Good breadmaking quality wheat *(Triticum aestivum L.)* genotypes with 2+12 subunit composition at the Glu-D1 locus

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Abstract

Wheats from Bánkút played an important role in Hungarian wheat production from the thirties to the early sixties of this century. Their good flour quality was characterised mainly by a Brabender farinograph value of A, high gluten content and generally a 2+12 subunit at the HMW glutenin Glu-D1 locus. The breeding of wheat varieties with a similar type of quality would serve to broaden the genetic basis for the selection of good flour quality. Breeding lines with good breadmaking quality can be created not only from genotypes with 5+10 Glu-D1 subunits, but also from those with a 2+12 HMW glutenin composition. One example of this will be described below through a characterisation of the flour quality of the wheat line MvM 57-91.

Introduction

Over the last 15 years considerable progress has been made in wheat flour quality research through studies on the role of HMW glutenin. This is responsible to a great extent to the change in emphasis in breeding programmes, with attention now being paid to an improvement in protein composition rather than to an increase in protein content. The differences to be found in endosperm proteins influence the technological quality of the varieties, so the discovery of these correlations has contributed to the setting up of more conscious selection programmes.

The greatest attention has been given to the correlation between HMW glutenins and the quality traits of wheat flour and it is this aspect that has been used to the greatest extent in breeding. Several authors are of the opinion that subunits 1 and 2* at the Glu-A1 locus make similar contributions to good flour quality (Payne et

al. 1981, Branlard and Dardevet 1985, etc.). According to Payne et al. (1984), of the glutenin subunits to be found on chromosome 1B, 7+8, 13+16 and 17+18 all improve breadmaking quality, while investigations carried out by Lorenzo et al. (1987) and Lagudah et al. (1988) indicate the prime importance of the 7+8 subunit. Khan et al. (1989) reported, that varieties with subunit 8 showed a higher mixing time but a lower gliadin content, a lower farinograph absorption and a lower wet gluten content. In contrast varieties with subunit 9 showed the opposite effect.

At the same time it is quite clear that a 5+10 subunit at the Glu-D1 locus leads to an improvement in quality compared with a 2+12 or 3+12 subunit. The presence of the 5+10 subunits at the Glu-D1 locus led to a greater sedimentation value compared to the 2+12 subunit, according to Odenbach and Mahgoub (1988). A similar conclusion was drawn with respect to the 5+10 subunit by Lorenzo et al. (1987). The negative role of 2+12 on the Zeleny sedimentation volume, resistance and extensibility of the extensogram was proved by Uhlen (1990) on the basis of a study involving Norwegian genotypes, but she didn't find a difference between loaf volume of wheat genotypes with 5+10 and 2+12 Glu-D1 subunits. When comparing biotypes of different varieties, Lawrence et al. (1987) obtained significantly better Extensograph Units for biotypes with a 5+10 HMW glutenin subunits than for those with 2+12. Lagudah et al. (1988) also found the 5+10 allele to have an advantage over 2+12 in studies involving Brabender farinograph and extensograph values.

The importance of the 5+10 subunit is also emphasised by the fact that several authors are of the opinion that the HMW glutenins on chromosome 1D have a greater influence on flour quality than alleles on chromosomes 1A or 1B (Payne et al. 1981, 1984, 1988, Burnouf and Bouriquet 1983, Rogers et al. 1991).

Accordingly, breeders endeavour to select genotypes possessing the 5+10 HMW glutenin subunit. At the same time, the exclusive use of these subunits may entail many potential dangers, such as an increase in genetic vulnerability, a reduction in genetic variability, etc., which it would be wise to avoid. It is thus essential to look for genotypes which do not contain the 5+10 allele at the Glu-D1 locus of chromosome 1D, but nevertheless have a positive influence on flour quality.

Material and Methods

In the first experiment the HMW glutenin composition of old Hungarian wheat varieties was studied (Payne et al. 1981), together with their technological quality. This latter was tested using the Soltek SDS sedimentation method (SDS test). The results obtained were calculated using the conversion chart, an estimation of the manual SDS sedimentation value. The rheological properties of the flour were measured using a Brabender farinograph, which provides information about the water absorption of the flour, the constancy and elasticity of the dough and the rate of softening (Quisenberry 1967). The farinograph value is measured in accordance with the International Association of Cereal Chemistry (ICC) Standard (No. 115). The quantity and quality of gluten are decisive in the development of breadmaking quality. Gluten quality is determined by such characters as stretchiness, elasticity and rate of softening (Spillane and McGovern 1966). The gluten extension is a useful method for determining these characters (Pollhamer 1964). Wet and dry gluten content were measured using the Falling Number Glutomatic System.

In the second experiment sublines of the wheat variety MvM 57-91 were tested for gliadin composition and for the presence or absence of the 1B/1R translocation (Metakovsky et al. 1984, Sozinov et al. 1987). The HMW glutenin analysis and the flour quality tests were carried out using the methods described above.

Results and Discussion

The breadmaking quality of old Hungarian wheat varieties with 2+12 subunits at the Glu-D1 locus is generally characterised by high gluten content, combined with good gluten quality, as can be seen by the gluten extension values (Table 1). These old varieties were mainly selection in Bánkút, which is situated in S.E.Hungary in one of the most fertile regions of the Great Plain, traditionally famous for its wheat production. According to our investigations Bánkúti 5, Bánkúti 1201, Bánkúti 1205 and Székács 1242 contain subunit 2*, Béta Bánkúti subunit 1 in Glu-A1 locus and all of them possess subunit 7+9 in Glu-B1 locus. There was observed a low level heterogeneity in Glu-A1 where subunit 1 occured instead of 2* and subunit 7+8 instead of 7+9. This phenomenon reflects the character of the old varieties populations. Bánkúti 5 and Bánkúti 1205 can be

placed in farinograph category A_1, and Béta Bánkúti, Bánkúti 1201 and Székács 1241 in farinograph category A_2. On the basis of SDS sedimentation value these wheat varieties have good flour quality, though this is not reflected in the values calculated from Glu-1 scores. The other parental line involved in the Bánkút wheat varieties tested, Marquis, also has good rheological quality and a higher gluten content than Bánkúti 5, so the Bánkúti derivatives probably inherited their above-average gluten contents from this parent.

As in other breeding programmes, a negative correlation, confirmed by literary data, can be demonstrated between the breadmaking quality of the Martonvásár wheat varieties and breeding lines and the 2+12 Glu-D1 HMW glutenin subunits. Nevertheless, studies on a new breeding line, MvM 57-91, whose pedigree can be derived from Bánkúti 1201, have shown a high gluten content, with a dominant ratio of 2+12 HMW glutenin subunits at the glutenin locus on the 1D chromosome.

Table 1

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

Variety	SDS sedimentation value	Brabender farinograph value	Brabender farinograph water uptake (%)	Gluten content (%)	Gluten extension (mm)	Glu-1 score
Bánkúti 5	75	100.0	52.3	27.1	4.5	7
Bánkúti 1205	70	87.5	56.3	33.8	5.5	7
Béta Bánkúti	68	75.3	56.0	33.1	7.0	7
Bánkúti 1201	70	74.0	57.6	36.1	7.5	7
Székács 1242	68	76.4	58.8	34.2	6.5	7
Marquis (control)	66	71.6	56.4	33.8	4.5	6

In the course of detailed analysis it was discovered that the individual sublines differ from each other in their HMW glutenin composition and, based on gliadin analyses, in the presence or absence of the rye chromosome segment on the 1B

chromosome. Differences are to be found between the various 2+12 glutenin subunit sublines as to the characteristics determining their flour quality, depending on whether they contain the rye translocation or not (Table 2). An analysis of 8 lines from each type indicated that 1B/1B sublines, not containing the rye translocation, had greater SDS sedimentation values and Brabender farinograph values. The best 1B/1B sublines had SDS sedimentation values close to those of the Bánkút wheat varieties and could be placed in farinograph category A_2.

Although there was no demonstrable difference in gluten content between the two groups, the gluten extension of the 1B/1R lines increased, suggesting less favourable gluten quality and thus poorer rheological quality.

Table 2

SDS sedimentation and Brabender farinograph values of MvM 57-91 wheat lines with 2+12 HMW glutenin subunits and 1B/1B or 1B/1R genetic background*

Trait	1B/1B	1B/1R
SDS sedimentation	64	54
range	54-73	48-60
Brabender farinograph	68.7	54.6
range	55.3-78.4	49.6-61.5

* Average of 8 lines

In the course of the analysis two lines in the MvM 57-91 population were found to contain 5+10 subunit rather than 2+12. When the flour quality of these lines was compared to that of the 2+12 subunit sublines with the best SDS sedimentation values, it was found (Table 3) that although there was no difference in SDS sedimentation value, the Brabender farinograph value indicative of rheological quality was A_1 for the 5+10 sublines and A_2 for the 2+12 sublines. These results confirm the observation that the flour quality of the old Bánkút-type Hungarian wheats was characterised in the majority of cases by an A_2 farinograph category and high gluten content.

Table 3

Breadmaking quality properties of MvM 57-91 sublines selected for high SDS sedimentation value

HMW glutenin composition	Rye translo-cation	SDS value	Brabender farinograph value	Gluten content extension (%)	Gluten content extension (mm)
1 7+9 2+12	none	73	78.4 (A_2)	36.0	3.5
1 7+9 2+12	present	60	61.5 (B_1)	36.3	4.5
1 7+9 5+10	none	68	90.3 (A_1)	35.2	1.0
2* 7+9 5+10	none	68	91.2 (A_1)	34.3	2.0

Some of the parents in the pedigree of the line MvM 57-91 can be derived from Bánkúti 1201, so it can be assumed that its flour quality characters originate to some extent from this variety, since the other parents have poorer quality. Sublines containing the 1B/1R translocation have inherited the rye segment from the Mv 15 parent.

The above example confirms the conclusion that the role of HMW glutenin subunits, and thus the Glu-D1 locus, in influencing flour quality may be considerably modified by different genetic backgrounds, thus emphasising the presence of a complex system regulating wheat breadmaking quality. In the course of selection, genotypes with good flour quality must therefore be chosen after the joint consideration of a number of characters. The present data do not contradict earlier observations on the effect of 2+12 subunits on flour quality, but they draw attention to the need to study other protein components and the role of genotype.

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