

Characterization of endosperm proteins and bread-making quality in wheat breeding lines carrying resistance genes for *Mayetiola destructor* and/or *Heterodera avenae*.

B. Fernández, P. Giraldo, A. Delibes, C. Jalvo, J.M. Carrillo, E. Benavente, J.F. Vázquez, I. López-Braña, E. Simonetti, and M. Rodríguez-Quijano.

The experimental material included thirteen bread wheat-breeding lines that carry genes for resistance to *M. destructor* and/or *H. avenae*. The sources of these resistances are the wild species *Ae. triuncialis* and *Ae. ventricosa* (lines TR and H-93, respectively) (Delibes et al. 1993, 1997; Romero et al. 1998). We have determined the composition in HMW-glutenin subunits (related with bread-making quality), puroindoline proteins (related with hardness of grain), and waxy proteins (related with starch viscosity). In addition to, we analysed the bread-making quality and some agronomic parameters of the lines. A previous analysis of prolamins by electrophoresis SDS-PAGE indicated the homogeneity of the lines.

Glutenins were extracted from crushed endosperm (Singh et al. 1991) and the extracts fractionated by SDS-PAGE electrophoresis (Payne et al. 1980). Waxy proteins were extracted from the flour, and electrophoresis was performed as described by Rodríguez-Quijano et al. (1998). Puroindoline allelic composition was obtained by DNA isolation (Dellaporta et al. 1983) and PCR amplification of pinA and pinB coding regions with specific primers (Giroux and Morris 1997).

Gluten strength was estimated by the SDS-sedimentation (SDSS) test (Mansur et al. 1990). Protein was measured with a NIR spectroscope (Infra-lyzer 300). Mixing time (MT), and resistance to breakdown (BDR) were determined using 10 g of flour and a National Manufacturing Co. Mixograph apparatus (Lincoln, NE), as described by Finney and Shogren (1972). Starch viscosity was analysed by a Rapid Visco Analyser (RVA-3D, Newport Scientific, Pty. Ltd.) and the viscosity peak (VP) parameter was derived from the RVA curve. All parameters were measured twice. Line Ma-99-75-5 (H93) was not tested because the amount of material was insufficient.

The results indicate variability for proteins in the breeding lines (Table 3). Regarding to bread-making quality, four lines stand out for their high dough strength: ID-2193, ID-2151, ID-2004 and Ma-99-93-1 (Table 3). Lines ID-2193 and Ma-99-93-1 are resistant for *M. destructor*, line T-2004 carries resistance genes for both *H. avenae* and *M. destructor* while line ID-2151 lacks resistance genes.

According to their composition in puroindoline proteins, the lines were identified as having a 'soft' or 'hard' endosperm (Table 3). This is an important classification to determine their final use since the hard wheat varieties are the most valuable in bread-making industry. Among the lines with good bread-making quality, three are hard and one is soft (Table 3).

The waxy protein analysis has revealed that two lines possess the null allele (*b*) for the *Wx-B1* locus. Yamamori et al. (1992) related the presence of null alleles with less amylose content on bread wheat starch. The

ratio amylose/amylopectin is very important in relation to the end use of any variety. Oda et al. (1980) determined that the noodles made of flour that are low in amylose were the favourites of Japanese consumers. High viscosity peak from

Table 3. Genetic composition of the breeding lines.

Breeding line	Locus and HMW-glutenin subunits			Hardness	Locus and alleles of waxy proteins		
	<i>Glu-A1</i>	<i>Glu-B1</i>	<i>Glu-D1</i>		<i>Wx-A1</i>	<i>Wx-D1</i>	<i>Wx-B1</i>
ID-2181 (TR)	2*	17+18	5+10	Hard	<i>a</i>	<i>a</i>	<i>a</i>
T-2003 (TR)	1	7*+9	5+10	Hard	<i>a</i>	<i>a</i>	<i>a</i>
T-2004 (TR)	2*	6+8	5+10	Hard	<i>a</i>	<i>a</i>	<i>b</i>
T-2105 (TR)	2*	17+18	5+10	Hard	<i>a</i>	<i>a</i>	<i>b</i>
ID-2193 (H93)	1	7*+8	2+12	Hard	<i>a</i>	<i>a</i>	<i>a</i>
ID-2150 (H93)	1	7*+9	5+10	Hard	<i>a</i>	<i>a</i>	<i>a</i>
ID-2151 (H93)	1	7*+8	2+12	Soft	<i>a</i>	<i>a</i>	<i>a</i>
Ma-1612a (H93)	1	7*+8	2+12	Hard	<i>a</i>	<i>a</i>	<i>a</i>
Ma-1612b (H93)	1	7*+8	2+12	Hard	<i>a</i>	<i>a</i>	<i>a</i>
Ma-99-75-5 (H93)	1	7*+8	2+12	Hard	<i>a</i>	<i>a</i>	<i>a</i>
Ma-99-93-1 (H93)	1	7*+8	2+12	Hard	<i>a</i>	<i>a</i>	<i>a</i>
Ma-99-41-6 (H93)	Null	7*+8	2+12	Soft	<i>a</i>	<i>a</i>	<i>a</i>
Ma-99-104 (H93)	1	7*+8	2+12	Soft	<i>a</i>	<i>a</i>	<i>a</i>

RVA correlates with a lower content in amylose. The highest values for the VP parameter are found in the lines ID-2150, Ma-99-93-1, ID-2181, T-2004 and T-2105 (Table 4). These two latter lines are those having the null allele at the *Wx-B1* locus (Table 3, p. 140).

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Table 4. Quality parameters of the breeding lines.

Breeding lines	% Protein (14% Hum)	SDSS (mm)	Mixograph analysis		Starch viscosity VP (RVU)
			MT (s)	BDR (%)	
ID-2181 (TR)	9.9	71.0	156.0	15.4	306.6
T-2003 (TR)	10.5	67.0	120.0	27.7	275.6
T-2004 (TR)	11.4	86.5	165	13.3	301.9
T-2105 (TR)	9.9	79.0	90.0	17.2	313.9
ID-2193 (H93)	9.5	94.0	110.0	18.3	280.7
ID-2150 (H93)	8.9	65.5	150.0	15.4	313.9
ID-2151 (H93)	10.6	79.0	140.0	13.43	266.5
Ma-1612a (H93)	10.2	57.0	130.0	18.2	254.7
Ma-1612b (H93)	8.9	67.5	210.0	13.4	187.9