нерівномірно розподілені пори, що погіршувало якість виробів порівняно з іншими зразками. Спираючись на отримані результати борошно пшениці сортів *Деміра* та *Чадо* рекомендовано для подальшого використання в технології хлібобулочних виробів, у той час як пшеницю *Спадщина* доцільно розглядати як культуру круп'яного та макаронного спрямування.

Ключові слова: тверда пшениця, пшениця подвійного використання, клейковина, якість борошна, якість хліба

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