Identification of *Triticum aestivum* L., *Triticum spelta* L. and *Triticum durum* DESF. genotypes on the HMW-GS base

V. Oslovičová, Z. Gálová, M. Chňapek, Ž. Balážová

Department of Biochemistry and Biotechnology, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Nitra, Slovak Republic

ABSTRACT

The main goal of this work was to identify genotypes of three wheat species (*Triticum aestivum* L., *Triticum spelta* L., *Triticum durum* DESF.) on the basis of individual high-molecular-weight glutenin subunits (HMW-GS) and to predict their technological quality. Detection of HMW-GS was carried out by the standard reference method ISTA SDS-PAGE and the Glu-score was calculated according to the catalogue of alleles for HMW-GS. Among the common wheat varieties the highest Glu-score (10) was determined for the cultivars Axis, Istra and Solara. The most frequently occurring HMW-GS in genotypes of *Triticum aestivum* L. were 0; 7 + 9; 5 + 10. On the other hand, in the spelt wheat the highest frequency of HMW-GS was detected for 2*; 6 + 8; 2 + 12. The Glu-score for *Triticum spelta* L. genotypes ranged from 6 to 8. Among the *Triticum durum* DESF. cultivars, up to 71% were characterized by Glu-score 4, which predetermines them for special baking purposes. The most frequent combination of HMW-GS in durum wheat was 0 and 7 + 8. Thus, SDS PAGE of HMW-GS can be used for identification, differentiation and characterization of different species of wheat and for prediction of bread-making quality of wheat.

Keywords: *Triticum aestivum* L., HMW-GS, Glu-score, SDS-PAGE

Identification, differentiation and characterization of plant genotypes represent an ever increasing necessity for applied requirements of plant-breeders, testing and accreditation of newly-formed species. These issues are also very important in their patent protection, cultivation for seed-production and in the seed corn market.

The single species of hybrids or population of agricultural plants differ in some morphological and agronomical characters and attributes. The variability in these traits, however, is not high enough to differentiate quickly the individual genotypes. At present, the identification of plant genotypes is oriented towards the analysis of the proteins and DNA polymorphisms (Kraic 2004). Nevertheless, these analyses complement the analyses based on the evaluation of morphological characteristics.

Bread wheat dough possesses unique characteristics, the most important of which is the elasticity of gluten – an important component of wheat storage proteins. This special property allows baking bread, which has been a basic food for man throughout recorded history, and probably for a much longer period, it remains the principal food product made of wheat.

Wheat gluten proteins consist of two major fractions: the gliadins and the glutenins. High polymorphisms of the storage wheat proteins are a consequence of the complexity of the genome (Kraic 2004).

Most importantly, high-molecular-weight glutenin subunits (HMW-GS) of wheat proteins have significant effect on bread-making quality. The HMW-GS are controlled by codominant alleles Glu-A1, Glu-B1 and Glu-D1, which are located on the long arm of the chromosomes 1A, 1B and 1D. Monitoring of relationship between individual high-molecular-weight glutenin subunits and technological quality of wheat has revealed correlation between them and therefore these subunits can be considered as genetic markers of wheat grain quality (Kolster et al. 1992).

The main goal of this work was to identify and

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Table 1. Composition of HMW glutenin subunits in selected cultivars of *Triticum aestivum* L.

Triticum aestivum L.	HMW-GS			Glu-score
	Glu-A1	Glu-B1	Glu-D1	
Arga	1	7 + 9	5 + 10	9
Arida	0	7 + 9	5 + 10	7
Armelis	0	7 + 9	5 + 10	7
Astella	2*	7 + 9	5 + 10	9
Auburn	1	7 + 9	5 + 10	9
Axis	2*	7 + 8	5 + 10	10
Barbara	1	7 + 9	5 + 10	9
	0	7 + 9	5 + 10	7
Barma	0	7 + 9	5 + 10	7
Bonita	0	7 + 8	5 + 10	7
Bučianská 106	0	7 + 9	2 + 12	6
Bučianská 202	1	7 + 9	3 + 12	7
	1	7 + 9	3 + 12	7
Bučianská 316	0	7 + 9	3 + 12	5
Bučianská Červenoklasá	1	6 + 8	2 + 12	6
	0	6 + 8	2 + 12	4
Butín	2*	7 + 9	5 + 10	9
Calovská	1	7 + 9	2 + 12	7
Diana I	0	7 + 9	5 + 10	7
Istar	0	7 + 9	5 + 10	7
Istra	1	7 + 8	5 + 10	10
Košutská	0	7 + 9	5 + 10	7
Krajová Brestovec	2*	7 + 9	5 + 10	9
Krajová Chmelnica	2*	7 + 9	5 + 10	9
Malé Karpaty	0	6 + 8	5 + 10	6
Malyska	0	6 + 8	5 + 10	6
Mila	0	7 + 8	5 + 10	8
Nový život	1	7 + 9	2 + 12	7
Petrana	0	7 + 9	5 + 10	7
Radošinska Karola	1	7 + 9	5 + 10	9
Radišinská Norma	2*	7 + 9	5 + 10	9
Šamorínska	0	7 + 8	2 + 12	6
Slovenská 2	0	6 + 8	2 + 12	4
Slovenská 200	1	7 + 9	5 + 10	9
Slovenská 777	1	7 + 9	3 + 12	7
Slovenská B	1	7 + 9	3 + 12	7
Slovenská intenzívna	2*	7 + 9	2 + 12	7
Solara	1	7 + 8	5 + 10	10
Solaris	1	7 + 9	5 + 10	9
Solida	2*	7 + 9	5 + 10	9
Vanda	2*	7 + 9	5 + 10	9
Viator	0	7 + 9	5 + 10	7
Viglašská	0	7 + 9	5 + 10	7
Viglašská červenoklasá	1	7 + 9	3 + 12	7
Vrakunska	0	7 + 8	2 + 12	6

compare different genotypes within a selected set of three wheat species (*Triticum aestivum* L., *Triticum spelta* L., *Triticum durum* DESF.) on the basis of their individual high-molecular-weight glutenin subunits and to predict the technological quality of given wheat cultivars.

MATERIAL AND METHODS

For the analyses, seeds of 42 genotypes of hexaploid *Triticum aestivum* L., (Table 1), 8 genotypes of hexaploid *Triticum spelta* L. (Table 2) and 17 genotypes of tetraploid *Triticum durum* DESF. (Table 3) were obtained from the Gene Bank of the Slovak Republic (Research Institute of Plant Production, Piešťany, Slovak Republic).

Detection of HMW-GS was performed by the standard reference electrophoretic method ISTA SDS-PAGE (Wrigley 1992) and the Glu-score was calculated according to the catalogue of alleles for HMW-GS (Payne et al. 1987).

RESULTS AND DISCUSSION

Wheat is the only cereal the flour of which enables to create and form the rheological properties necessary for the production of fermented bread.

The high-molecular-weight glutenin subunits are prominent with respect to baking quality of wheat flour, while single subunits or their pairs were shown to influence the technological quality differently (Chňapek et al. 2006). The Glu-D1 locus revealed the largest influence on the variability of technological quality of different wheat species, while the effect of the alleles located on Glu-A1 and Glu-B1 loci is known only in combination with 'high quality' Glu-D1 allele encoding for the subunits 5 + 10 (Kolster et al. 1992).

In this work 67 different wheat genotypes were analysed for their HMW-GS characteristics. The results showed that the collection of *Triticum aestivum* L. genotypes analyzed (Table 1) contains high-molecular-weight glutenin subunits 0; 1 and 2* from the Glu-A1 locus. The subunit 0 was the most frequent and was present in 45.20% of the analyzed genotypes. The locus Glu-B1 demonstrated three pairs of HMW glutenin subunits, namely the 6 + 8; 7 + 8 and 7 + 9; the subunits 7 + 9 showed the highest frequency. The Glu-D1 locus contained three types of HMW-GS, namely 5 + 10; 2 + 12 and 3 + 12, while the 5 + 10 subunits appeared to be the most frequent in the total of 30 genotypes.

Two biotypes were detected in the cultivar Barbara, Bučianská 316 and Bučianská červenoklasá. In these genotypes there were two subunits (subunit 0 and subunit 1) detected on the Glu-A1 locus.

In order to predict the bread-making quality of wheat genotypes, Glu-score was calculated for the wheat genotypes on the basis of high-molecular-weight glutenin subunits detected. Our data showed that the Glu-score in common wheat varieties varied within an interval from four to ten. The lowest Glu-score was recorded in cultivars Slovenská 2 and one of the two lines of Slovenská červenoklasá. The cultivars Axis, Istra and Solara accounted for the highest (10) Glu-score reflecting to high baking quality. These results are in accordance with those reported by Knoblochová and Gálová (2000), Gálová et al. (2002) and Chňapek et al. (2006).

Spelt wheat is an alternative type of wheat, which is characterized by special quality and higher content of nutritionally important substances. Our analyses revealed the HMW-GS 0; 1 and 2* on the Glu-A1 locus in the samples of *Triticum spelta* L. (Table 2). The subunit 0 was only absent in the case of the newly-bred variety Line 3/96. Four high-molecular-weight glutenin subunits (6 + 8; 7 + 8;

Table 2. Composition of HMW glutenin subunits in selected cultivars of *Triticum spelta* L.

Triticum spelta L.	HMW-GS			Glu-score
	Glu-A1	Glu-B1	Glu-D1	
Cv. Beatting Niederuill	2*	7 + 8	2 + 12	8
Cv. Fuggers Babenhauser Zucgtveessen	2*	6 + 8	2 + 12	6
Cv. Weisser Winter-Granendinkel aus Hohen	2*	6 + 8	2 + 12	6
Line 3/96	0	17 + 18	2 + 12	6
Ostro	2*	6 + 8	2 + 12	6
Renval	1	7 + 9	2 + 12	7
Rotweil Fruhnkorn	1	6 + 8	5 + 10	8
Schwabenkorn	1	6 + 8	2 + 12	6

Table 3. Composition of HMW glutenin subunits in selected cultivars of *Triticum durum* DESF.

Triticum durum DESF.	HMW-GS		Glu-score
	Glu-A1	Glu-B1	
SO-90-d-55	0	7 + 9	3
SO-93-d-126	0	7 + 9	3
SO-94-d-166	0	7 + 9	3
SO-94-d-168	0	7 + 9	3
SO-94-d-169	0	7 + 8	4
SO-94-d-170	0	7 + 8	4
SO-94-d-201	0	6 + 8	2
SO-94-d-205	0	7 + 8	4
SO-94-d-57	0	7 + 8	4
SO-94-d-64	0	7 + 8	4
SO-94-d-66	0	7 + 8	4
SO-94-d-68	0	7 + 8	4
SO-94-d-70	0	7 + 8	4
SO-90-d-112	0	7 + 8	4
SO-90-d-31	0	7 + 8	4
Soldur	0	7 + 8	4
Vendur	0	7 + 8	4

7 + 9; 17 + 18) were detected on the locus Glu-B1. The subunits 17 + 18 were observed only in the newly-bred variety Line 3/96, and the subunits 7 + 9 were recorded only in the cultivar Renval.

In the genome of tetraploid durum wheat there is the D-genome absent; consequently, this wheat species is inappropriate for leavened bakery products. The locus Glu-A1 in all durum wheat cultivars is characterized by the presence of the HMW glutenin subunit 0. The HMW-GS 6 + 8; 7 + 8 and 7 + 9 were detected on the Glu-B1 locus, while the most frequent presence (in 70.60% of the durum wheat genotypes) was observed for the subunits 7 + 8. The highest Glu-score detected (4) could be seen in 70.61% of *Triticum durum* DESF. Genotypes, whereas the lowest score (2) was recorded for the cultivar SO-94-d-201, which was the only cultivar with the subunit 6 + 8 on the Glu-B1 locus. Similar results were also obtained by He et al. (1999), Brites and Carrillio (2001) and Gálová et al. (2002).

The present results confirmed that there are pronounced differences in the representation of HMW-GS in the hexaploid and tetraploid wheat. The absence of the D-genome in the tetraploid wheat coincides with low bread-making quality of these wheat genotypes and predetermines their utilization for production of pasta and other special products. Although common wheat relishes the priority position in the agricultural production among all the hexaploid wheats, using of admixture of spelt flour in wheat flour gains on increasing popularity since it positively affects the freshness and aroma of products. Spelt wheat raises interest of farmers particularly in terms of higher nutritional value compared to conventional varieties of wheat.

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REFERENCES

Brites C., Carrillio J. (2001): Influence of high molecular weight (HMW) and low molecular weight (LMW) gluten subunits controlled by Glu-1 and Glu-3 loci on durum wheat quality. Cereal Chemistry, *78*: 59–63.

Gálová Z., Michalík I., Knoblochová H., Gregová E. (2002): Variation in HMW glutenin subunits of different species of wheat. Rostlinná výroba, *48*: 15–19.

He G.Y., Rooke L., Steele S., Békés F., Gras P., Tatham A.S., Fido R., Barcelo P., Shewry P.R., Lazzeri P.A. (1999): Transformation of pasta wheat (*Triticum durum* L. var. durum) with hight-molecular-weight glutenin subunit genes and modification of dough functionality. Molecular Breeding, *5*: 377–386.

Chňapek M., Vivodík M., Gálová Z., Gregáňová Ž. (2006): Detection of wheat technological quality by molecular markers. In:

Safety and quality of raw materials and foodstuffs: Proceedings of scientific works from the II. International Scientific Conference. November 9, 2006, Nitra, SPU: 174–179.

Kraic J. (2004): Plant Genetic Markers. SPU, Nitra, 67.

Knoblochová H., Gálová Z. (2000): High-molecular-weight glutenin subunits variation and relative quantitation in winter spelt wheat cultivars. Rostlinná výroba, *46*: 255–260.

Kolster P., Krechting C.F., Van Gelder W.M.J. (1992): Qualification of individual high-molecular-weight glutenin subunits of wheat using SDS-PAGE and scanning densitomery. Journal of Cereal Science, *15*: 49–61.

Payne P.I., Nightingale M.A., Krattiger A.F. (1987): The relationship between HMW glutenin subunit composition and the bread-making quality of British-grown wheat varieties. Journal of the Science of Food and Agriculture, *40*: 51–65.

Wrigley C.W. (1992): Identification of Cereal Varieties by Gel Electrophoretis of the Grain Proteins. In: Linkes H.F., Jackson J.F. (eds): Modern methods of plant analysis (New Series): Seed analysis. Springer, Berlin, 17–41.

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Corresponding author:

Ing. Veronika Oslovičová, Slovak Agricultural University in Nitra, Faculty of Biotechnology and Food Sciences, Department of Biochemistry and Biotechnology, Tr. A. Hlinku 2, 949 76 Nitra, Slovak republic
phone: + 421 376 414 596, fax: + 421 376 513 097, e-mail: Veronika.Oslovicova@uniag.sk