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EFFECT OF Glu-B1 ALLELIC VARIABILITY ON BREAD-MAKING QUALITY IN WHEAT

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ABSTRACT

The relationship between the high molecular weight glutenin subunits (HMW GS) and bread-making quality components in 31 wheat cultivars from wheat core collection of Novi Sad wheat breeding centre were studied. All chosen cultivars possessed subunit 5+10 in the Glu-D1 locus, and subunits 1 or 2 in the Glu-A1 locus. Allelic variability was also observed in the Glu-B1 where subunits 7+8 were found in 9 cultivars, and 7+9 in 22 cultivars. All analysed cultivars had high Glu-1 quality score (ranged form 9 to 10). Eleven bread-making quality (BMQ) components were evaluated and significant differences were found for wet gluten content, extensigraph area and loaf width, between cultivars with 7+8 or 7+9 HMW GS.*

KEY WORDS:

wheat, HMW GS, bread-making quality

1. INTRODUCTION

The bread-making quality of wheat (*Triticum aestivum* L.) is primarily influenced by its protein content and gluten quality. Gluten is a polymeric protein network and a main source of the viscoelastic properties in dough [14]. The major gluten fractions are glutenin proteins composed of high molecular weight glutenin subunits (HMW GS) and low molecular weight glutenin subunits (LMW GS). These subunits provide a structural backbone to the gluten macropolymer through formation of disulfide bonds [6].

HMW GS are encoded by homeologous *Glu-1* loci located on long arms of group 1 chromosomes in cultivated bread and durum wheats, as well as in wild species of the Triticeae tribe. Allelic variability at *Glu-A1* locus in bread wheat cultivars is low when compared to the variability of *Glu-B1* and *Glu-D1* loci. It is known that only three alleles in *Glu-A1* locus are present in bread wheat cultivars, whereas thirty and eleven alleles are present in *Glu-B1* and *Glu-D1* loci, respectively.

Electrophoretic analyses of seed storage proteins – glutenins and gliadins have proven to be very useful in evaluation and characterization of wheat quality. It was shown that up to 60-65% of variability in bread making quality can be accounted for by differences in HMW glutenin composition [10,12]. Relationship between different *Glu-1* loci or different *Glu-1* allelic composition and quality parameters has been widely investigated in our region [3,5,18]. High dough strength is used as a predictor of good quality bread wheat and it has been attributed largely to the type of allele present at the *Glu-D1* locus, where the *Glu-D1*d allele (HMW GS 5+10) is most favourable [11]. Contribution of *Glu-A1* coded HMW GS to BMQ variation was minor and always was observed in synergic effect with *Glu-D1* coded subunit 5+10 [3,4]. Recently, it has been observed that *Glu-B1* alleles also could enhance dough strength and BMQ [11,2].

In the light of these new findings, the aim of present paper was to evaluate the effect of *Glu-B1* allelic variability on bread-making quality components in wheat cultivars from Novi Sad wheat core collection.

2. MATERIAL AND METHODS

Thirty-one wheat cultivars from core collection of Research Institute of Field and Vegetable Crops, Novi Sad were used. Ten cultivars were bred in Serbia, while 21 cultivars had international breeding background (Tab. 1). Wheat cultivars Cheyenne and Baranjka were used as control cultivars.

Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) on 10% gel, in Tris-glycine buffer (pH 8.3) was used for the analyses of twenty grains of each cultivar [16]. For allele clasification the system proposed by Payne and Lawrence [8] was used. *Glu-1* quality score was determined according to Payne et al. [9].

The following bread-making quality components were analysed: protein content (%, determined by Kjeldahl method), Zeleny sedimentation test (ml), Wet gluten content (%), Extensigraph area (cm^2), Farionograph quality number, Bread yield (g/100g flour), Loaf volume yield (ml/100g flour), Loaf height (mm), Loaf width (mm), Loaf volume (cm^3, rapeseed displacement method), and Loaf quality (scored 0-7, based on loaf volume, the spring and the break of the crust, cell size and distribution, and resilience and softness of the crumb). The values of bread-making quality components were based on 2-year average.

Statistical analysis: test of variances homogeneity between groups, and t test (two independent samples) for comparison of group mean values were performed using Statistica ver.5 software.

3. RESULTS AND DISCUSSION

The storage proteins of 31 wheat genotypes were separated by SDS-PAG electrophoresis to determine their HMW glutenin subunits. Five alleles at *Glu-1* loci were determined: two alleles at the *Glu-A1*, two at the

Glu-B1, and one at the *Glu-D1* locus. At the *Glu–A1* subunits 1 and 2* were determined. At the *Glu–B1* locus subunitis 7+9 and 7+8 were found. At the *Glu–D1* locus all cultivars possessed 5+10 HMW subunit. At the *Glu-A1* locus frequencies of subunits 1 and 2* were 41.93% and 58.07%, respectively. At the *Glu-B1* locus subunits 7+9 had significately higher frequency (70.97%) than subunits 7+8 (29.03%). The most frequent HMW glutenin composition was 2*7+9 5+10 (41.93%). *Glu-1* quality score was 10 for genotypes possessed HMW GS compositions 1 7+8 5+10 or 2* 7+8 5+10, and 9 for genotypes with 1 7+9 5+10 or 2* 7+9 5+10 (Tab.1).

TABLE 1. HMW GS COMPOSITION AND *Glu-1* QUALITY SCORE OF WHEAT CULTIVARS. UNDERLINED CULTIVARS ARE BRED IN SERBIA.

HMW GS	Cultivar	*Glu-1* score
1 7+8 5+10	Caldwell, Hira, Odeskaya 51, Lepenica	10
2* 7+8 5+10	Centurk, Flamura 80, Klein fortin, Leones Inta, Renan	10
1 7+9 5+10	Auburn, Cajeme 71, F 53-70, Nakhodka, Mironovskaya 808, NS 82/00, Sreca, Tavrichanka, Tiha	9
2* 7+9 5+10	Agent, Amadeus, Balkan, Bezostaya 1, Carazinho, Chris, Dnjestovkaya 25, Jugoslavija, NS 121/98, Partizanka, Pesma, Pinzon Inta, Pobeda	9

Statistical comparison of BMQ components average values showed that cultivars with *Glu-B1* coded subunit 7+9 possessed higher values for Zeleny sedimentation test, wet gluten content, loaf and loaf volume yield, loaf height and width, loaf volume and loaf quality score (Tab. 2). Significant differences were found for wet gluten content ($P_{0.01}$), and for loaf width ($P_{0.05}$). Cultivars with subunits 7+8 showed better dough strength through higher value of farinograph quality number, and significantly ($P_{0.05}$) higher value of extensigraph area (Tab. 2).

TABLE 2. MEAN VALUES OF BMQ COMPONENTS FOR CULTIVARS WITH *Glu-B1* HMW GS 7+8 AND 7+9

BMQ components	7+8	7+9	t value
Protein content (%)	13.29	13.26	0.08
Zeleny sed. test (ml)	31.78	32.05	0.18
Wet gluten (%)	28.80	29.48	3.00**
Extensigraph area (cm^2)	120.62	107.76	2.14*
Farin. quality number	71.93	69.59	0.93
Bread yield (g/100g flour)	139.10	139.34	0.80
Loaf vol. yield (ml/100g flour)	516.50	540.89	1.74
Loaf height (mm)	86.28	86.89	0.40
Loaf width (mm)	149.83	153.45	2.41*
Loaf volume (cm^3)	1278.33	1327.95	1.65
Loaf quality	4.40	4.98	0.93

In order to obtain genetic pattern suitable for evaluation of *Glu-B1* allelic variation effect on BMQ components, material for this study was selected according to previously reported results on the contribution of different *Glu-1* loci. At the *Glu-A1* subunits 1 and 2*, which equally contribute to BMQ [9, 17], were present at similar frequencies. The BMQ most important *Glu-D1* locus [9, 1] was uniform, represented by subunit 5+10. High *Glu-1* quality scores of all analysed cultivars reflect on their high genetic potential for good bread-making quality.

Statistical comparison of BMQ components mean values showed that cultivars with *Glu-B1* coded subunit 7+8 had higher dough strength, measured by farinograph quality number, and significantly ($P_{0.05}$) higher value of extensigraph area. These findings are in agreement with observations that the presence of allele *Glu-B1*b (subunit 7+8) was associated with higher dough strength based on several mixograph and extensigraph parameters [11, 2].

Cultivars with subunit 7+9 showed significant higher values for wet gluten content ($P_{0.01}$), and for loaf width ($P_{0.05}$). Among hard wheat cultivars high positive correlations existed between protein content, sedimentation value and wet gluten content [5, 10]. Our results showed significantly higher wet gluten content in 7+9 genotypes combined by roughly no difference in protein content, and nonsignificant difference in sedimentation value. One of the possible explanations for these findings may be the fact that subunits 7+9 had high frequency in Serbian germplasm [7] and it is shown that it was the most desirable among other *Glu-B1* HMW GS for Serbian wheat quality breeding programs. Positive selection pressure for high wet gluten content towards good bread making quality resulted in passive positive selection for subunit 7+9, too. Significantly higher value of 7+9 genotypes for loaf width and nonsignificant but higher values of all analysed baking parameters were in agreement with observations that high dough strength were negatively correlated with baking quality parameters [13, 15].

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