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Research paper

TECHNOLOGICAL QUALITY OF WHEAT CULTIVARS FROM NEW BREEDING PROGRAM (ZVEZDANA AND NS3-5299/2) AND COMPARISON TO THE TECHNOLOGICAL QUALITY OF WHEAT CULTIVARS COMMONLY USED IN AGRICULTURAL PRACTICE (NS RANA 5, LJILJANA, POBEDA AND EVROPA 90)

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ABSTRACT: Common wheat (*Triticum aestivum*) is one of the most important food crops. For this reason at cereals industry has been a long history of using descriptive empirical measurements of rheological properties to predict bread-making quality. In this paper technological quality and rheological properties of two wheat cultivars from new breeding program and (Zvezdana and NS3-5299/2) were examined by using traditional and new equipment in Serbian practice and compared with wheat cultivars which have been used in agricultural practice for more than a decade (NS Rana 5, Ljliljana, Pobeda and Evropa 90). Extensograph exstensibility of new cultivars, Zvezdana and NS3-5299/2 were in the level of the best results of commercial cultivars. However, extensigraph resistance of these cultivars was low which influenced that complex property such as extensigraph ratio was also poor, but still in the range which allows good breadmaking quality Moreover, according to alveograph properties, only the new cultivar NS3-5299/2 out of all investigated cultivars under the applied production conditions fulfilled the international standards required for export and trading goods.

Keywords: *technological quality, rheological properties, wheat cultivars*

INTRODUCTION

Wheat quality is assessed on the basis of physical, chemical, rheological and baking tests (Prabhasankar, 2002). Within the cereals industry there has been a long history of using descriptive empirical measurements of rheological properties, with an impressive array of ingenious devices such as amylograph, farinograph, mixograph, extensigraph (Dobraszczyk & Morgenstern, 2003) and Viscograph (Bhattacharya & Corke, 1996) produced by several well known laboratory equipment manufacturers.

Amylograph and viscograph measure apparent viscosity and gelatinisation temperature, while farinograph and mixograph determine mixing time, torque and apparent viscosity (Dobraszczyk and Morgenstern, 2003, Official Brabender web-site). Mixolab®, a new instrument developed by Chopin Technologies Company, has the capabilities to measure physical dough pro-

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perties such as dough strength and stability, but it also measures the pasting properties of starch on actual dough. It is used to characterize the rheological behaviour of dough subjected to a dual mixing and temperature constraint (Kahraman et al., 2008). Since it is a new instrument the information related to its utilization on different aspects of wheat flour quality is quite limited (Manthey et al., 2006).

The rheological properties of wheat-flour dough, among other parameters, include the extensibility and resistance to extension, which influence the processing behaviour very strongly, and are thus important factors of the wheat varieties' bread-making quality (Ma et al., 2005). A lot of researchers in wheat quality studies have been using instruments recording the extension behaviour of wheat dough, primarily Brabender Extensograph as an empirical rheological method for dynamic measurements and uniaxial extension of wheat flour (Ktenioudaki, et al., 2010a,b; Grausgrubera, H., 2000). On the other hand, Chopin's instrument Alveograph determines the biaxial extension produced during dough bubble inflation which is well linked from a physical view point with the process of stretching of dough (Indrani et al., 2007). Furthermore, this device has been used to evaluate bread making quality of wheat flours (Chen & D'Appolonia, 1985), cookie making quality (Bettge et al., 1989) and to assess the quality characteristics of wheat flour for parotta making (Indrani et al., 2007).

Since varietal surveys provide information about potential end-use quality of wheat, resistance to diseases, yield potential, environment variation in bread quality etc., during last centuries many researches performed numerous investigations. Sreenivasan (1974) evaluated the influence of rainfall on the wheat varieties grown at Jalgaon and Niphad (Maharashtra State) for a period of 22 years. Ghaly & Taylor (1982) examined quality effects of heat treatment of two wheat varieties, as part of a research programme on the thermal disinfestation of wheat and Reynolds et al. (1994) investtigated yield potential in modern wheat varieties. Several authors evaluated different effects of wheat varieties on bread-making properties (Khelifi & Branlard, 1992, Magnus et al., 1995; Hrušková et al., 2005; Ktenioudaki et al., 2010b). Finally, Ktenioudaki et al. (2010) used the rheological properties to discriminate among the wheat varieties from a range of geographical regions and to predict their potential for bread-making and Grausgruber et al. (2010) investigated stability of breadmaking quality of Austrian-grown quality wheats.

The aim of this paper was to examine rheological properties of six wheat cultivars of which four have been used in agricultural practice for more than ten years and two new varieties and to compare the results in order to find out if important improvements can be expected in new breeds.

MATERIAL AND METHODS

Four wheat cultivars (NS Rana 5, Ljliljana, Pobeda and Evropa 90) which have been used in agricultural practice for more than ten years and two new varieties (Zvezdana and NS3-5299/2) were examined. All six wheat varieties were cultivated at the Institute of Field and Vegetable Crops, Novi Sad, Department of Small Grains in microtrials and harvested in 2009.

Bühler laboratory mill MLU-202 was used for milling of samples of wheat cultivars. Rheological properties of wheat flour using Brabender farinograph, amylograph and extensigraph were determined according to the methods from the Regulation on methods of physical and chemical analysis for quality control of grain, milling and bakery products, pasta and quickly frozen dough – Pravilnik o metodama fizičkih i hemijskih analiza za kontrolu kvaliteta žita, mlinskih i pekarskih proizvoda, testenina i brzo smrznutog testa (Sl. List SFRJ br. 74/1988). Examination of rheological properties of wheat flour using Chopin Alveograph was performed according to ICC method No. 121.

Mean values of extensograph (duplicate measurements) and alveograph (quintuple measurements) properties, were tested by ANOVA, whereas differences among individual mean values were determined by *Duncan* test at significance level of 0.05. Software *STATISTICA* 9.0 was used for statistical calculations.

RESULTS AND DISCUSSION

Having in mind that the comparison between new and widely grown wheat varieties presented in this paper is per-

fomed on the basis of micro level tests conducted in one year, the first step in evaluation of the results was the comparison of obtained values for well known commercial varieties with multiannual average. Comparison of some rheological properties over multiannual period for old varieties (macro-level tests) published by Šarić et al. (2003; 2005) with the results from this study (micro-level tests) is presented in Table 1.

Table 1.
Comparison of multiannual ranges published for old varieties with the results from this study

			Water absorption (%)	Quality number	Quality level	Energy (cm^2)	Ratio (resistance / extensibility)	Viscosity peak values (BU)
Pobeda	multiannual (Šarić et al., 2003)	min	57.7	70.6	A-2	23	0.82	286
		max	60.7	78.0	A-2	55	1.87	650
	this study		66.1	62.0	B-1	66	1.35	255
Ljiljana	multiannual (Šarić et al., 2005)	min	58.4	57.9	B-1	41	1.03	853
		max	58.9	64.5	B-1	59	1.53	1733
	this study		61.9	64.7	B-1	59	1.19	640
NS Rana 5	multiannual (Šarić et al., 2003)	min	55.3	47.1	B-2	37	1.24	419
		max	57.0	68.8	B-1	65	1.91	1500
	this study		62.2	70.2	A-2	128	1.38	750
Evropa 90	multiannual (Šarić et al., 2003)	min	57.7	66.7	B-1	17	0.67	788
		max	59.1	68.3	B-1	59	1.91	1500
	this study		61.0	77.4	A-2	95	1.34	1250

According to the presented values, farinograph water absorption of all four wheat cultivars from micro-scale test was higher than maximal values from the multiannual ranges. The same trend was observed for extensograph energy values of wheat varieties from micro scale test. The reasons for these differences were probably better agricultural effect of micro-level tests in comparison to macro-level tests. However, the results of farinograph quality number and quality level were in the range of multiannual results, while amylograph viscosity peak values of Pobeda and Ljiljana varieties were below the minimal results of multiannual ranges. Cause for low values of amylograph viscosity peak could be germination as a result of rain prior to harvest or water imbibitions of harvested grain (Mares & Mrva, 2008) which could be expected in harvest 2009 due to surplus of rain.

In the second step of results evaluation, rheological properties determined for common, widely grown varieties were compared with new emerging varieties. Comparison of farinograph, extensograph and amilograph measurements are presented in Table 2.

Table 2.
Comparison of technological quality between commercial and new varieties

	Pobeda	Ljiljana	Evropa 90	NS Rana 5	Zvezdana	NS3-5299/2
FARINOGRAPH						
Water absorption (%)	66.1	61.9	61.0	62.2	64.3	65.3
Dough development (min)	2.5	3.5	3.0	2.5	3.5	2.5
Dough stability (min)	1.0	1.5	6.0	3.5	1.0	3.0
Dough softness (BU)	75	70	45	65	70	40
Quality number	62.0	64.7	77.4	70.2	60.2	74.9
Quality class	B-1	B-1	A-2	A-2	B-1	A-2
AMYLOGRAPH						
Viscosity peak values (BU)	255	640	1250	750	370	1220
EXTENSOGRAPH						
Energy (cm^2)	66^{ab}	59^{a}	95^{c}	128^{d}	82^{bc}	98^{c}
Resistance (BU)	210^{b}	190^{a}	240^{c}	270^{d}	195^{ab}	205^{ab}
Exstensibility (mm)	158^{a}	160^{a}	180^{b}	195^{bc}	193^{bc}	204^{c}
Ratio (resistance / exstensibility)	1.35^{c}	1.19^{b}	1.34^{c}	1.38^{c}	1.01^{a}	0.99^{a}

The values were expressed as mean value of two independent measurements for extensigraph.

Mean values of examinated quality parameters denoted with the same letter in a raw were not statistically significant differrence (P<0.05).

Farinograph water absorptions of two new varieties (Zvezdana and NS3-5299/2) were in the range of the water absorption of Pobeda cultivar, which were the highest among all varieties widely spread in agricultural practice. These two cultivars showed also the same trend for extensigraph extensibility which was on the same level as the best among the tested commercial varieties, NS Rana 5. Furthermore, NS3-5299/2 cultivar possessed the highest extensograph extensibility and the lowest dough softness among all examined wheat samples (Table 2). However, extensigraph resistance of Zvezdana and NS3-5299/2 varieties were statistically similar (p<0.05) with extensograph resistance of Pobeda and Ljiljana cultivars which showed significantlly lower values (p<0.05) for this rheological property in comparison to Evropa 90 and NS Rana 5 (Table 2). Extensigraph resistance and extensibility of new varieties influence that complex property such as extensograph ratio which was statistically lower (p<0.05) from those of all varieties from agricultural practice, but in the range which allow good breadmaking quality. Amylograph viscosity peak value of Zvezdana variety was on the same level as Pobeda cultivar which was the lowest as compared to the commercial varieties (Table 2).

Comparison of alveograph properties of new cultivars with commercial varieties is presented in Table 3.

Table 3.
Comparison of alveograph parameters between new and commercial varieties

	Pobeda	Ljiljana	Evropa 90	NS Rana 5	Zvezdana	NS3-5299/2
P, dough tenacity (mmH2O)	95^{d}	59^{a}	114^{e}	69^{b}	92^{d}	78^{c}
L, curve length (mm)	75^{a}	110^{b}	64^{a}	103^{b}	66^{a}	105^{b}
G, swelling index (ml)	19.2^{a}	23.2^{b}	17.7^{a}	22.6^{b}	18.0^{a}	22.7^{b}
W, deformity work (10^{-4} J)	237^{bc}	194^{a}	255^{c}	234^{bc}	212^{ab}	289^{d}
Ratio P/L	1.28^{c}	0.54^{a}	1.81^{d}	0.67^{ab}	1.42^{c}	0.76^{b}

The values were expressed as mean value of five independent measurement for alveograph.

Mean values of examined quality parameters denoted with the same letter in a raw were not statistically significant different (P<0.05).

According to alveograph curve length and swelling index NS3-5299/2 cultivar belongs to the statistically (p<0.05) segregated group of varieties (NS3-5299/2, NS Rana 5 and Ljiljana) that reveals appropriate values for end-use quality. On the other hand variety Zvezdana belongs to the significantly (p<0.05) different group of cultivars (Zvezdana, Evropa 90 and Pobeda) with poor values for end-use quality relating these two properties. Varieties NS3-5299/2 and Zvezdana were significantly different (p<0.05) according to alveograph ratio. Furthermore, this alveograph property indicates that NS3-5299/2 cultivar is characterized with potentially good technological quality, while Zvezdana variety revealed potentially poor bread-making quality. However, alveograph deformity work for both new cultivars in comparison to the comercial varieties were in the range of the cultivars which revealed potentially very good breadmaking quality. The deformity work of NS3-5299/2 variety was even the highest and statistically different from all other examined cultivars.

CONCLUSIONS

Quality of varieties already present in the production over long period determined in the samples derived from micro level trial was characterized with better results for farinograph water absorption and extensiograph energy values in comparison to multiannual ranges, probably because of satisfactory agricultural effects which were applied for micro-level tests, while determined over values for amylograph viscosity peak are most probably the consequence of characteristics of the production year.

In respect to technological quality which is measured by Brabender equipment, two new varieties were characterized with farinograph water absorptions and extensigraph extensibilities which were in the level of the best results of commercial cultivars. However, extensograph resistance of new cultivars was poor influencing that complex property such as extensograph ratio which was statistically lower than the extensograph ratio of all tested wheat samples, but still in the range which allows good breadmaking quality.

Concerning alveograph properties, alveograph deformity work of both new varieties revealed that both cultivars are characterized with potentially very good breadmaking quality. Alveograph ratio and curve length of Zvezdana variety were in the level of examined wheat cultivars with potentially poor breadmaking quality, while for NS3-5299/2 variety were on the level of investigated wheat samples with potentially good breadmaking quality making this variety interesting for milling and baking industry.

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