



## EVALUATION OF TECHNOLOGICAL AND ANTIOXIDANT PROPERTIES OF *TRITICUM AESTIVUM* L. AND *TRITICUM DURUM* L. VARIETIES

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### ABSTRACT

The study deals with the evaluation of technological and antioxidant characteristics of selected varieties of *Triticum aestivum* and *Triticum durum* grown in Slovakia and Serbia. Research was conducted during the two years 2009 and 2010. Measured values of water activity were in the range 0.4 - 0.5. Optimal activity of alpha-amylase was measured in Serbian varieties Etida (210 seconds), Pobeda (218 seconds) and Renesansa (272 seconds). The highest sedimentation capacity expressed as sedimentation index by Zeleny had variety Karpatia (60 cm<sup>3</sup>). The high content of insoluble protein (gluten) was measured in a variety Rusija (36.6%). Nitrogen content was in the range 12.7 - 13.9% of dry matter, starch content in the range 56.6 - 61.6% of dry matter. Antioxidant activity measured by DPPH method ranged in wheat varieties from 44 to 49%. The highest content of polyphenols was measured in a variety Etida (0.464 mg of catechin/g of sample). Durum wheat varieties have a higher content of polyphenols in general. The production of semolina flour from durum wheat may have the positive antioxidant effect according to gained measurements.

**Keywords:** wheat, carbohydrates, proteins, antioxidants, polyphenols

### INTRODUCTION

Wheat grain consists of several cells that considerably differ in morphological and chemical composition, which is associated with the function of each anatomical part of a grain (Gruppen, 1992). According to several authors (Lorenz and Kulp, 1991; Anderson et al., 2000; Muchová, 2001; Macevilly, 2004) carbohydrate content in wheat grain range between 65% - 72%, protein content from 8.5 to 18%. Flour carbohydrates are formed by starch, non-starch polysaccharides, low molecular weight oligosaccharides, dextrin, mono- and disaccharides. The most represented carbohydrate is the starch. It contains amylose (24%) and amylopectin (76%). Their ratio depends on the variety (Cauvain, 2003). The starch content and its composition affect the weight of bread and pasta texture (Sahlstrom et al., 2003). Wheat flour, which is obtained from wheat grain endosperm, contains about 80% of protein from which the major part is represented by gluten proteins, gliadin and glutenin (Shewry and Halford, 2002). Gliadin content affects the viscosity and glutenin affects the gluten elasticity. Their mutual ratio depends on variety (Antes and Wieser, 2001). According to Onyeneho and Hettiarachchy (1992), Lachman (2003), Zielinski and Kozłowska (2000) cereals contain significant amounts of antioxidants mainly polyphenols, carotenoids, tocopherols thus affecting the health of humans.

### MATERIAL AND METHODS

To carry out analysis and to evaluate parameters samples of the Institute of Field and Vegetable Crops from Novi Sad, Serbia and the Central Testing Institute for Agriculture Solary from Slovakia were provided. Samples were analyzed and evaluated after a period of post-harvest ripening during the storage time. Evaluated were varieties from the crop years 2009 and 2010.

Varieties grown in Serbia: *Triticum aestivum* L.: Etida, Pobeda, Renesansa, Rusija, Vojvodina, *Triticum durum* L.: Durumko, NS Dur. Varieties grown in Slovakia: *Triticum aestivum* L.: Karpatia, *Triticum durum* L.: Pentadur.

Sampling of material was in accordance with the procedure according to STN ISO 24 3333 for cereals and cereal products. Samples were homogenized using laboratory mills Quadrumat Senior Brabender and Perten.

Technological-predictive parameters: determination of water activity: device Nowasina Labmaster aw 25 °C; determination of alpha-amylase activity (Falling Number): FN device 1800 (Perten) according to ICC Standard No. 107/1 (1995); determination of crude protein: ICC Standard No. 159 (1995); determination of

starch: under ICC Standard 123/1; determination of gluten: Glutomatic 22000 (Perten) - ICC Standard No. 155 (1994); sedimentation index by Zeleny: ICC Standard No. 116/1 (1994).

Antioxidant parameters: determination of antioxidant activity by DPPH method: the method is based on the reaction of antioxidants from extract with a stable radical 2,2-diphenyl-1-picrylhydrazol (DPPH\*) radical. Reduction of DPPH in the presence of antioxidants or radicals is manifested as reduction in absorbance at 515 nm (Sánchez-Moreno et al., 1998). Determination of total polyphenols: by adding Folin-Ciocalteu agent to extract. Measurement of absorbance at 760 nm is expressed in results of catechin (Swain and Hills, 1959).

### RESULTS AND DISCUSSION

Nine wheat varieties were evaluated in this work. Six varieties of wheat *Triticum aestivum* L. (T.A.): Etida, Vojvodina, Pobeda, Renesansa, Rusija and Karpatia. Three varieties of durum wheat *Triticum durum* L. (T. D.): NS Dur, Durumko, Pentadur. Seven of these varieties were grown in Central Europe such as Serbian varieties (Etida, Vojvodina, Pobeda, Renesansa, Rusija, NS Dur, Durumko) and two varieties were grown in Slovakia (Karpatia, and Pentadur). This group of varieties has been compiled as a representative set of wheat varieties from both research institutions.

The paper presents two years results of conducted analysis and evaluated parameters. Crops production of 2009 and 2010 has been evaluated. The official evaluation system for wheat according to STN 46 1100-2,3 was used. Technological requirements for wheat in terms of bakery and pasta production were taken into consideration as well. Since the material was stored, the biological effect of post-harvest dormancy and storage conditions was taken into account.

Table 1 presents the results of analysis of technological parameters from the year 2009. Explanatory parameter for the safety of the stored material is measurement of the water activity ( $a_w$  25 °C). It indicates material stability and resistance against contamination by microorganisms. Value  $\leq 0.700$  is optimal for common microbiological processes. In the year 2009 the measured values were below 0.500, except variety Pentadur (0.512). Material can be in terms of microbiological safety assessed as stable. In series of technological parameters evaluated in accordance to STN 46 1100-2.3 and according to international standards we evaluated: falling number (FN), sedimentation index by Zeleny

(ZI), gluten content in dry matter (GI), crude protein in dry matter (NC) and starch content in dry matter (St).

**Table 1** Technological quality parameters of evaluated varieties (production year 2009)

Variety	a <sub>w</sub>	FN	ZI	GI	NC	St
Etida	0.441	215	34	23.5	11.7	60.4
Vojvodina	0.442	370	33	24.6	12.5	59.0
Pobeda	0.443	211	40	32.4	11.9	60.7
Renesansa	0.440	304	39	30.2	13.0	56.3
Rusija	0.441	185	43	35.9	11.5	59.0
NS Dur	0.438	73	21	34.5	13.8	55.3
Durumko	0.440	106	20	32.4	12.9	58.6
Karpattia	0.492	348	63	27.0	13.7	61.2
Pentadur	0.512	392	18	24.6	13.8	62.3

**Legend:** a<sub>w</sub> - water activity measured by 25 °C, FN - Falling number (seconds), ZI - sedimentation index by Zeleny (cm<sup>3</sup>), GI - gluten content in dry matter (%), NC - nitrogen content in dry matter (%), St - starch content in dry matter (%)

Falling number (FN) expresses the alpha-amylase activity, the time of starch degradation (seconds) needed for the yeast activity during dough creating and its rheological characteristics. Optimal values are between 200 - 300 seconds (Mareček et al., 2011). At lower values of falling number is alpha-amylase activity higher, which negatively causes the insufficient carbohydrates supply for the yeast activity. High value of falling number causes slower degradation of starch and thus slower creation of air pores in the dough during the specific time period. Optimal values of falling number were measured in varieties Etida (215 seconds) and Pobeda (211 seconds). In varieties Vojvodina, Renesansa, Karpattia and Pentadur was measured a lower alpha-amylase activity. The highest activity was measured in variety NS Dur (73 seconds).

Sedimentation index by Zeleny (ZI) reflects the ability of wheat protein to increase the volume in grit emulsion in a solution of lactic acid. The optimal value is at least 25 cm<sup>3</sup>. For most T. D. varieties indication of values is more informative and it is not subject of STN. All T. A. varieties meet the ability to achieve the desired volume. Similarly, the presence of insoluble proteins (gliadin, glutenin) is expressed as gluten (GI) in dry matter (%). Optimal values for T. A. are at least 25% and for T. D. 27%. Higher content of insoluble protein was measured in varieties Rusija (35.9%), NS Dur (34.5%) and Durumko (32.4%). Higher content of gliadin and glutenin in flours affects the elasticity and viscosity of produced dough and consequently, the quality of bakery products (Mareček et al., 2011).

Nitrogen content (NC) in T. A. varieties ought to be at least 11.5% in dry matter and in T. D. varieties at least 13.5%. Values of nitrogen content in varieties were in the range 11.7 - 13.7% for T. A. and 12.9 - 13.8% for T. D. The starch content in Serbian varieties in the year 2009 was lower (55.3 - 60.7%) than in varieties grown in Slovakia (61.2 - 62.3%).

Table 2 presents the results of analysis of technological parameters from the year 2010. In this reporting period the water activity in the grain was slightly higher than in the year 2009 (0.482 - 0.551). Slovak varieties have a lower water activity than Serbian varieties.

**Table 2** Technological quality parameters of evaluated varieties (production year 2010)

Variety	a <sub>w</sub>	FN	ZI	GI	NC	St
Etida	0.551	205	45	24.9	13.5	60.7
Vojvodina	0.542	281	38	28.3	13.8	60.2
Pobeda	0.561	224	57	36.2	13.4	62.2
Renesansa	0.554	240	54	28.4	13.2	61.2
Rusija	0.560	185	63	37.2	15.9	54.1
NS Dur	0.549	85	32	17.9	12.6	62.4
Durumko	0.534	67	19	23.6	14.8	60.2
Karpattia	0.491	288	57	42.7	13.8	61.9
Pentadur	0.482	331	20	23.7	12.5	60.2

**Legend:** a<sub>w</sub> - water activity measured by 25 °C, FN - Falling number (seconds), ZI - sedimentation index by Zeleny (cm<sup>3</sup>), GI - gluten content in dry matter (%), NC - nitrogen content in dry matter (%), St - starch content in dry matter (%)

The activity of alpha-amylase (FN) was in Serbian varieties lower in normative values in the range from 18 to 81 seconds. In varieties NS Dur (85 seconds) and Durumko (67 seconds) the high activity of alpha-amylase was measured. On the other hand Slovak varieties Karpattia (288 seconds) and Pobeda (311 seconds) have lower alpha-amylase activity but in optimal values. Zeleny index (ZI) in varieties of T. A. was in the year 2010 expressed by higher levels of ability of wheat proteins to swell. The highest sedimentation values have Serbian varieties Rusija 63 cm<sup>3</sup> and Pobeda 57 cm<sup>3</sup>. Gluten content in Serbian varieties had above-average values (Pobeda 36.2%, 37.2% Rusija). Levels of nitrogen content (NC) were in the range 12.5 - 15.9%. For most varieties, the NC content was above 13%. Higher content of the NC in dry matter was relative to the lower starch content in a variety Rusija (54.1%). For other varieties the starch content in dry matter was measured over 60%.

**Table 3** Evaluation of antioxidant capacity by DPPH method (% of inhibition)

Variety	2009	2010	a <sub>v</sub>
Etida	47	45	46
Vojvodina	41	46	44
Pobeda	44	46	45
Renesansa	49	48	49
Rusija	44	44	44
NS Dur	46	44	45
Durumko	47	45	46
Karpattia	44	48	46
Pentadur	44	46	45

**Legend:** 2009/2010 – evaluated production of material in monitored years, DPPH method – antioxidant activity (%), a<sub>v</sub> – average values of antioxidant activity in monitored years (%)

Evaluation of antioxidant activity (table 3) was carried out by method of DPPH radical. Antioxidant activity is expressed as % of inhibition. Values of % of inhibition were in the evaluated years balanced in the range from 41 to 49%. For cereals the values of inhibition % may be affected by the flour fraction (Yu et al. 2002; Fatrcová - Šramková et al., 2010).

Polyphenols as antioxidant components of wheat grain are expressed in mg of catechin/g of sample. In the year 2009 the highest content of polyphenols was measured in variety NS Dur 0.458 mg of catechin/g of sample. The lowest value was measured in a variety Pobeda 0.098 mg of catechin/g of sample. In the year 2010 the highest content of polyphenols has variety Etida 0.596 mg of catechin/g of sample and variety NS Dur 0.495 mg of catechin/g of sample (table 4).

**Table 4** Evaluation of polyphenol content (mg of catechin/g of sample)

Variety	2009	2010	a <sub>v</sub>
Etida	0.331	0.596	0.464
Vojvodina	0.278	0.273	0.276
Pobeda	0.098	0.135	0.117
Renesansa	0.305	0.490	0.398
Rusija	0.172	0.135	0.154
NS Dur	0.458	0.495	0.477
Durumko	0.416	0.225	0.321
Karpattia	0.326	0.035	0.181
Pentadur	0.405	0.283	0.344

**Legend:** 2009/2010 – evaluated production of material in monitored years, polyphenol content – expressed in mg of catechin/g of sample, a<sub>v</sub> – average values of polyphenol content in monitored years in mg of catechin/g of sample

## CONCLUSION

The results of varieties standards grown in Central Europe were achieved by comparing varieties of Slovak and Serbian origin. Assessed Slovak variety Karpattia showed high swelling ability of proteins and its sedimentation and high content of insoluble protein. Serbian variety Rusija expressed the highest values of insoluble protein. These varieties would have been assessed as improving varieties in mixtures for flour production. Antioxidant activity was balanced at the range of 49% of inhibition (DPPH method). Higher content of polyphenols was measured in durum wheat, which is positive in terms of processing raw material for production of pasta made from semolina.

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