Agronomic and bread-making characteristics of durum wheat genotypes deriving from interspecific hybridisation with bread wheat

Palumbo M., Spina A., Boggini G.

in

Royo C. (ed.), Nachit M. (ed.), Di Fonzo N. (ed.), Araus J.L. (ed.).
Durum wheat improvement in the Mediterranean region: New challenges

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 40

2000
pages 515-518

Agronomic and bread-making characteristics of durum wheat genotypes deriving from interspecific hybridisation with bread wheat

M. Palumbo, A. Spina and G. Boggini
Experimental Institute for Cereal Research, Catania Section, Via Varese 43, 95123 Catania, Italy
E-mail: iscct@iol.it

SUMMARY – Modern durum wheat cultivars have been selected for pasta-making aptitude and usually present very strong and slightly extensible gluten, traits not suitable for bread-making utilisation. For this reason a breeding program was started with the aim of improving the bread-making quality of durum wheat. This research showed that the right relation between tenacity and elasticity of gluten greatly depends on some protein compositions rarely present in durum wheat cultivars, but frequent in lines or varieties obtained from interspecific hybridisation with bread wheat. From this type of germplasm, 17 breeding lines were selected for agronomic traits and bread-making aptitude. The best agronomic and qualitative results were nevertheless found in the lines characterised by the glutenin subunits HMW *Glu-A1 Null* and *Glu-B1 7+8.*

Key words: Durum wheat, interspecific genotypes, bread-making quality.

RESUME – *"Caractéristiques agronomiques et boulangères de génotypes de blé dur dérivés d'hybridation interspécifique avec* Triticum aestivum*". Les modernes variétés de blé dur ont été sélectionnées pour leur aptitude à produire des pâtes et d'ordinaire elles ont un gluten très fort et peu extensible. Ces caractéristiques ne sont pas aptes pour la panification. Pour cette raison un programme de croisement fut commencé pour améliorer la qualité de panification du blé dur. Cette recherche montra que la relation exacte entre la ténacité et l'élasticité du gluten dépend principalement de quelques compositions protéiques qui sont rarement présentes dans les variétés de blé dur, mais qui sont fréquentes dans les lignées ou les variétés obtenues par hybridation interspécifique avec blé tendre. De ce germoplasme, 17 lignées furent sélectionnées pour leurs caractéristiques agronomiques et leur aptitude à la panification. Toutefois les meilleurs résultats agronomiques et qualitatifs furent trouvés en lignées caractérisées par la sub-unité HPM* Glu-A1 Nulle *et* Glu-B1 7+8.

Mots-clés : *Blé dur, génotypes interspécifiques, qualité de panification.*

Introduction

Durum wheat utilisation in bread production is ever increasing in many Mediterranean regions. Many types of bread, whose features vary according to local habits, have spread because of their good qualities and diffusion of the Mediterranean diet. In Italy, in the last 10 years, the share of durum wheat used for bread-making has shifted from 4% to 10% of the national production of durum wheat.

Since 1984 the Catania Section of the Experimental Institute for Cereal Research has evaluated the bread-making quality of Italian durum wheat cultivars (Boggini *et al*., 1988a, 1994). These studies showed that most of the modern durum wheat cultivars, selected for past-making aptitude, usually present very strong and slightly extensible gluten, traits not suitable for bread-making utilisation.

For this reason a breeding program was started with the aim of improving bread-making quality of durum wheat. This research showed that the right relation between tenacity and elasticity of gluten greatly depends on protein compositions. In particular we previously observed that some HMW glutenin components rarely present in durum wheat germplasm are frequently present in lines or varieties obtained from interspecific hybridisation with *Triticum aestivum* and that they showed a better bread making quality (Boggini *et al*., 1995a,b, 1998). Therefore, genetic material from *aestivum* × *durum* crosses was created with the main objective to transfer in *Triticum durum* genome the HMW glutenins encoded by the chromosome 1A (*Glu-A1*), usually absent in most cultivars of durum wheat.

Materials and methods

During the four year period 1996-1999, 45 durum wheat genotypes deriving from interspecific hybridisation with common wheat were evaluated for agronomic and productive characteristics. Agronomic trials were carried out at Catania, Sicily (180 m asl) in comparison with the commercial varieties Duilio, Simeto and Ofanto. The 17 best productive genotypes were re-evaluated in 1997 and 1998 for agronomic values and protein content, while the other quality parameters as previously described by Boggini and Pogna (1998b) and Boggini *et al*. (1995b) were evaluated on the 1998 production. Electrophoretic analysis of the reduced total proteins of the genotypes was made according to Pogna *et al*. (1990).

Results and discussion

Because of the high agronomic selection pressure, only two new genotypes showed the HMW *Glu-A1* composition different from *Null* type: line CTA 201, presenting HMW *Glu-A1* subunit *1* and line CTA 309, with subunit *2**.

Concerning the HMW glutenin compositions, seven genotypes showed subunits *7+8*, six subunit *20* and four subunits *6+8*. Only one line had LMW glutenin type 1.

Line CTA 379 resulted the most productive and showed the same yield of testers Duilio and Simeto. The other seven genotypes showed good production in both years, due to their good adaptability to the Sicilian environment.

Interspecific genotypes showed hectolitre weight better than tester varieties and some lines presented also a superior 1000 grain weight. The best kernel characteristics of the interspecific lines allow a superior mean protein content than the commercial varieties. Relatively to the other quality traits, we observed that some new genotypes presented values superior to the testers. Only for the farinograph development time the high value of the testers resulted superior to the interspecific hibrids value. It is interesting also to observe that for the alveograph P/L, mean and lowest value of the new lines are lower than those of the tester varieties (Table 1).

Table 1. Mean, range and standard deviation of yield and qualitative parameters of lines deriving from interspecific hybridisation and testers

Quality factor	Interspecific lines		Testers		SD
	Mean	Range	Mean	Range	
Wheat†					
Yield (t/ha)	5.06	3.86-6.18	5.75	5.13-6.17	
Hectolitre weight (kg/hl)	80.59	77.55-82.95	78.93	76.55-81.80	
1000 grain weight (g)	34.21	26.55-41.95	36.60	32.75-39.60	
Semolina					
Protein (% DM)†	12.04	10.45-13.25	11.47	11.00-11.80	0.7
SDS sedimentation volume (ml)	46.80	35.0-63.0	51.33	47.0-56.0	10.6
Farinograph					
– Dough development time (s)	147.8	120.0-180.0	166.7	150.0-200.0	3.8
– Dough stability (s)	159.8	90.0-306.0	206.0	186-240	8.2
– Mixing tolerance (B.U.)	85.3	60.0-145.0	60.0	55.0-75.0	24.5
Alveograph					
– W (10^{-4} j)	111.82	46.11-198.68	144.27	94.89-175.40	49.8
– P/L	1.37	0.81-2.42	1.48	0.94-1.86	0.6
Bread					
– Loaf volume (cm^3)	382.6	295.0-442.5	410.0	390.0-437.5	42.8
– Porosity (1÷8)††	6	5-8	6	5-7	0.8

†Data from biennium 1997-1998.
††1 = highest; 8 = lowest.

We found a significant correlation between protein content, P/L alveograph and farinograph development time with bread volume therefore we considered these parameters appropiate to evaluate the influence of glutenin subunits composition on bread-making quality. Our data confirmed the superior effect of the composition HMW *Glu Null,7+8* and LMW *Glu* type *2* on bread-making quality, as previously observed by Boggini and Pogna (1988b), and poor effect of glutenins encoded by *Glu-A1* gene (Table 2).

Table 2. Means of agronomic and qualitative parameters of interspecific lines grouped by glutenin composition in comparison with testers

Proteic composition		Number genotypes	Yield (t/ha)	Hectolitre weight (kg/hl)	1000 grain weight (g)	Protein (%)	Alveograph (P/L)	Farinograph dough development time (s)	Bread volume (cm^3)
HMWG	LMWG								
N, 6+8	2	4	5.00	79.4	33.7	12.12	1.37	152.0	388.7
N, 7+8	2	6	4.96	78.6	33.5	11.90	1.85	158.5	407.5
2*, 7+8	2	1	4.05	77.3	31.9	11.40	2.12	120.0	385.0
N, 20	2	4	5.34	79.5	31.9	11.10	1.30	145.5	353.1
N, 20	1	1	4.58	76.0	25.2	12.10	2.00	120.0	332.5
1, 20	2	1	5.53	80.0	39.1	12.40	1.27	132.0	375.0
		Testers:							
N, 7+8	2	Duilio	5.71	79.6	34.2	11.80	1.63	200.0	390.0
N, 20	2	Ofanto	5.26	73.7	30.2	11.70	0.94	150.0	437.5
N, 7+8	2	Simeto	5.54	76.3	31.9	11.50	1.86	150.0	402.5

These results indicate that genetic improvement for bread-making aptitude in durum wheat seems to be a difficult task. Probably glutenin composition influence on baking performance is as important as protein content and interaction between proteins and starch.

However, recent evidence suggests a positive effect on bread-making quality of the same LMW glutenin subunits, encoded by the *Glu-D3* locus, translocated into durum genotypes using common wheat variety with 1AS/1DS translocation (Ceoloni *et al.*, 1995, 1996; Pogna *et al*., 1996).

Waiting for the availability of this new germplasm, we work on improving line CTA 230 (HMW *Glu Null, 7 + 8* and LMW *Glu* type *2*) for yield, high protein content, low P/L alveograph, good dough development time and high bread volume.

References

Boggini, G., Palumbo, M. and Biancardi, A.M. (1988a). Panificabilità delle varietà di grano duro. Risultati di un triennio di prove. *Tecnica Molitoria,* 7: 609-617.

Boggini, G. and Pogna, N.E. (1988b). The breadmaking quality and storage protein composition of Italian durum wheat. *J. Cereal Sci.,* 9: 131-138.

Boggini, G., Tusa, P. and Pogna, N.E. (1994). Qualità panificatoria di genotipi di grano duro a composizione proteica “atipica”. *Tecnica Molitoria,* 8: 825-835.

Boggini, G., Tusa, P. and Pogna, N.E. (1995a). Protein composition and bread making quality of durum wheat. In: *Proc. Wheat Kernel Protein, Molecular and Functional Aspects.* Un. Studi Tuscia and CNR, pp. 291-293.

Boggini, G., Tusa, P. and Pogna, N.E. (1995b). Bread making quality of durum wheat genotypes with some novel glutenin subunit compositions. *J. Cereal Sci.,* 22: 105-113.

Boggini, G., Tusa, P., Di Silvestro, S. and Pogna, N.E. (1998). Agronomical and quality characteristics of durum wheat lines containing the 1BL/1RS translocation. *J. Genet. Breed.,* 53: 167-172.

Ceoloni, C., Biaggetti, M., Ciuffi, M., Forte, P. and Pasquini, M. (1996). Wheat chromosome engineering at the 4x level: The potential of different alien gene transfers into durum wheat. *Euphytica,* 89: 87-97.

Ceoloni, C., Ciaffi, M., Lafiandra, D. and Giorni, B. (1995). Chromosome engineering as a means of transferring 1D storage protein genes from common to durum wheat. In: *Proc. 8th Inter. Wheat Genetics Symp.,* Li, Z.S. and Xin, Z.Y. (eds), Beijing (China), 1993, pp. 159-163.

Pogna, N.E., Autran, J.C., Mellini, F., Lafiandra, D. and Feillet, P. (1990). Chromosome 1B-encoded gliadins and glutenin subunits in durum wheat: Genetics and relationship to gluten strenght. *J. Cereal Sci.,* 11: 15-34.

Pogna, N.E., Mazza, M., Redaelli, R. and Ng, P.K.W. (1996). Gluten quality and storage protein composition of durum wheat lines containing the Gli-D1/Glu-D3 loci. In: *Gluten 96,* Wrigley, C.W. (ed.). Cereal Chem. Div. Royal Austr. Chem. Inst., North Melbourne, Sidney, pp. 18-22.