Euphytica **100:** 179–182, 1998.

Breeding for breadmaking quality using old Hungarian wheat varieties

Z. Bedõ, G. Vida, L. Láng & I. Karsai
Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár, Hungary

Key words: wheat, breadmaking quality, HMW glutenin subunits

Summary

Due to their broad population diversity, old wheat varieties or landraces play an important role in increasing the genetic variability of agronomic traits. On these grounds, an analysis was made of the high molecular weight (HMW) glutenin subunit composition of the old Hungarian wheat variety Bánkúti 1201. It was found that several genotypes with differing breadmaking qualities can be distinguished for this character. When using old varieties in breeding, it is possible to broaden the genetic background of characters responsible for breadmaking quality by separating the populations. A more detailed analysis of the protein composition of germplasm created in this way will be required to obtain a better understanding of this complex character for its conscious introduction into breeding programmes.

Introduction

The breeding of wheat with good breadmaking quality is characterised by different types of genetic backgrounds in Eastern Europe. One is selection based on the Bezostaya 1 type, where good baking quality is achieved through a combination of excellent rheological quality and high average gluten content. This type generally has a 2*, 7+9 and 5+10 HMW glutenin subunit composition. Among the Martonvásár varieties, Mv 4, Mv 5, Mv 9 and Mv 12 can be included in this group, as can many other Eastern European wheat varieties with breadmaking qualities similar to that of Bezostaya 1.

In many countries, the genetic basis of good breadmaking quality was represented by improved landraces created through mass selection, or by the first primitive varieties. In Hungary this role was played by populations from the Tisza and Bánát regions. The latter were also grown on areas now in the Ukraine under the variety name Ukrainka, which was later improved and renamed Novoukrainka. In this way, a progeny originating from a population of the Bánát local type became one of the parents of Bezostaya 1.

We can find a similar situation in the breeding process of the old Hungarian varieties. Their genetic background stems partly from the Tisza region landraces and partly from the Canadian spring wheat Marquis. However, these wheat varieties represent another breadmaking quality type because the rheological properties are slightly weaker and their gluten content is higher than that of Bezostaya 1. During the summer heatwaves prior to ripening, frequent in this region, the gluten stability of the old varieties is better. The most frequently cultivated of these varieties were Bánkúti 1201, Bánkúti 1205 and Béta Bánkúti. In Austria, the variety Austro Bankut, a selection made from Bánkúti 1201, was developed in 1948. Austro Kolben was selected from an irradiated population of Austro Bánkút (Hänsel et al., 1994). Both were regarded as good or blending quality varieties, regardless of their poorer gluten quality. These old Hungarian varieties and their Austrian derivatives have 2+12 or 3+12 HMW glutenin subunits on the 1D chromosome, although this subunit composition is usually

associated with lower breadmaking potential. At the same time their populations are heterogeneous for the *Glu Al* and *Glu B1* loci.

The aim of the present experiments was to study the breadmaking quality of old Hungarian varieties and to develop new genotypes with the quality type and protein composition of the old Hungarian varieties in order to improve the genetic variability of breadmaking quality.

Materials and methods

In the first experiment, the HMW glutenin subunit composition of old Hungarian wheat varieties was studied (Payne et al., 1981). The technological quality was tested using the Soltek SDS sedimentation method (SDS test). The results obtained were calculated using a conversion chart, which is an estimation of the manual SDS sedimentation value. The determination of gluten content was carried out using a Glutomatic 2200 instrument equipped with an 80m metal sieve, according to the ICC Standard Method No. 137/1. The gluten index (GI) was determined using a Centrifuge 2015, according to ICC Standard Method No. 151.

In the second experiment sublines of the wheat variety MvM 57-91 were tested with the methods indicated above. In addition, the presence or absence of the 1R/1B translocation in the sublines was examined (Metakovsky et al., 1984; Sozinov et al., 1987), and the rheological characters of the flour were analysed using a Brabender farinograph according to ICC Standard Method No. 115.

Results and discussion

The breadmaking quality characteristics of old Hungarian wheat varieties with 2+12 subunits at the *Glu-D1* locus are shown in Table 1. Compared to the control variety Marquis, varieties Beta Bankuti, Bankuti 1201 and Székács 1242 all have the same Brabender farinograph values (class A_2), and have similar SDS sedimentation volumes. Bánkúti 5, one of the parents of Bánkúti 1201 and of other old Hungarian varieties which were developed by mass selection from the Tiszavidéki (Tisa River region) landrace, gave both higher Brabender farinograph and SDS values. The wet gluten content of the old Hungarian varieties was similar to that of Marquis.

Table 1. Breadmaking properties of old Hungarian varieties with 2+12 subunit composition at the *Glu-D1 locus*.

Variety	SDS sedimentation ml	Brabender farinograph value	Wet gluten content (%)
Bánkúti 5	75	100.0	27.1
Bánkúti 1205	70	87.5	33.8
Béta Bánkúti	68	75.3	33.1
Bánkúti 1201	70	74.0	36.1
Székács 1242	68	76.4	34.2
Marquis (control)	66	71.6	33.8

The technological quality parameters were studied using the populations of these varieties. On analysing the HMW glutenin subunit composition of variety Bánkúti 1201, different subunits on chromosomes 1A and 1B were found. The 1D 2+12 subunits proved to be consistently the same in all cases. Sublines with different subunits were separated and tested for SDS sedimentation volume, gluten content and gluten index (Table 2). Sublines with the HMW glutenin subunit composition 2*, 7+8 and 2+12 gave the best results according to the two-year experiments. Bánkúti sublines with 7+9 subunits on chromosome 1B resulted in lower SDS sedimentation. The performance of the 1, 7+8 and 2+12 genotypes was not consistent in the two years. The average gluten content did not show significant differences between sublines with different HMW glutenin compositions, but the gluten index, indicating the gluten quality, was the highest in genotypes with

*Table 2.*Breadmaking properties of Bánkúti 1201 genotypes with different HMW glutenin compositions.

HMW glutenin composition	SDS sedimentation (ml)	Wet gluten content (%)	Gluten index
2* 7+9 2+12	63.5	37.8	64.3
1 7+9 2+12	61.4	39.1	59.4
2* 7+8 2+12	68.0	37.2	84.6
1 7+8 2+12	66.7	37.2	65.7

Source: ***Martonvasar*** 1994, 1995.

Table 3. Breadmaking quality properties of MvM 57-91 sublines in the F8 generation.

HMW glutenin composition	Rye translocation	SDS sedimentation	Brabender farinograph value	Wet gluten content (%)
1 7+9 2+12	none	73	78.4 (A2)	36.0
1 7+9 2+12	present	60	61.5 (B1)	36.3
1 7+9 5+10	none	68	90.3 (A1)	35.2
2* 7+9 5+10	none	68	91.2 (A1)	34.3

Source: ***Martonvasar,*** 1994.

a 2*, 7+8 and 2+12 HMW glutenin subunit composition.

To transfer the traditional breadmaking quality of Bánkúti wheat varieties, a selection program was carried out with sublines of MvM 57-91, whose origin can be traced back to the variety Bánkúti 1201. As shown in Table 3, genotypes from the population of MvM 57-91 with different HMW glutenin compositions and the presence or absence of the 1R/1B translocation were selected. Regardless of genetic background there was no difference between the genotypes in wet gluten content and SDS sedimentation. However, the Brabender farinograph classes were A_1 for sublines with 5+10 subunits on chromosome 1D, A_2 for genotypes with 1, 7+9 and 2+12 subunits and B_1 for some with the 1R/1B translocation, reflecting differences in the rheological properties.

A more detailed analysis was carried out in the next (F_9) generation (Table 4). The highest SDS sedimentation values were measured in genotypes with 1 and 2*subunits on chromosome 1A, and 2+12 and 5+10 on chromosome 1D without the rye chromosome translocation. If these subunits were not present on chromosome 1A, or if the 1R/1B translocation was found, lower SDS sedimentation volumes were observed. In this respect, similar gluten indexes were calculated, but there was a significantly higher gluten index (GI) in lines with 5+10 subunits and a lower wet gluten content than in sublines with the 1, 7+9 and 2+12 composition and a 1R/1B genetic background. These latter genotypes represent a transition with regard to gluten index and their wet gluten contents are as high as those of other genotypes with lower gluten indexes.

As the F_7 population of MvM 57-91 was heterogeneous for HMW glutenin subunit composition and rye translocation, artificial mixtures of selected pure sublines with different genetic backgrounds were made to study the technological quality properties. Table 5 shows the effect of sublines on gluten content, gluten index and Brabender farinograph value. In accordance with the previous results for the F_9 generation, the highest GI was measured in the mixtures where 1, 7+9, 5+10; 2*, 7+9, 5+10; and 1, 7+9, 2+12 were present in the populations without the rye translocation. The Brabender farinograph shows the superiority of 5+10 subunits on chromosome 1D, while 1, 7+9 and 2+12 represent a transitional value, as indicated by the gluten index in the experiment on the F_9 MvM 57-91 sublines.

On the basis of the results presented, it can be stated that the selection basis for wheat varieties with good breadmaking quality can be extended to

Table 4. Breadmaking properties of MvM 57-91 sublines in the F9 generation.

HMW glutenin composition	1R/1B	SDS sedimentation (ml)	Gluten content (%)	Gluten index
1 7+9 2+12	none	76.0	35.6	80.7
0 7+9 2+12	none	69.9	35.8	64.6
1 7+9 5+10	none	75.8	32.1	96.6
2* 7+9 5+10	none	79.6	32.6	97.5
1 7+9 2+12	present	66.7	35.4	69.9

Source: ***Martonvasar,*** 1995.

Table 5. Effect of MvM 57-91 sublines on breadmaking quality in different mixtures.

HMW glutenin composition	1R/1B	Brabender farinograph value	Wet gluten content (%)	Gluten index
1 7+9 2+12	none	77.6	31.4	75.5
2* 7+9 5+10	none	77.8	31.3	68.3
1 7+9 2+12	none	70.9	32.1	71.7
0 7+9 2+12	none	65.5	31.5	59.0
1 7+9 2+12	present	66.2	31.8	59.3

Source: ***Martonvasar,*** 1995.

include the 2+12 and HMW subunit components from the old Hungarian varieties if the aim is to increase gluten content, combined with good rheological properties. The latter did not reach the level of sublines with 5+10 subunits in all parameters, and the results obtained do not contradict the importance of the 5+10 subunits at the *Glu-D1* locus for the improvement of breadmaking quality found by several authors (Lorenzo et al., 1987; Lawrence et al., 1987; Lagudah et al., 1988). The results suggest further investigations concerning the role of the other HMW and LMW glutenin subunits and the interactions between them. This would provide further opportunities to separate genotypes with different genetic backgrounds in breeding for good breadmaking quality, especially from the old variety populations like Bánkúti 1201.

As in the old Hungarian varieties, morphologically similar populations of modern varieties, which consist of sublines with various glutenin components provide the possibility for greater plasticity with respect to both quality characters and other agronomic traits.

References

Hänsel, H., L. Seibert, S. Gröger & T. Lelley, 1994. HMW-Glutenin-Unterheiten von 22 seit 1948 in Österreich gezüchteten Qualitätswinterweizen und von deren Eltern. Bericht über die 45. Arbeitstagung 1994. der Arbeitsgemeinschaft der Saatzuchtleiter im Rahmen der VÖP, pp. 15-22. BAL Gumpenstein.

Lagudah, E.S., L. O'Brien & G.M. Halloran, 1988: Influence of gliadin composition and high-molecular-weight subunits of glutenin on dough properties in an F_3 population of a bread wheat cross. J Cereal Sci 7: 33-42.

Lawrence, G.J., H.J. Moss, K.W. Shepherd & C.W. Wrigley, 1987: Dough quality of biotypes of eleven Australian wheat cultivars that differ in high molecular weight glutenin subunit composition. J Cereal Sci 6: 99-101.

Lorenzo, A., W.E. Kronstad & L.G.E. Vieira, 1987: Relationship between high molecular weight glutenin subunits and loaf volume in wheat as measured by the sodium dodecyl sulfate sedimentation test. Crop Sci 27: 253-257.

Metakovsky, E.V., A.Y. Novoselskaya, M.M. Kopus, T.A. Sobko & A.A. Sozinov, 1984: Blocks of gliadin components in winter wheat detected by one-dimensional polyacrylamide gel electrophoresis. Theor Appl Genet 67: 559-568.

Payne, P.I., K.G. Corfield, L. Holt & J.A. Blackman, 1981: Correlations between the inheritance of certain high-molecular-weight subunits of glutenin and breadmaking quality in progenies of six crosses of bread wheat. J Sci Food Agric 32: 51-60.

Sozinov, A.A., A.J. Novoszelszkaja & A.A. Lusnyikova, 1987: Citologo-biohimicseszkij analiz szortov mjágkoj psenyicii sz zamesényijami i transzlokácijami 1B/1R v kariotipe. Citologia i Genetika 21: 256-260.