Quality (Breadmaking) Characteristics of Normal (1B/1B) and Translocation (1B/1R) Wheats Varying in Dough Stickiness Character at Two Mixing Speeds

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INTRODUCTION

It has been suggested (Dhaliwal et al., 1988; Martin and Stewart, 1986; Payne et al., 1987) that the introduction of the 1RS chromosome of rye into wheat results in decreased breadmaking quality and dough stickiness, particularly at high mixing speeds. However, this has not been proven. In contrast, some studies (Barnes, 1990; Dhaliwal et al., 1990; Peña et al., 1990; Rogers et al., 1989) have shown that there are 1B/1R translocation cultivars, particularly soft wheats, which do not show inferior baking quality and/or sticky dough. This study examined normal (1B/1B) and translocation (1B/1R) wheats in relation to their quality characteristics, HMW-glutenin subunit composition, and dough stickiness character under low and high mixing speed.

MATERIALS AND METHODS

Twenty-one normal (1B/1B) and 18 translocation (1B/1R) bread wheats, grown in Sonora, Mexico, in 1988/89, were used in this study. Grain hardness index, (percent of meal produced) was determined by pearling 20 g-grain samples for 1.0 min in a wheat pearler. Flour protein content (Nx5.7), SDS-sedimentation, Alveographic characteristics, and breadmaking properties (100 g-flour formula) were determined as previously described (Peña et al., 1990). Doughs for stickiness assessment and for breadmaking were slightly overmixed in a pin mixer (National Mfg Co.) at low and high (70 and 185 rpm, respectively) mixing speeds. The dough was placed in a covered aluminum bowl and allowed to rest for 5 min. The dough was then hand-kneaded, applying a light pressure to see if it stuck to the hands when they were pulled apart. The kneading-pressing operation was repeated 12 times. In sticky doughs , stickiness appeared after four to eight kneading-pressing operations, whereas nonsticky doughs could be kneaded and pressed 12 times without evidence of stickiness. Some doughs showed from moderate to slight sticky character at the end of the stickiness assessment. Stickiness was evaluated by three previously trained persons. To evaluate stickiness statistically, a stickiness score from 1 to 5 was established; 1 corresponding to nonsticky doughs and 5 corresponding to very sticky doughs. From this scoring, three stickiness classes were derived: nonsticky (NS), 1.0 to 2.2; slightly sticky (SS), 2.3 to 3.5; and sticky (S), 3.6 to 5.0. High molecular weight-glutenin (HMW-glu) subunit composition was determined using SDS-PAG electrophoresis. HMW-glu subunits

were identified and numbered as described by Payne and Lawrence (1983).

RESULTS

Dough mixing time, at high speed, was significantly longer in the normal (1B/1B) than in the translocation (1B/1R) wheat population (Table 1). No other significant differences were found when comparing the quality characteristics of these two populations (Table 1).

Both genotypic populations included lines showing nonsticky, slightly sticky and sticky doughs; two (2) 1B/1B lines and four (6) 1B/1R lines had sticky dough at low (high) mixing speed (Table 2). More than 50% of the lines in both populations fell into the SS stickiness class. Some samples changed in their stickiness classification when passing from the low-speed to the high-speed mixing condition; only one sample (1B/1R) changed from NS to S when mixed at high speed (Table 2). However, differences in stickiness due to mixing speed were not significant.

The samples (1B/1B and 1B/1R) were grouped into dough stickiness classes (as determined at low and high mixing speeds), and compared with respect to their quality characteristics. At low mixing speed, the NS group showed significantly softer grain, larger protein content and better quality-related characteristics than the SS and S groups (not shown). At high mixing speed, the NS group showed stronger gluten type (larger sedimentation volume, larger W value and longer mixing time) than the SS and S groups (Table 3); however, no differences were observed with respect to flour protein, gluten tenacity/extensibility (P/G) ratio, and bread loaf volume, among the three stickiness groups.

Electrophoretic analysis revealed the HMW-glu subunit variations present in both genotypic populations. The distribution, in relation to HMW-glu subunit composition, of the two populations, grouped in stickiness classes, was similar at both mixing speed conditions; distribution at high mixing speed is shown in Table 4. Most of the lines (1B/1B or 1B/1R) showed subunits 1 or 2*. The 1B/1B population and its NS class were characterized for having a larger (approximately 70%) proportion of lines with one of the three good subunits, 7+8, 13+16, or 17+18, than with 7+9; the other two stickiness classes had approximately the same proportions of these two subunit variants (Table 4). In contrast, the 1B/1R population and its SS and S classes were characterized for having a very large proportion of lines with subunit 7+9; the NS class did not have lines with subunit 7+9. In the 1B/1B population and in its SS and S classes, subunit 2+12 was present in larger proportion than 5+10; in its NS class, 5+10 predominated over 2+12. In the

1B/1R population and in its three stickiness classes, 5+10 predominated over 2+12.

CONCLUSIONS

Dough stickiness was observed in both normal and 1B/1R translocation wheats. This indicates that the stickiness problem cannot be attributed exclusively to the rye translocation in wheat. The only consistent quality differences between the nonsticky and the other two stickiness classes were in relation to gluten strength parameters. Although it has been suggested that mixing speed plays a role in dough stickiness, this could not be showed under the high mixing speed conditions used in this study. The HMW-glu subunits under the control of chromosome 1B, particularly subunit 7+9, appeared to contribute, at least partially, to the dough stickiness character of normal and 1B/1R translocation bread wheats.

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Table 1. Mean values for quality characteristics of normal (1B/1B) and translocation (1B/1R) wheat populations.

				Alveograph		Stickiness		Breadmaking	
Group	GH[a,d] % ± SD	FP % ± SD	SDS-S ml ± SD	$Wx10^{-4}J$ ± SD	P/G ± SD	LS[b] ± SD	HS[c] ± SD	Mix min ± SD	LV ml ± SD
1B/1B (n=21)	42.1 ± 5.2a	10.5 ± 1.1a	14.0 ± 3.1a	279 ± 85a	5.9 ± 2.3a	2.7 ± 1.0a	2.8 ± 1.0a	2.0 ± 0.7a	686 ± 68a
1B/1R (n=20)	41.0 ± 3.1a	10.6 ± 1.0a	12.4 ± 2.9a	253 ± 92a	6.8 ± 2.2a	2.9 ± 1.0a	3.0 ± 1.1a	1.7 ± 0.7b	686 ± 64a

[a]: GH=grain hardness; FP=flour protein; SDS-S=SDS-sedimentation; Mix=mixing time; LV=loaf volume.
[b]: Low Speed (70rmp).
[c]: High Speed (185rpm).
[d]: Mean values within one column followed by the same latter are not significantly different (alpha=0.05).
[e]: Under high mixing speed conditions.

Table 2. Distribution (No. of lines) of the normal (1B/1B) and the translocation (1B/1R) wheat population in relation to their dough stickiness classification at two mixing speeds.

	Dough Stickiness Class					
	NS[a]		SS		S	
Population	LS[b]	HS	LS	HS	LS	HS
1B/1B (n=21)	8	7	11	12	2	2
1B/1R (n=18)	3	1	11	11	4	6

[a]: NS=nonsticky; SS=slightly sticky; S=sticky.
[b]: LS=low mixing speed (70rpm); HS=high mixing speed (185rpm).

Table 3. Mean values for quality characteristics of wheats (1B/1B) grouped according to their dough stickiness characteristic under high speed (185rpm) mixing condition.

Stickiness class[a]	GH[b,c] % ± SD	FP % ± SD	SDS-S ml ± SD	Alveograph		Breadmaking	
				$Wx10^{-4}J$ ± SD	P/G ± SD	Mix min ± SD	LV ml ± SD
NS (n=8)	43.0 ± 6.0a	11.0 ± 1.2a	17.4 ± 2.9a	337 ± 101a	5.4 ± 2.2a	2.8 ± 0.6a	702 ± 89a
SS (n=31)	41.0 ± 2.3a	10.4 ± 1.1a	12.5 ± 2.1b	263 ± 73b	6.5 ± 2.3a	1.9 ± 0.6b	688 ± 59a
S (n=8)	42.0 ± 6.2a	10.5 ± 0.6a	11.8 ± 1.0b	224 ± 66b	6.5 ± 2.3a	1.7 ± 0.4b	675 ± 36a

a: NS=nonsticky; SS=slightly sticky; S=sticky.
b: GH=grain hardness; FP=flour protein; SDS-S=SDS-sedimentation; Mix=mixing time; LV=loaf volume.
c: Mean values within one column followed by the same latter are not significantly different (alpha=0.05).

Table 4. Distribution (%) of the normal (1B/1B) and the translocation (1B/1R) bread wheat population grouped in high mixing speed-dough stickiness classes in relation to their HMW-glutenin subunit composition.

Genotype and Stickiness class[b]		1A[a]	1B		1D	
		1 or 2*	7+8,13+16,or 17+18	7+9	5+10	2+12
1B/1B	(n=21)	95	67	34	43	58
NS	(n=7)	28	28	5	19	14
SS	(n=12)	57	34	24	24	34
S	(n=2)	10	5	5	0	10
1B/1R	(n=18)	100	23	72	72	28
NS	(n=1)	6	6	0	6	0
SS	(n=11)	61	11	50	44	17
S	(n=6)	33	6	22	22	11

[a]:Chromosome control.
[b]:NS=nonsticky; SS=sligthly sticky; S=sticky.