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SOME CORRELATIONS BETWEEN PARAMETERS OF WINTER WHEAT TECHNOLOGICAL QUALITY

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Abstract

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The results of three-year trials (1999 to 2001) conducted with six winter wheat varieties in which was studied the grain yield and parameters of technological quality. Varieties of wheat come from four different localities of the Czech Republic. The most favourable weather conditions, a lot of precipitation and high temperature in the course of ripening from three years were proved in the year 2000. The best grain yield were in 2001 (average of sites 8.84 t/ha) and variety Semper, worst quality, had the highest grain yield of 9.17 t/ha, the least grain yield had Sulamit, best quality (7.94 t/ha). The laboratory analysis revealed negative correlation between grain yield and baking quality. The number of statistically highly significant correlations among bread-making quality parameters too.
The negative correlation was of grain yield and grain volume mass ($P < 0.05$), Zeleny test and protein content taken as a whole for three years ($P < 0.01$).
The correlation of loaf volume, which is the traits of baking quality and Zeleny test (r = 0.6016**), protein content (r = 0.5932**), dough stability (r = 0.2898**) and flour water absorption (r = 0.3632**) was positive ($P < 0.01$).

wheat, technological quality, correlation

The technological quality of wheat is to a great extent total concept, which cannot be specify by one of performance criterion.

The relatioships between quality parameters of wheat varieties to varying extent were described by Branlard et al. (1991), Muchová (2001), Werteker (2003), Zimolka et al. (2005). The results of these investigations showed that environments have an influence on quality traits, and in some conditions the direction of influence on the trait is known.

The aim of this contribution is to highlight those criteria which clearly describe the correlations in the set of the investigated parameters for the selected varieties, sites and years.

MATERIALS AND METHODS

Six varieties of winter wheat with different quality levels were included in this investigation. There are varieties Ebi and Ludwig (E – elite), Sulamit, Nela (A – good quality), Vlasta (B – standard), Semper (C – undersirable baking quality). Field trails were carried out during 1999–2001. The selected set of wheat varieties comes from different localities of the Czech Republic. **Chrlice** – the site is 190 m above the sea level. Type of soil is eutric fluvisol, the sort of soil is loamy (medium). **Jaroměřice** – the site is 425 m above the sea level. The soil type is orthic luvisol, sort of soil clayey-loam (heavy). **Sedlec** – the site is 300 m

above the sea level. The soil type is orthic luvisol haplic chernozem, the sort is loamy soil (medium). **Žatec** – the site is 285 m above the sea level. The soil type is orthic luvisol haplic chemozem, the sort of soil is clayey – loam (heavy).

Wheat grain samples used for laboratory evaluation were obtained from variety test stations of the Central Institute for Supervising and Testing.

Characteristics of climatic conditions on the sites for 1999–2001: average year temperature and average year sums of precipitation – Chrlice +8.8 °C and 512 mm, Jaroměřice +7.8 °C and 487 mm, Sedlec +8.2 °C and 501 mm, Žatec +8.3 °C and 451 mm. The course of the weather (temperatureas and precipitations) is given in Tab. I and Tab. II.

We evaluated 17 characteristics, which represent technological quality (milling and baking) in wheat. The evaluation methods included the common ones for determination of test weight – grain volume mass (g/l), thousand grain weight (g), ash content of flour T-550 (%), percentage of complete grains (%), extraction of flour T-550 (%) milling on Chopin mill. From the chemical and physical analytical methods, were used standard methods of determination of the dry matter (%), wet gluten content in the whole grain meal (%), gluten swelling (cm^3), protein content (crude protein, CP) after Kjeldahl (%), rapid assesment methods as SDS- test (ml), Zeleny sedimentation test (ml) and falling number (s); furthermore the determination of farinograph parameters: dough developememt time (min), dough stability (min), softening degree after 12 minutes (FJ), flour water absorption capacity (%) and baking test (Rapid Mix Test) – parameter loaf volume (ml/100g of flour) were carried out.

Numerical results obtained were processed by a correlation analysis to find out correlations between the traits of grain quality.

RESULTS AND DISCUSSION

To observe potential relationships between individual parameters, the correlation analysis by Pearson was used (Tab. III) which suggested a lot of significant correlations. Most of all, the highly significant positive correlation ($P < 0.01$) were observed beetwen **grain volume mass** and the following parameters: a percentage of complete grains, extraction of flour T-550, the same results describe Pelikán (1989), Muchová (2003). The bigger grain has a part of endosperm and then more extraction of flour. The highly significant positive correlation ($P < 0.01$) was observed beetwen grain volume mass and flour water absorption capacity and negative to farinograph parameters.

A statistically significant positive correlation was found between **thousand grain weight** and ash content ($P < 0.05$). Also a negative correlation between wet gluten content ($P < 0.01$) and protein content ($P < 0.05$) was demonstrated. Thousand grain weight was, beside percentage of complete grains and falling number, one of the traits for which a greater variety specificity of relations and relatively smaller degree of dependence on other grain quality traits was characteristic. Similar conclusions were drawn also by Šíp et al. (2000).

In **ash content** statistically significant positive dependence on extraction of flour T-550 and flour water absorption capacity was observed, whereas the correlation between other traits was either negative or non-significant.

An interesting result is a highly significant positive correlation ($P < 0.01$) between **percentage of complete grains** which is a milling criterion, and the loaf volume, whereas a correlation between other traits, except grain volume mass, is non-significant.

A highly significant positive correlation-effect was found for **wet gluten content** and the value of SDS-test, sedimentation test according to Zeleny and protein content which was described also by Šíp et al. (2000). A similar positive significant correlation ($P < 0.01$) between loaf volume and reologic dough properties was reported, e.g. by Schober and Kuhn (1999).

Both the **sedimentation tests** showed a highly significant correlation for loaf volume and crude protein content. These close positive correlations between loaf volume yield were confirmed by both the sedimentations tests, protein content and reologic properties of dough as reliable traits of baking quality of wheat, which was demonstrated by many researchers (Schober and Kuhn, 1999; Jandásek, Pelikán, 2002 and others).

CP content showed a highly significant positive correlation for reologic properties, sedimentation tests, wet gluten content and loaf volume, which was also reported by Martini and Kuhn (1999).

A statistically significant negative correlation between the **falling number** value and softening degree was observed. Higher values of falling number indicates lower activity of amylases and therefore this correlation is expected. However, a negative correlation between falling number and percentage of complete grains reported by Šíp et al. (2000) could not be confirmed. On the contrary, in our trials we observed that the falling number positively correlates between flour water absorption capacity ($P < 0.05$). Another correlation was not found for this quality parameter, which can be explained by the fact that falling number has no direct linkage with wheat protein and to a significant extent it is affected by weather conditions (Meyer, 1999).

In dough development and **dough stability** highly significant positive correlations between loaf volume

were observed, among others, and on the other hand negative correlations between degree of dough softening, which is in agreement with the positive reologic evaluation.

Loaf volume showed a highly significant correlation with gluten content, protein content, sedimentation tests, reologic dough properties and flour water absorption capacity (Fig. 1), which are the traits of baking quality, but also with percentage of complete grains which belongs to the milling quality criteria.

The highest **grain yield** was achieved with the Semper variety of undesirable baking quality (C) (average 9.17 t/ha), the standard Vlasta variety (B) was placed the second, whereas the lowest values were obtained with the elite varieties (E) Sulamit (7.94 t/ha) and Ebi (8.19 t/ha).

High baking quality of grain is negatively correlated with grain yield, which was described also by many authors (e.g. Muchová, 2003). There is a very strong negative link between grain yield and protein content and Zeleny test (Fig. 2). High yield does not necessary indicates low quality and low yield high quality.

I: *Percentages of the precipitation normal in the period (April – August), in sites Chrlice (A), Jaroměřice (B), Sedlec (C), Žatec (D) (evaluated according to WHO method, Kožnarová and Klabzuba 2002)*

Month	Precipitation normal (mm)				Percentage of precipitation normal																					
					1999								2000								2001					
	A	B	C	D	A		B		C		D		A		B		C		D		A		B		C		D	
April	27	31	39	29	50	bn	72	n	25	vbn	88	N	8	ebn	21	vbn	13	ebn	36	vbn	39	vbn	65	n	81	n	52	bn
May	61	59	70	56	25	vbn	55	bn	24	vbn	25	vbn	30	vbn	31	vbn	42	vbn	46	vbn	21	vbn	37	vbn	50	vbn	41	vbn
June	74	68	77	57	48	vbn	47	vbn	50	bn	60	bn	7	ebn	8	ebn	39	vbn	34	vbn	17	ebn	33	vbn	25	vbn	28	vbn
July	86	66	73	77	47	bn	79	n	55	bn	42	bn	67	n	68	n	43	bn	34	vbn	25	vbn	52	bn	74	n	51	bn
August	62	69	77	54	24	vbn	52	bn	10	ebn	37	bn	28	bn	36	bn	15	ebn	38	vbn	60	bn	40	vbn	26	vbn	44	bn

ebn – extraordinary below normal, vbn – very below normal, bn – below normal, n – normal, an – above normal, van – very above normal, ean – extraordinary above normal

II: *Deviation of the temperature normal in the period (Apríl – August), in sites Chrlice (A), Jaroměřice (B), Sedlec (C), Žatec (D) (evaluated according to WHO method, Kožnarová and Klabzuba 2002)*

Month	Temperature normal (°C)				Deviation of temperature normal (°C)																					
					1999								2000								2001					
	A	B	C	D	A		B		C		D		A		B		C		D		A		B		C		D	
April	9.1	8.0	8.4	8.4	1.3	n	1.6	an	1.3	n	1.5	n	3	van	4	van	3.6	van	3.6	van	–2	bn	–0.5	n	0.2	n	–0.6	n
May	14.1	13.0	13.4	13.2	0.5	n	1.1	n	1.2	n	2.5	an	1.1	n	2.8	van	3.1	van	3.8	van	1	n	2.3	an	2.1	an	2.6	van
June	14.6	16.0	16.6	17.0	3.2	ean	0.4	n	–0.9	n	0	n	3.8	ean	2.8	ean	1.9	an	3	ean	0.4	n	–1.2	bn	–1.1	bn	–1	n
July	16.3	18.0	13.4	18.3	3.4	ean	1.4	an	6.2	ean	2.5	van	–0.1	n	–1	n	3.5	ean	–1	n	2.9	ean	1	n	5.9	ean	2.2	van
August	18.1	17.0	18.1	18.1	–0.7	bn	0.5	n	0	n	0.6	n	1.7	van	3.3	ean	2.4	van	2.7	ean	1.3	an	2.5	van	1.8	an	2.2	van

ebn – extraordinary below normal, vbn – very below normal, bn – below normal, n – normal, an – above normal, van – very above normal, ean – extraordinary above normal

III: *Correlations (r by Pearson) between the traits of grain quality*

Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	****															
2	0.0211	****														
3	0.2639*	0.2521*	****													
4	0.3501**	0.1791	–0.1149	****												
5	0.5849**	0.0283	0.2725*	0.0982	****											
6	–0.0530	–0.2958**	–0.2438*	–0.1504	–0.0310	****										
7	–0.0657	–0.1420	–0.2285*	–0.0847	–0.0299	0.1607	****									
8	–0.2353	0.0508	–0.3669**	0.0763	–0.3434**	0.3727**	0.2572*	****								
9	0.2085	–0.0877	0.0202	0.0159	–0.0420	0.5094**	0.0185	0.6714**	****							
10	–0.1425	–0.2475*	–0.3023**	–0.0788	–0.1498	0.8008**	0.1917	0.6934**	0.8225**	****						
11	0.0272	0.0547	0.0467	–0.1471	–0.0325	0.1188	–0.0272	0.1730	0.1812	0.1023	****					
12	–0.3197**	–0.0555	–0.2402*	–0.0356	–0.3191**	0.4265**	0.4342**	0.4857**	0.6141**	0.6669**	0.0610	****				
13	–0.4978**	–0.0486	–0.4066**	–0.0143	–0.6796**	0.2328*	0.2270*	0.5125**	0.4663**	0.4619**	0.1779	0.5350**	****			
14	0.4549**	0.1057	0.4074**	0.1290	0.5102**	–0.4194**	–0.2965**	–0.6039**	–0.7036**	–0.6753**	–0.2658*	–0.7524**	–0.8646**	****		
15	0.3165**	–0.0316	0.4987**	–0.0102	0.2516*	0.1890	–0.1677	0.0462	0.6656**	0.2899**	0.2099*	0.1571	–0.1501	–0.0406	****	
16	–0.0349	–0.1277	–0.1221	0.2895**	–0.0166	0.4244**	–0.0184	0.5757**	0.6016**	0.5932**	0.0101	0.3919**	0.2898**	–0.3679**	0.3632**	****

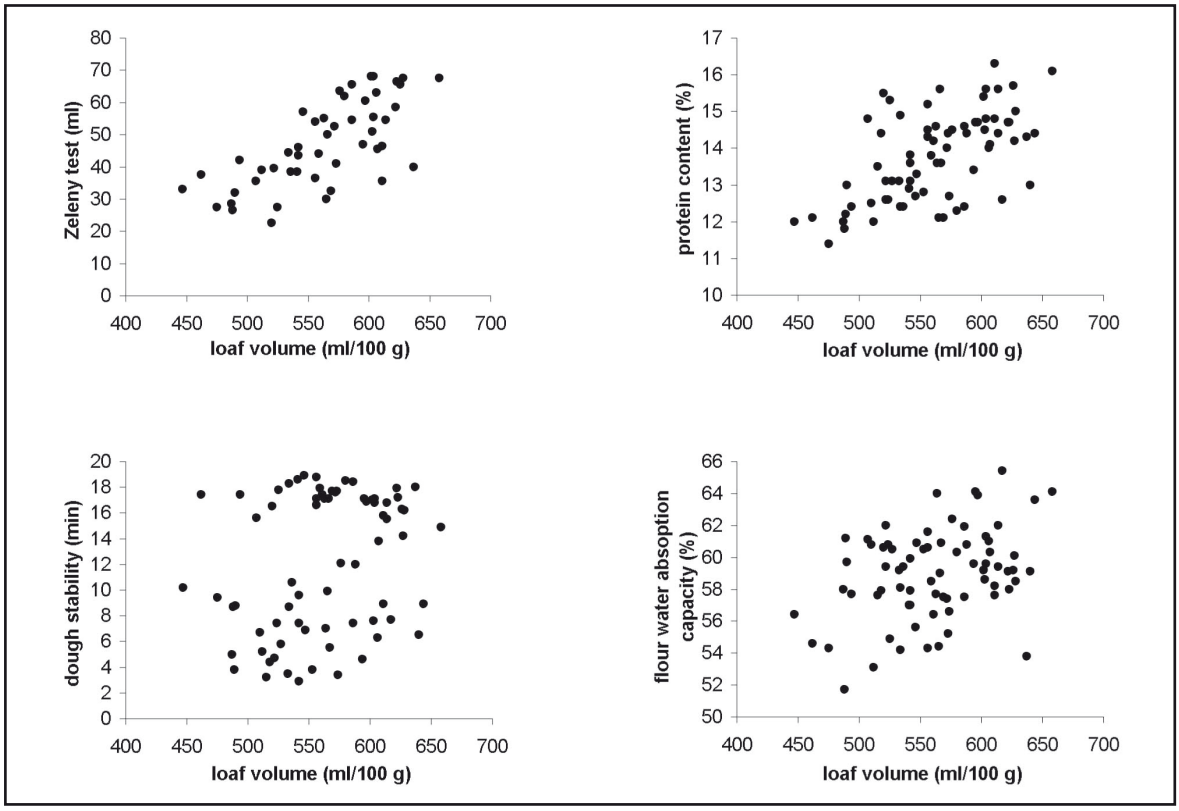
* indicate significance at P < 0,05

** indicate significance at P < 0,01

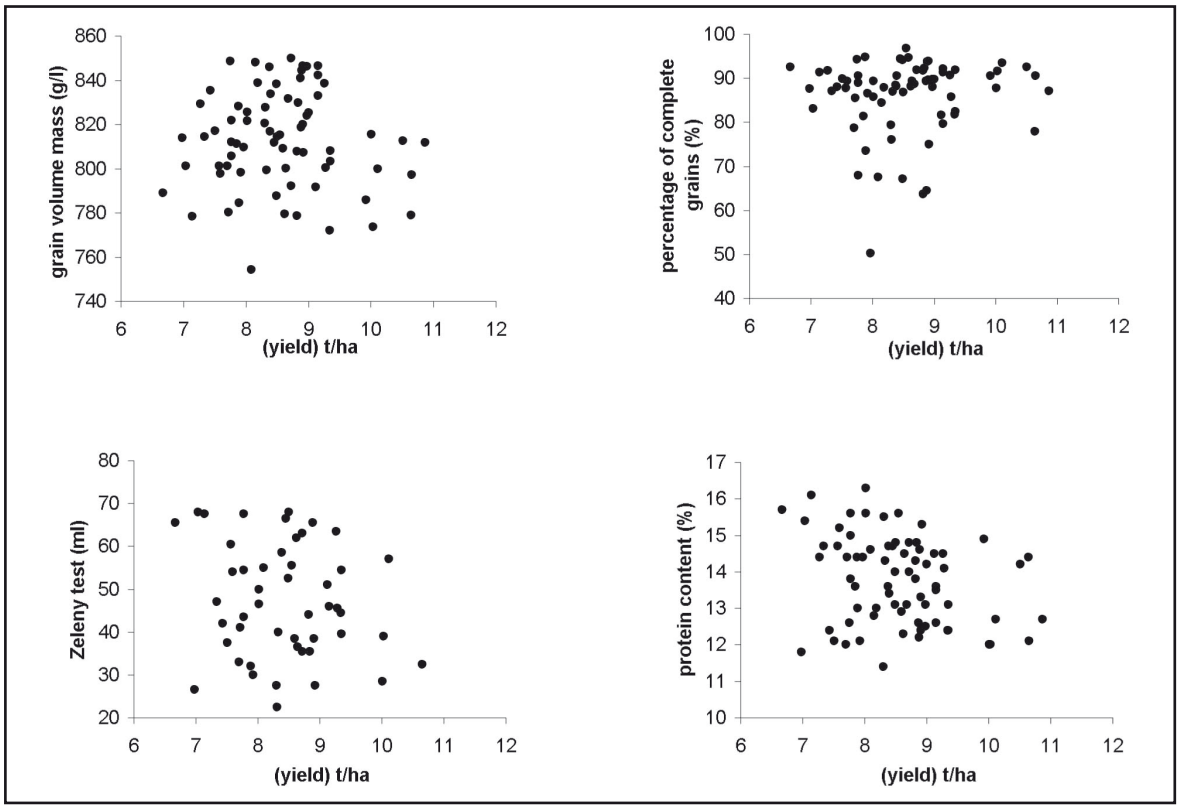
– * (–**) indicate negative significance

n = 72

1 – test weight (grain volume mass) 2 – thousand grain weight, 3 – ash content, 4 – percentage of complete grains, 5 – extraction of flower T-550, 6 – wet gluten content, 7 – gluten swelling, 8 – SDS- test, 9 – Zeleny sedimentation test, 10 – protein content, 11 – falling number, farinograph parameters (12 – dough developement time, 13 – dough stability, 14 – softening degree after 12 minutes, 15 – flour water absorption capacity), 16 – loaf volume



1: *Relationship between loaf volume and traits of baking quality (Zeleny test, protein content, dough stability, flour water absorption capacity)*



2: *Relationship between yield and grain volume mass, percentage of complete grains, Zeleny test, protein content*

SOUHRN

Některé korelace mezi kritérii technologické jakosti pšenice

U šesti odrůd ozimé pšenice v průběhu tří let (1999 až 2001) byl sledován výnos zrna a kritéria technologické jakosti. Pšenice byla pěstována na čtyřech rozdílných stanovištích. Nejpříznivější povětrnostní podmínky z hlediska jakosti, hodně srážek a vysoké teploty při dozrávání byly zaznamenány v roce 2000. Nejvyšší výnosy dosáhly odrůdy v roce 2001, průměr stanovišť byl 8,84 t/ha. Za celé sledované období měla nejvyšší výnos odrůda Semper s nejnižší pekařskou jakostí (průměr 9,17 t/ha) a nejnižší výnos odrůda Sulamit s nejlepší pekařskou jakostí (průměr 7,94 t/ha).

Mezi jednotlivými sledovanými znaky byly stanoveny vzájemné korelace, které ukázaly na významné závislosti mezi jednotlivými parametry technologické jakosti. V souhrnu tří let byl zjištěn negativní korelační vztah mezi výnosem zrna a objemovou hmotností ($P < 0,05$), Zeleny testem i obsahem bílkovin ($P < 0,01$).

Korelační vztah mezi měrným objemem pečiva, stěžejním ukazatelem pekařské jakosti a Zeleny testem (r = 0,6016**), obsahem bílkovin (r = 0,5932**), stabilitou těsta (r = 0,2898**) a vazností mouky (r = 0,3632**) byl pozitivní ($P < 0,01$).

pšenice, technologická jakost, korelace

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REFERENCES

BRANLARD, G. et al.: Comparison of 46 technological parameters used in breeding for bread quality evaluation. J. of Genet. and Breed., 1991, 45: 263–279.

JANDÁSEK, J., PELIKÁN, M.: Vzájemný vztah kritérií pro rychlou specifikaci pekařské jakosti pšenice. Acta univ. agric. et silvic. Mendel. Brun., 2002, I. No.1, pp. 173–178.

KOŽNAROVÁ, V., KLABZUBA, J.: Recommendation of World Meteorological Organization to describing meteorological or climatological conditions. Rostl. Výr., 2002, 48, 190–192.

MARTINI, A., KUHN, M.: Eifluss der Stickstoffdüngung auf die Zusammensetzung und die Eigenschaften von Dinkelproteinen. Getreide, Mehl und Brot, 1999, 3, 282–290.

MEYER, D.: Verarbeitungsqualität neuer Weitzensorten 1998. Getreide, Mehl und Brot, 1999, 1, 3–7.

MUCHOVÁ, Z.: Faktory ovplyvňujúce technologickú kvalitu pšenice a jej potravinárske využitie. Nitra, SPU, 2001, 112. ISBN 80-7137-923-9.

MUCHOVÁ, Z.: Changes in technological quality of food wheat in a four crop rotation. Plant, Soil and Environment, 2003, 49, 146–150.

PELIKÁN, M.: Odběr živin ve vztahu k jakosti ozimé pšenice. Rostl.Výr., 1989, 35, 647–654.

SCHOBERT, T., KUHN, M.: Einsatz von Kapillarelektrophorese und Fundamental rheologischen Methoden in der Sortendifferenzierung bei Dinkel. Getreide, Mehl und Brot, 1999, 3: 169–176.

ŠÍP, V. et al.: Effect of cultivar and cultural practices on grain yield and bread-making quality of winter wheat. Rostl. Výr., 2000, 46: 159–167.

WERTEKER, M.: Beziehungen zwischen Qualitätsparametern des Weizens an Hand von Ergebnissen aus der österreichischen Sorten wertprüfung. Getreide, Mehl und Brot, 2003, 57, 140–145.

ZIMOLKA, J. et al.: Pšenice pěstování, hodnocení a užití zrna, 1. vyd. Praha: Profi Press, 2005, 180 s. ISBN 80-86726-09-6

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