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Influence of genotype and weather environment on quality of flour of soft spring wheat of Myronivka selection

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The purpose. To determine extent of influence of genotype and weather environment on conditionality of physical and baking capacities of flour of new grades of soft spring wheat of Myronivka selection. **Methods.** General scientific and special: laboratory, technological analysis of flour, mathematical-statistical. Researches were carried out in 2015 – 2017 on the basis of Myronivka institute of wheat. Subjects of researches were quality factors of flour: content of protein and crude gluten, deformation index of gluten (DIG), «force» of flour (W), configuration of alveogram (P/L), volumetric exit of bread which was determined for new grades of soft spring wheat (Simkoda Myronivska, Panianka, MIP Zlata, Bozhena, Oksamyt Myronivskyi, Dubravka, MIP Svitlana, Elehiia Myronivska (standard)). **Results.** Main role in formation of physical properties of quality of flour of soft spring wheat played conditions of cultivation, variation of indexes was within the limits of 49,6 – 96,5%. The extent of influence of genotype was lower (to 32,6%), but on the majority of indexes authentic. The highest percentage of influence of genotypic component was registered for quality factors: «force» of flour, and index of deformation of gluten (32,6 and 28,8% accordingly). On the average on years high (280 u.a.) indices of «force» of flour had grades Simkoda Myronivska, Panianka, MIP Zlata, Bozhena, and Oksamyt Myronivskyi. Stable high level of attribute was formed with grades MIP Zlata (315 – 380 u.a.) and Oksamyt Myronivskyi (336 – 432 u.a.). Grades Simkoda Myronivska, Panianka, MIP Zlata, Bozhena, Oksamyt Myronivskyi, and Dubravka exceeded the standard (783 cm3) by volume of bread. The majority of grades matched the I-st group of quality of gluten on GID index. **Conclusions.** They determined crucial influence of conditions of year of growing and smaller, but authentic, of genotype of grade on the majority of probed attributes of quality of flour of soft spring wheat. The factor of genotype essentially influenced index of deformation of gluten and «force» of flour. Grades Simkoda Myronivska, MIP Zlata, Oksamyt Myronivskyi and Panianka may be allocated among probed grades on physical and baking capacities of flour, which by «force» of flour belong to group of strong wheat, and can be used in selection as a source of that attribute.

Key words: *protein, crude gluten, index of deformation of gluten, «force» of flour, volumetric exit of bread.*

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There are many factors that must be combined to produce high-quality grain crops with good grain quality, especially spring wheat. Only if the favorable conditions for cultivation and adherence to all the measures required by a particular crop are created, the full potential of yield and grain quality of any variety can be realized. Against the background of growing conditions, the genotype of the variety has also significant influence on grain quality [1]; therefore in breeding bread spring wheat much attention is paid to creation of varieties with high potential and a number of valuable traits.

Analysis of recent research and publications. Wheat grain and flour quality is characterized by such main indices as 1000 kernel weight, test weight, vitreousness, damage with wheat bugs, protein content, wet gluten content and its quality, flour strength, dough tenacity, dough extensibility, the balance between elasticity and extensibility, bread volume, etc.

In the problem of improving wheat quality it is important to identify the patterns of formation of individual technological indicators in different conditions and purposefully use them. When varying

agrometeorological conditions of cultivation, the yield and quality of cereals changes [2–4]. Indices of grain quality and baking properties of flour depend to a greater extent on the weather conditions during the period of grain filling and ripening, as well as, in fact, on the genotype of the variety [5–8]. This is confirmed by studies conducted at the V. M. Remeslo Myronivka Institute of Wheat [9–11].

The instability of weather conditions in regions of spring wheat growing encourages the breeder to study the relationship between them and the quality indices of grain produced and flour of new spring wheat varieties. Determining the proportion of the influence of factors on quality indices will allow us to identify the traits that can be enhanced by breeding to a larger extent.

The purpose of the study is to determine the proportion of the influence of the factors "genotype" and "weather conditions" on the physical and baking properties of flour of new varieties of bread spring wheat bred at Myronivka.

Materials and methods of the research. The studies were conducted in 2015–2017 on the basis of the V. M. Remeslo Myronivka Institute of Wheat of NAAS (MIW). The influence of two factors (variety genotype and weather conditions of growing seasons) on quality indices was studied for 8 bread spring wheat varieties bred at the Spring Wheat Breeding Laboratory of MIW, namely, Simkoda myronivska, Panianka, MIP Zlata, Bozhena, Oksamyt myronivskyi, Dubravka, and Elehiia myronivska (standard). Quality indices were determined in the Grain Quality Laboratory (MIW) when using conventional techniques [12, 13] and devices, namely, the mill Buhler MLU-202 for obtaining flour of 70 % output; “Spektran 119-M” for protein content; wet gluten content was determined by centrifugation and washing it manually; IDK 1M for gluten deformation index (GDI); Chopin Alveograph for flour strength (W) and configuration ratio of the Alveograph curve (P/L); Swanson type kneader model 100-200 A for kneading dough; thermostat model 505-SS for dough rising; electric oven with horizontal-rotary tray (at t 230 °C for baking bread; OMKh-1 for determining bread volume.

Statistical data processing was performed using the Excel application package, descriptive statistics methods and two-factor analysis of variance [12].

The weather conditions of the years of the research varied significantly in air temperature and humidity, which made it possible to determine the reliable genotypic conditionality of the physical properties of bread spring wheat flour.

Period of grain filling and ripening in 2015 was characterized by sufficient humidity and increased temperatures. May was characterized by exceeding normal rainfall (125 %) and excess of average daily (hereinafter as a. d.) air temperature by 0.7°°C to the annual average (hereinafter as a. a.). In June, a significant amount of storm rainfall (131 % to a. a.) with increase in air temperature of 1.5 °C was observed, which led to lodging. July proved to be arid (58 % of precipitations to a. a. with an excess of a. a. temperature by 1.4 °C), but such conditions did not significantly affect on the physical properties of spring wheat flour, except for the baking qualities in some varieties.

In May and June 2016, the average rainfall averaged 125.4 % of a. a. with air temperature being close to the a. a., which promoted the normal growth and development of bread spring wheat plants. July was arid (50 mm or 59.5 %) with excess of a. d. temperatures of 1.7 °C to a. a. These conditions partially reduced the protein and wet gluten content in the varieties studied.

In May–July 2017, rainfall was insufficient (on average 62.8 % of a. a.) with excess of. a. d. air temperature of 1.0 °C, which adversely affected the formation and filling of grain, reduced gluten content, but did not affect its quality, flour strength and bread volume.

Research results. Depending on the distribution patterns of the three-year data obtained, the methods of mathematical and statistical processing were applied. The degree of asymmetry significance was evaluated by the ratio of the asymmetry coefficient to its standard deviation, and the significance of the distribution excess was by the ratio of excess to its standard deviation (Table 1).

1. Significance of asymmetry of spring wheat quality characteristics (MIW, 2015–2017)

Parameters of numerical characteristics	Protein content	Wet gluten content	GDI, units of device IDK-1M	Flour strength	P/L	Bread volume
Excess (E_X)	-0.84	-0.41	-1.18	-0.03	-0.69	1.28
Asymmetry (A_S)	-0.13	0.26	0.09	0.71	0.46	1.02
Standard deviation of excess (σEX)	0.80	0.80	0.80	0.80	0.80	0.80
Standard deviation of the coefficient of asymmetry (σAS)	0.45	0.45	0.45	0.45	0.45	0.45
$\lvert E_X/\sigma E_X\rvert$	1.05	0.51	1.48	0.03	0.87	1.59
$\lvert A_S/\sigma A_S\rvert$	0.30	0.58	0.19	1.56	1.01	2.26

The data obtained for all parameters investigated were close to the normal distribution, since the degree of significance of asymmetry and excess corresponded to $|AS/\sigma AS| \leq 3$ and $|EX/\sigma EX| \leq 3$ respectively. This distribution of indices made it possible to use parametric statistics methods.

Analysis of variance showed that the weather conditions in the years of growing had a decisive influence (from 49.6 to 96.5 %) on all quality traits studied (Table 2). Significant genotypic component of gluten deformation index (28.8 %) and considerable, but not significant of flour strength (32.6 %) were established. The factor genotype of the variety slightly, but significantly influenced on the bread volume, alveogram configuration, protein and wet gluten content in flour (respectively 5.8; 9.5; 2.8; 6.4 % for $p \leq 0.05$). During the years of studies, the average protein content of the experiment was 12.6 % (Table 3).

The highest value of this indicator (13.5 %) was the variety of Simkoda myronivska. The high content (29.0 and 27.1 %) of wet gluten and bread volume (1030 and 1070 cm^3) formed the varieties Simkoda myronivska and Panianka, respectively.

2. ANOVA results of spring wheat quality characteristics (MIW, 2015–2017)

Source of variation	Df	SS	MS	MS_f/MS_Σ, %	F fact
Protein content					
Total	24	85.2			
Year	2	73.5	36.8	96.5	131.07*
Variety	7	7.5	1.1	2.8	3.80**
Residual	15	4.2	0.3	0.7	
Wet content					
Total	24	911.5			
Year	2	689.7	344.8	92.6	94.11*
Variety	7	166.9	23.8	6.4	6.51*
Residual	15	55.0	3.7	1.0	
GDI					
Total	24	2,664.6			

Year	2	660.3	330.1	60.3	5.50**
Variety	7	1,104.0	157.7	28.8	2.63***
Residual	15	900.4	60.0	11.0	
Flour strength					
Total	24	209,274.0			
Year	2	34,893.3	17,446.6	49.6	2.78***
Variety	7	80,346.7	11478.1	32.6	1.83
Residual	15	94,034.1	6,268.9	17.8	
Alveogram configuration					
Total	24	11.7			
Year	2	7.4	3.7	88.2	38.5*
Variety	7	2.8	0.4	9.5	4.1**
Residual	15	1.5	0,1	2,3	
Bread volume					
Total	24	2,000,850.0			
Year	2	1,544,775.0	772,387.5	93.2	98.28*
Variety	7	338,183.3	48,311.9	5.8	6.15*
Residual	15	117,891.7	7,859.4	0.9	

Note: * $p \leq 0.01$; ** $p \leq 0.05$; *** $p \leq 0.01$.

During the years of the research average protein content was at 12.6 % level (Table 3). The variety Simkoda myronivska was distinguished with higher the index (13.5 %). The varieties Simkoda myronivska and Panianka were characterized with high wet gluten content (29.0 and 27.1 %) and bread volume (1,030 and 1,070 cm^3) respectively.

3. Flour quality indices of bread spring wheat varieties (MIW, average for 2015–2017)

Variety	Protein content, %	Wet gluten content, %	GDI, units of device IDK-1M	Flour strength, u. a.	P/L	Bread volume, cm^3
Elehiia myronivska (standard)	13.3	25.5	59	396	1.60	783
Simkoda myronivska	13.5	29.0	57	327	1.13	1,030
Panianka	12.8	27.1	56	340	1.51	1,073
MIP Zlata	12.9	25.4	65	351	1.66	897
Bozhena	12.5	25.9	63	288	1.20	823
Oksamyt myronivskyi	12.4	23.4	49	414	2.14	827
Dubravka	11.9	21.0	49	279	1.93	917
MIP Svitlana	12.1	22.0	44	228	1.27	743
X	12.6	24.9	55	328	1.56	887
Min	11.9	21.0	44	228	1.13	743
Max	13.5	29.0	65	414	2.14	1,073

Gluten quality of all genotypes tested by GDI corresponded to Group I (except for the variety MIP Svitlana). The varieties MIP Zlata and Bozhena were within the standard by gluten content.

The alveogram configuration index of the varieties under study remained at the level of the variety standard (P/L =1.6±0.5).

The varieties Simkoda myronivska, MIP Zlata, Panianka, and Oksamyt myronivskyi including the standard Elehiia myronivska were characterized with the maximum values (327–414 u. a.) of flour strength in the years of the research; they met the requirements (280 u. a.) to strong wheat. These varieties as well as the variety Dubravka by bread volume per 100 g flour exceeded the standard by 40–290 cm^3.

The arid conditions of 2017 contributed to the formation of high protein and wet gluten content (max 14.5 and 33.7 % respectively), which in turn made it possible to obtain high bread volume (max 1,480 cm^3).

Conclusions

It was established the determining influence of the factor of growing season conditions and less, but the reliable influence of the factor of variety genotype on the most of the investigated flour quality traits of bread spring wheat. The factor of genotype significantly influenced on the indices of gluten deformation index and flour strength. Among the varieties studied the varieties Simkoda myronivska, MIP Zlata, Oksamyt myronivskyi, and Panianka were distinguished in terms of physical and baking properties of flour and by flour strength they belong to strong wheat and can be used in breeding as a source of this trait.

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