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PROTEIN COMPOSITION AND QUALITY OF WINTER WHEAT FROM ORGANIC AND CONVENTIONAL FARMING

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Abstract

During a two-year experiment we evaluated relations between the grain protein composition and wheat quality parameters in a set of varieties from different quality groups from conventional and organic farming. Our results indicate an influence of organic and conventional growing on the grain storage proteins composition and technological quality. Varieties with a higher content of high molecular weight (HMW) glutenins (quality group E – elite, the most suitable for baking utilization, A – high-quality) reached more positive values of rheology characteristics and of baking quality indicators. Varieties from the quality group C (others – wheat unsuitable for baking utilization) were mainly characterized by a higher content of low molecular weight (LMW) glutenins and gliadins and a higher content of valuable nutritional albumins and globulins. This trend was noticed in wheat varieties from both systems of growing.

Key words: winter wheat quality, protein composition, organic farming, conventional farming.

Introduction

The criteria for technological wheat grain quality evaluation are the object of many studies. Basically, the characters deciding the wheat grain quality are the content and viscoelastic character of gluten protein, grain hardness, flour yield, pharinographic water absorption and activity of hydrolytic enzymes. Technological quality and the wheat grain protein composition are influenced by the growing system, variety, locality, year conditions and growing technology significantly /Šíp et al., 2000/.

The wheat from organic farming has a number of differences in technological quality compared with the technological quality of wheat from conventional growing. The most significant differences between qualitative wheat parameters from organic and conventional growing are in the crude protein content in dry matter of grain and in the parameters that characterize the wheat protein complex quality. Higher nitrogen levels require a later vegetation phase, when the grain is forming and maturing. It is in organic farming with the absence of fast effect industrial fertilizers, that a nitrogen deficit and a lower accumulation of wheat storage proteins – gliadins and glutenins, are frequently experienced /Prugar, 1999/. This adversely affects the wheat’s food potential, mainly the baking utilization (total crude protein content correlates significantly with a number of other qualitative wheat parameters /Branlard et al., 1991/.

However, the present studies indicate that the genetically determined differences, e.g. in the baking quality of wheat from conventional farming can also be observed in wheat from organic farming. Some high-quality varieties from the quality groups “E” (elite) and “A” (high-quality) may give good baking utilization possibilities. Organic farming, due to the favourable quality of gluten therefore offers a satisfactory quality of dough rheology /Prugar, 1999; Capouchová, 2003/.

Wheat flour ability to create viscoelastic properties of dough depends on the wheat protein character. When the flour is mixed with a certain amount of water, its proteins are hydrated and they go into interactions with carbohydrates as well as lipids and create gluten. The gluten quality for the specific final utilization depends on the combination of many physical and chemical properties of the protein complex and it is determined especially by the optimal storage protein combination – gliadins and glutenins. Each of them affects rheology in a unique way – viscosity is affected by gliadins and elasticity by glutenins /Bushuk, Bekes, 2002/.

Various elasticity and viscosity ratios, which are primarily genotype values, determine the wheat flour utilization for bread or biscuit production. Well-balanced elasticity and viscosity predestinate the usage of these genotypes for the baking production of proofing dough. By contrast, high viscosity and low elasticity of gluten proteins, even of dough, are suitable for biscuit production /Novotný, Jurečka, 2000/.

Evaluation results of the wheat varieties’ complex protein provide important information for assessment of the technological wheat quality.

The primary Osborne system of wheat protein classification, which is based on the proteins solubility principle, classifies wheat proteins into albumins, globulins, gliadins, glutenins and the insoluble remainder. Technologically, the most important storage proteins create gliadins and glutenins /Bushuk, 1989b/.

However, we more often divide wheat proteins into three groups: storage proteins, structural and metabolic proteins and protective proteins. The storage proteins fall into three different Osborne fractions and offer three different tissues of grain /Shewry, Halford, 2001/.

The embryo and outer layer of endosperm contain storage globulins /Kriz, 1999/. These storage globulins are saved in protein bodies and it appears that they function only as storage proteins. These proteins have only a local influence on the utility grain properties. Albumins have a double role, functioning as a nutrient store for the sprouting embryo and as inhibitors of insects and fungi pathogens before sprouting. Generally, albumins and globulins are not considered to be proteins with a critical role for the flour quality even though a small significance was noticed /Schofield, Booth, 1983/.

Albumins and globulins have the highest nutritional quality in the way of amino acids composition. According to some authors they decrease the quality of gluten /Payne, 1987; Bushuk, 1989a/.

The main storage proteins of the cereal grain endosperm are gliadins and glutenins /Shewry, Halford, 2001/. Gliadins create 30-40 % of the total protein amount, these are, however, proteins with the lowest nutritional values. They are judged largely in relation to viscosity and tensibility of gluten /Gianibelli et al., 2001/.

Glutenins are proteins, which could be partitioned into groups depending on their electrophoresis mobility in SDS-PAGE (SDS-polyacrylamid gel electrophoresis) after reduction of S-S bindings. The Group A with the molecular weight of 80 000 – 120 000 Daltons (Da) matches the high-molecular (HMW) glutenins. The Group B (42 000 – 51 000 Da) and the Group C (30 000 – 40 000 Da) are the low-molecular (LMW) glutenins reminiscent of gliadins /Thompson et al., 1994/. HMW glutenins are the key factors during the bread making process. They provide the gluten strength and elasticity /Weegels et al., 1996/. LMW glutenins constitute about one third of the total grain proteins and 60 % of the total glutenins /Bietz, Wall, 1973/. Despite their worth, they have been far less explored than the HMW glutenins. This is due to their difficult identification in one-dimension SDS-PAGE (overlaying gliadins and LMW glutenins).

Influence of particular proteins (HMW glutenins, LMW glutenins and gliadins) on the dough characteristics may be valuable during the study of flour during its mixing /Bekes et al., 1998/. Proteins in the branched chain as HMW glutenins and LMW glutenins increase the dough strength /Lee et al., 1999/.

The tasks and aims of our research were:

1. To test the technological quality of a selected set of winter wheat varieties from different quality groups (E, A, B, and C) from conventional and organic farming systems.

2. To find out information about the protein composition of the tested wheat varieties.

Materials and Methods

During the two-year experiment (the harvest years of 2004 and 2005) the relations between the grain protein composition, flour-milling parameters and baker quality were evaluated in a set of winter wheat varieties from different quality groups based on their baking quality (E – elite, the most suitable for baking utilization, A – high-quality, B – additional, suitable for use in a mixture, C – others, unsuitable for baking utilization) from conventional farming at the Stupice Breeding Station, and organic farming at the Experimental Station of Plant production Department, Faculty of Agrobiology, Food and Natural Resources, Czech University of Agriculture in Prague – Uhříněves.

The experimental sites of the Stupice Breeding Station and the Uhříněves Experimental Station lie in nearly the same soil-climatic conditions (approx. 2 km apart) in the sugar-beet growing region of the central Bohemian area, with the elevation above sea-level 295 m, average annual temperature 8.4°C and average annual precipitation total of 575 mm. There is a clay-loam brown soil with good reserves of all essential nutrients and with the arable land depths of 25-30 cm.

The experiments were established according to the methods valid for performing the State Varietal Trials in the Czech Republic – using the method of random blocks, in 4 replicates, and with the size of experimental plots of approximately 15 m^2. The experiments at the Stupice Breeding Station were established with the use of the total N fertiliser rate of 130 kg N ha^{-1}, plus a herbicide, fungicide, insecticide, and a morphoregulator.

At the Experimental Station in Prague-Uhříněves the experiments were carried out in an organic growing system according to the principles of IFOAM (International Federation of Organic Agriculture Movements) and Methodical instruction for organic farming of the Ministry of Agriculture of the Czech Republic. Field experiments were carried out in the same manner as at the Stupice Breeding Station, but no industrial or organic fertilizers and pesticides were used there.

After the harvest approx. 3 kg of grain samples were collected for the laboratory quality analysis. The grain samples were analyzed for the total crude protein content in dry matter of grain according to the ČSN ISO 1871 standard, wet gluten content in dry matter of grain (the ČSN ISO 5531 standard) and the sedimentation index by Zeleny (the ČSN ISO 5529 standard). The remaining part of the grain was milled on the Bühler laboratory mill (MLU-202 type). Following this procedure the individual components of the mixture corresponded to the T 550 common baker smooth flour. This was used for the analysis of the rheology quality on the pharinograph (ČSN ISO 5530-1 standard) and for baker test (methodology by the VÚ MPP Prague research institute).

For the classification of wheat grain protein composition the electrophoresis analysis of the storage proteins was used – the SDS-PAGE in polyacrylamide gel method according to Laemmli (1970). The grain was extracted with the SDS extraction buffer (1M Tris-HCl, pH = 6.8, 2 % SDS, glycerol, mercaptoethanol, Pyronin, and distilled water) in a microcentrifuge tube (100-120 µl) for 30 minutes. Then the sample was boiled for 10 minutes and centrifugated (10 minutes at 15 000 rpm). The clear supernatant (15µl) was pipetted onto the gel. Quantitative evaluation of electrophoreograms was made using the Bio 1D software from the Vilber-Lourmat firm (France). Relationships between the protein composition and other qualitative parameters of the wheat technological quality were statistically evaluated by the correlation analysis in the Statgraphics Plus, Version 5.1 programme, with the references of the statistical correlation coefficients demonstrated at the 0.05 significance level.

Table 1. Weather pattern at the Prague-Uhříněves Experimental Station and at the Stupice Breeding Station in the years 2003-2005, and the long-time average
1 lentelė. *Prahos Uhříněves bandymų stoties ir Stupice selekcijos stoties orai 2003-2005 metais ir daugiametis vidurkis*

Month *Mėnuo*	Monthly average temperature °C *Vidutinė mėnesio temperatūra °C*			Sum of precipitation mm *Kritulių kiekis mm*			Long-time average of temperature °C *Daugiametis temperatūrų vidurkis °C*	Long-time average of precipitation mm *Daugiametis kritulių vidurkis mm*
	2003	2004	2005	2003	2004	2005	1950-2000	1950-2000
January / *Sausis*	-0.66	-2.93	1.77	29.4	54.8	30.9	-2.1	28
February / *Vasaris*	-2.70	2.70	-1.94	5.3	25.1	47.3	-0.8	27
March / *Kovas*	5.40	4.25	3.17	7.9	42.4	14.2	3.4	31
April / *Balandis*	9.05	10.27	10.71	22.2	15.9	19.5	8.2	46
May / *Gegužė*	16.55	12.73	14.78	72.8	54.8	52.5	13.4	65
June / *Birželis*	20.97	17.04	17.86	30.9	90.2	62.4	16.3	74
July / *Liepa*	21.00	18.91	19.32	76.0	35.4	137.8	18.2	74
August / *Rugpjūtis*	21.82	19.82	17.20	26.5	56.6	68.5	17.5	72
September / *Rugsėjis*	14.48	14.39	15.64	37.3	43.2	50.0	14.0	49
October / *Spalis*	6.46	10.01	10.22	30.1	20.5	11.0	8.6	41
November / *Lapkritis*	5.18	4.68	3.16	7.2	68.7	15.7	3.2	34
December / *Gruodis*	0.91	0.78	0.35	33.2	12.6	38.2	-0.5	34

Results and Discussion

The obtained results (Tables 2 and 3) document the influence of organic and conventional ways of growing on the wheat grain storage proteins composition and technological quality characteristics, predicative partly of the protein quantity (total crude protein content and wet gluten content in the dry matter of grain), partly of the protein complex quality (sedimentation index by Zeleny, rheology characteristics determination on pharinograph and the yield of bread).

Regarding the contents of the LMW glutenins and gliadins we have uncovered considerable differences between those from organic and from conventional growing. Under the conditions of organic growing wheat was in its content a little bit higher compared with conventional wheat. In case of HMW glutenins, a considerably higher content was found in the conventionally grown wheat; while in case of organic wheat we recorded a considerably higher content of the most high-quality nutritional albumins and globulins.

Table 2. Selected qualitative parameters of wheat from the conventional and organic farming – harvests in 2004 and 2005

2 lentelė. *Įprastoje ir organinėje žemdirbystės sistemose užaugintų kviečių kokybės rodikliai (2004 ir 2005 metų derlius)*

Year *Metai*	Locality *Vietovė*	Quality group *Kokybės grupė*	Crude protein content in grain DM % *Žalių baltymų kiekis grūduose (SM) %*	Wet gluten content in grain DM % *Šlapiojo glitimo kiekis grūduose (SM) %*	Sedimentation index by Zeleny ml *Zeleny Sedimentacijos indeksas ml*	Pharinographic water absorption % *Farinografinė vandens absorpcija %*	Dough development time min. *Tešlos vystymosi laikas min.*	Dough stability time min. *Tešlos stabilumo laikas min.*	Degree of dough softening FU *Tešlos praskiedimo laipsnis FU*	Yield of bread (ml 100 g^{-1} of dough) *Duonos išeiga (ml 100 g^{-1} tešlos)*
2004	Conventional farming *Įprasta žemdirbystė*	E	9.52	23.32	33	55.25	1.50	3.75	95	342
		A	11.01	27.64	34	52.83	1.25	3.67	107	344
		B	11.65	27.75	25	52.93	1.75	4.33	87	331
		C	9.94	18.20	22	48.35	0.88	2.13	100	300
	Organic farming *Organinė žemdirbystė*	E	8.58	16.21	22	52.30	1.00	2.00	180	271
		A	8.27	16.81	20	51.90	1.00	2.33	147	290
		B	8.28	12.79	16	53.15	0.88	1.75	165	225
		C	7.61	10.84	12	50.84	0.85	1.65	174	238
2005	Conventional farming *Įprasta žemdirbystė*	E	11.95	22.64	30	63.50	1.25	3.75	100	358
		A	12.24	26.46	33	54.90	1.25	3.00	120	317
		B	11.42	24.39	29	32.66	1.00	3.25	150	265
		C	11.78	23.34	23	52.10	1.50	1.75	163	242
	Organic farming *Organinė žemdirbystė*	E	11.59	23.27	29	54.70	1.50	3.08	100	314
		A	10.94	22.91	35	35.85	1.17	3.58	120	292
		B	10.61	21.04	32	51.10	1.17	2.83	140	269
		C	10.10	19.28	18	50.90	1.13	2.33	147	251

Values in the Table are statistical means

Vertės, pateiktos lentelėje, yra statistiniai vidurkiai

Table 3. Electrophoretic analysis of storage proteins of wheat from the conventional and organic farming – harvests in 2004 and 2005
3 lentelė. *Atsarginių baltymų elektroforetinė analizė kviečių grūdų, užaugintų taikant įprastą ir organinę žemdirbystės sistemas (2004 ir 2005 metų derlius)*

Year *Metai*	Locality *Vieta*	Quality group *Kokybės grupė*	HMW glutenins % *DMM gliuteninai %*	LMW glutenins + gliadins % *MMM gliuteninai+ gliadinai %*	Residual albumins and globulins % *Liekamieji albuminai ir globulinai %*
2004	Conventional farming *Įprasta žemdirbystė*	E	28.74	67.19	4.06
		A	25.85	66.59	8.10
		B	25.82	69.07	5.11
		C	24.77	59.88	15.35
	Organic farming *Organinė žemdirbystė*	E	15.40	71.16	13.44
		A	10.66	69.86	18.81
		B	10.92	68.76	20.28
		C	7.73	67.71	24.50
2005	Conventional farming *Įprasta žemdirbystė*	E	34.90	62.34	2.75
		A	30.05	64.22	5.67
		B	23.60	70.51	5.53
		C	20.13	70.65	8.43
	Organic farming *Organinė žemdirbystė*	E	17.52	70.56	11.92
		A	14.78	69.90	14.02
		B	14.20	70.98	14.87
		C	10.88	70.78	18.40

Values in the Table are statistical means
Vertės, pateiktos lentelėje, yra statistiniai vidurkiai

These results are in accordance with the conclusions of Prugar (1980) and Graveland (1996), who found that nitrogen application generally increases the part of the protein fractions typical for gluten – glutenins and gliadins. Increasing the amount of these fractions in the total protein content leads to an improvement in the technological, especially baking, wheat quality, but also to a decrease in the biological and nutritional value of proteins, due to the reduction in the amino-acids content.

Except for the differences in the wheat grain storage proteins composition from organic and conventional growing we have recorded certain differences in the protein composition among the single varieties groups of quality. In both the conventional and organic way of growing the highest contents of HMW glutenins and at the same time the lowest contents of albumins and globulins were found in the varieties from the quality group "E" – elite, and the "A" – high-quality, and the lowest in the varieties from the quality group "C" – other, which is unsuitable for baking utilization. This supports the results of Michalík (1992), according to which the changes in the ratio of single protein fractions are affected. Not only by the total proteins content in wheat grain, but also by the genotype and results of Prugar (1999) and Capouchová (2003), who show that the varieties from the quality groups "E" and "A" being observed, have genetically dependent differences in the characters of the baking quality and act as technologically better, superior, while also using an ecological way of growing. The differences in the wheat grain storage proteins composition reflect also at the level of the technological quality parameters being assessed and in the correlation between them.

Table 4. Correlation analysis of selected qualitative parameters of wheat from the conventional and organic farming – harvests in 2004 and 2005
4 lentelė. *Kviečių grūdų, užaugintų įprastoje ir organinėje žemdirbystės sistemose, kokybės rodiklių koreliacinė analizė (2004 ir 2006 metų derlius)*

Trait *Savybė*	HMW glut. *DMM glut.*	LMW glut.+ gliad. *MMM glut.+ gliad.*	Alb.+ glob.	Protein content *Baltymų kiekis*	Gluten content *Glitimo kiekis*	Zeleny test *Zeleny testas*	Water absorption *Vandens absorbcija*	Dough development *Tešlos vystymasis*	Dough stability *Tešlos stabilumas*	Degree of softening *Praskiedimo laipsnis*	Yield of bread *Duonos išeiga*
HMW glut. *DMM glut.*	1										
LMW glut.+gliad. *MMM glut.+gliad.*	-0.36 -0.68*	1									
Albumins + globulins *Albuminai+ globulinai*	-0.78* -0.23	-0.62* -0.60*	1								
Protein content *Baltymų kiekis*	0.64* 0.29	0.29 0.25	-0.66* -0.52*	1							
Gluten content *Glitimo kiekis*	0.62* -0.11	0.31 0.48	-0.67* -0.48	0.85* 0.59*	1						
Zeleny test *Zeleny testas*	0.65* 0.44	0.36 -0.10	-0.76* -0.39	0.73* 0.18	0.73* 0..57*	1					
Water absorption *Vandens absorbcija*	0.27 0.27	0.05 0.27	-0.26 -0.63*	0.15 0.07	0.61* 0.16	0.20 0.34	1				
Dough development *Tešlos vystymasis*	0.54* 0.24	0.20 0.37	-0.58* -0.68*	0.67* 0.24	0.38 0.48	0.48* 0.41	-0.08 0.41	1			
Dough stability *Tešlos stabilumas*	0.50* 0.62*	0.29 -0.25	-0.59* -0.38	0.71* 0.34	0.56 0.48*	0.73* 0.47	0.14 -0.06	0.73* 0.70*	1		
Degree of softening *Praskiedimo laipsnis*	-0.44* -0.57*	-0.22 0.37	0.46* 0.29	-0.58 0.19	-0.26 -0.45	-0.49 -0.37	0.11 0.31	-0.77* -0.44	-0.67* -0.72*	1	
Yield of bread *Duonos išeiga*	0.53* 0.60*	-0.11 -0.23	-0.41 -0.38	0.42* -0.15	0.49* 0.20	0.43 0.55*	0.17 0.13	0.40 0.38	0.47 0.52*	-0.19 -0.73*	1

Statistically significant correlation, No1 - organic, No 2 - conventional
Statistiškai patikima koreliacija, Nr. 1 - organinė žemdirbystė, Nr.2 - įprasta žemdirbystė

Negative correlations were found between the HMW glutenins and LMW glutenis+gliadins. In case of the conventional way of growing the correlation was statistically significant and relatively close. In the organic way of growing the relation was statistically non-significant. Negative correlations were also found between albumins + globulins and HMW glutenins. In this case the organic way of growing was found statistically significant and relatively close to the correlation, while in the conventional way of growing the correlation was statistically non-significant. Statistically significant negative correlations were found again. This time in both ways of growing, between albumins + globulins and LMW glutenins + gliadins (Table 4). From our results (Table 2) it is evident that there is a considerable influence of conventional and organic way of growing on the total crude protein content and wet gluten content in the grain dry matter. The higher contents of the total crude protein and wet gluten in the grain dry matter have been confirmed also by Petr et al. (1998), Prugar, Štorková-Turnerová (1998) and Capouchová (2003) in their experiments with a set of organic and conventional wheat varieties. Between the total crude protein content and wet gluten content in the organic and conventional systems of growing, statistically significant positive correlations were found. Close relation was found in the case of the organic way of growing (Table 3). A positive correlation between the protein content and the wet gluten content is also described by Branlard et al. (1991) and Fredriksson et al. (1997).

Positive, statistically significant correlations were found between the total crude content, wet gluten content and the amount of LMW glutenins + gliadins as well as HMW glutenins. By contrast, statistically significant negative correlations were found between the total crude content and wet gluten content and the amount of albumins + globulins. These results are in accordance with the conclusions of Bushuk (1989a), Graveland (1996) and Michalík (1992), according to which the rising total crude protein content and wet gluten content in the dry matter of wheat grain increases the proportion of gliadins, glutenins and lowers the proportion of albumins and globulins.

Branlard et al. (1991), Šíp et al. (2000) and Capouchová (2003) mention the high genetic conditionality of Zeleny sedimentation index. Also, it is evident from our results that there are differences between the single qualitative groups and between the single assessed varieties. At the same time, the highest levels of sedimentation were reached in the index varieties from the quality groups “E” and “A” in both the conventional and the ecological ways of growing. The lowest levels of sedimentation index for the varieties from the quality group C were reached in both ways of growing

However, we also noticed, especially in the harvest year 2004, a relatively marked influence of the growing intensity (when comparing the organic and conventional ways). Overall, the lower levels of sedimentation index in the organically grown wheat are also mentioned by Petr et al. (1998) and Capouchová (2003) on the basis of their results.

From the classification of the relationships between the protein composition and sedimentation index by Zeleny, in both ways of growing the statistically significant positive correlations are evident between the sedimentation index by Zeleny and the amount of HMW glutenins, which are critical for gluten strength and elasticity. It is indicative, in accordance with the conclusions of Hanišová and Horčička (2002), that the sedimentation index by Zeleny is an indicator with a really very good predicate ability about the viscoelastic properties of the gluten proteins and about the wheat technological quality. A positive correlation between the HMW glutenins content and the gluten strength, and the classification by the sedimentation index was also found by Payne et al. (1987).

Positive, but statistically non-significant correlations were found in both ways of growing between the sedimentation index by Zeleny and the LMW glutenins + gliadins content. On the other hand, the correlations between the sedimentation index by Zeleny and albumins + globulins content were statistically significant and negative.

From the other assessed relations it is also necessary to talk about the statistically significant, positive correlations between the sedimentation index by Zeleny and the total crude protein content and wet gluten content in the grain dry matter which are, on the basis of their results, also described by Šíp et al. (2000) and Capouchová (2003).

The pharinographic data characterize the flour quality, for example the dough and dough tolerance on mechanical straining on the basis of the consistence change monitoring at plasticization under standard conditions. In pharinographic classification the conventionally grown wheat was better, and compared with organic wheat it reached a higher water absorption, longer time of dough stability and a lower degree of dough softening. Bigger differences in favour of the conventionally grown wheat were registered in the harvest year 2004 (Table 2). Better rheology characteristics of the conventionally grown wheat features are also mentioned by Capouchová (2003).

A statistically significant positive correlation was found and a non-significant correlation between the amount of the main gluten proteins fractions (HMW glutenins and LMW glutenins + gliadins) and water absorption, time of dough development and stability and by contrast, a statistically significant negative correlation between their pharinographic characteristics and the amount of albumins + globulins. In the case of a degree of the dough softening the result had an opposite character. These findings again confirm the opinions of Bushuk (1989b), Bushuk and Bekes (2002), and Novotný and Jurečka (2000) about the critical role of gliadins and glutenins in the formation of dough viscoelastic properties while the influence of albumins and globulins on the dough quality is rather negative /Bushuk, 1989a/.

Furthermore, we recorded a positive, mostly statistically significant correlation between the time of the dough stability and the dough development as well as the total crude content, wet gluten content and the sedimentation index by Zeleny. Statistically significant positive correlation coefficients between these parameters were also found by Branlard *et al*. (1991), Hubík (1995) and Capouchová (2003). Additionally, they also recorded a statistically positive correlation between the total crude protein content, wet gluten content, sedimentation index and the water absorption. On the other hand, Fredriksson et al. (1997) comments, that in accordance with our results, the correlation between the water absorption and protein content were non-significant. Between the degree of dough softening and other assessed parameters of the technological quality the negative correlation predominates. Statistically significant negative correlations between the degree of dough softening and other rheology characteristics and the total crude protein content, wet gluten content and the sedimentation index were also shown by Hubík (1995) and Capouchová (2003).

The baking test is the final direct indicator of the wheat baking quality. According to Hanišová and Horčička (2002) in general, the yield of bread significantly correlates with the sedimentation index, rheology characteristics and the point value of glutenins spectra. A statistically significant positive correlation between the yield of bread and the amount of HMW glutenins was shown by our results as due to the conventional and organic ways of growing. On the other hand, the relationship between the average yield of bread and the amount of the LMW glutenins + gliadins and albumins + globulins was negative. We found a mostly statistically significant positive correlation between the yield of bread and total crude protein content, wet gluten content, water absorption, time of dough development and the time of dough stability. The correlation was negative between the yield of bread and degree of dough softening.

Conclusions

1. Our results show a noticeable influence of organic and conventional ways of growing on the wheat grain storage proteins composition and the technological quality characteristics, predicative partly of the protein quantity (total crude protein content and wet gluten content in the dry matter of grain), partly of the protein complex quality (sedimentation index by Zeleny, rheology characteristics determination on pharinograph and the yield of bread).

2. Varieties with higher content of HMW glutenins (varieties from the "E" and "A" quality groups), which are the most suitable for baking utilization – for making products from proofing dough, reached higher values of pharinographic water absorption, longer dough development time, longer dough stability time and lower values of the softening degree.

3. Varieties from the "C" quality group (unsuitable for baking utilization) reached worse values of the rheology characteristics and these varieties were mainly characterized by the higher content of LMW glutenins, gliadins and with the higher content of valuable nutritional albumins and globulins.

4. This trend was noticed in the wheat varieties from both systems of growing – organic and conventional ways of growing, when the varieties from the "E" and "A" quality groups retained their better baking quality even under the conditions of organic growing, while the varieties from the "C" quality group attained worse baking quality and higher nutritional quality under both ways of growing.

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ŽIEMINIŲ KVIEČIŲ, AUGINTŲ TAIKANT ORGANINĘ IR ĮPRASTĄ ŽEMDIRBYSTĖS SISTEMAS, BALTYMŲ SUDĖTIS IR KOKYBĖ

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Santrauka

Tyrimai daryti dvejus metus ir įvertinti ryšiai tarp grūdų baltymų sudėties ir kviečių kokybės rodiklių rinkinyje veislių iš įvairių kokybės grupių ir užaugintų taikant įprastą ir organinę žemdirbystės sistemas. Rezultatai rodo organinės ir įprastos žemdirbystės įtaką grūdų atsarginių baltymų sudėčiai ir technologinei kokybei. Veislės, turinčios didesnį kiekį didelės molekulinės masės (DMM) gliuteninų (kokybės grupė E – elitinė, pati tinkamiausia naudoti kepimui, A – aukšta kokybė) pasiekė geresnius reologinės charakteristikos ir kepimo kokybės rodiklius. Veislės iš C kokybės grupės (kitos – kviečiai netinkami kepimui) pasižymėjo didesniu mažos molekulinės masės (MMM) gliuteninų ir gliadinų kiekiu ir didesniu vertingų maistinių albuminų ir globulinų kiekiu. Ši tendencija buvo pastebėta kviečių veislėse iš abiejų auginimo sistemų.

Reikšminiai žodžiai: žieminių kviečių kokybė, baltymų sudėtis, organinė žemdirbystė, įprasta žemdirbystė.

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