AGRONOMIC AND BAKING PERFORMANCE OF SEMI-DWARF TRITICALES[1]

K. LORENZ and J. WELSH, Department of Food Science and Nutrition and Department of Agronomy, respectively, Colorado State University, Fort Collins, CO 80523

ABSTRACT

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The agronomic and baking performance of seven semi-dwarf triticales, recently developed at CIMMYT, were evaluated. Under agronomic and climatic conditions, which in previous years produced tall spring triticales of satisfactory quality, the semi-dwarf variety Rahum produced yields higher than those of the wheat control and better than the average yield for triticales nationwide. The other semi-dwarf varieties performed less satisfactorily. Flour extraction rates of all triticales were relatively low due to poor kernel characteristics. All triticale flours had high α-amylase activities. Two of the semi-dwarf triticale flours, however, still produced breads of very satisfactory quality with minor modifications in the bread-baking process.

Commercial production of triticales in the U.S. began about 1970 with an estimated acreage of 30,000. It is believed that production has now increased to 200,000 acres (1). Triticale grain standards are now being considered.

Triticale milling fractions have been used for the production of breads (2–5), cakes and cookies (6), pasta products (7), extruded breakfast cereals (8), and in brewing (9), demonstrating that this man-made cereal has potential in many food applications.

Several of the inherent shortcomings of triticales—susceptibility to lodging, low tillering capacity, endosperm shrivelling during maturity, and high α-amylase activity—have been at least partially corrected in some lines in recent years. The genetic base of newer varieties is constantly being made more diverse, making continued evaluation of improved lines advisable.

CIMMYT has recently developed some semi-dwarf lines which, on experimental plots in Mexico, have shown great promise. It was the purpose of this study to evaluate the agronomic and baking performance of some of those semi-dwarf lines when grown in Colorado under agronomic and climatic conditions which in past years have produced tall spring varieties of very satisfactory quality (4,10).

MATERIALS AND METHODS

Sample Identification

Included in this study were one wheat and seven semi-dwarf triticales. The wheat cultivar, Colano, is a semi-dwarf hard red spring wheat selected from the CIMMYT program and released by Colorado State University in 1971. It was used as the control. The triticale variety Rahum and the other six semi-dwarf triticale selections originated in the CIMMYT program. They represent advanced lines which have shown improvement in agronomic type over earlier developed material.

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The wheat and the variety Rahum were grown at three different locations within Colorado—Fort Collins, Greeley, and Grand Junction. The other six triticale selections were grown at Fort Collins only under conditions which in past years have produced triticales which permitted the production of 100% triticale breads of satisfactory quality (10). All locations received a total of 10–12 in. of irrigation. The experimental plots were summer fallow ground. There were four replications for each trial. Grain yields and test weights were determined at each location.

Milling of Samples

The wheat and the triticales were milled on a Quadrumat Jr. mill. Wheat samples were tempered to 15% moisture and the triticales to 14%. Preliminary milling experiments indicated these moisture levels to be optimum.

Proximate Analyses and Rheological Properties

The grains and the flours were analyzed for moisture, protein, and ash using AACC approved methods ash 08-01 (1962), moisture 44-15A (1968), and protein 46-13 (1962) (11).

Amylograph viscosity of the flours was determined using Method 22-10 (1962). Mixing times and tolerances of the flours as well as absorptions were measured with the farinograph, Method 54-21 (1962).

Baking Experiments

Pup loaves were baked from each of the flours by the straight-dough procedure and the following formulation: 4% sugar, 3% nonfat dry milk, 3% shortening, 2.5% yeast, 2% salt, 0.5% yeast food, 0.5% sodium stearoyl-2-lactylate, 0.3% calcium propionate, and 20 ppm potassium bromate. Wheat-flour doughs were mixed in a Hobart N-50 mixer using a dough hook. The triticale-flour doughs were mixed with a paddle as described by Lorenz *et al.* (4). Fermentation time was 90 min for wheat-flour doughs and 60 min for triticale doughs at 30°C and 85% RH. The loaves were scaled 200 g each, four loaves per batch. They were mechanically molded, proofed to height at 35°C and 95% RH, and baked at 218°C for 18 min.

Specific loaf volume was measured by rapeseed displacement. The breads were scored as follows: for crust color, 7; symmetry, 7; break and shred, 6; crumb color, 10; volume, 15; flavor, 15; grain, 20; and texture, 20, the maximum number of possible points being indicated after each bread characteristic.

Bread crumb color was also measured with a Hunter Color Difference meter. The standard was L = 94.65, a = −0.6, and b = 0.1. The total color difference between the standard and each sample is expressed as

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}.$$

RESULTS AND DISCUSSION

Agronomic Performance

Yields and test weights recorded for the wheats and the semi-dwarf triticales are given in Table I. Rahum outyielded a wheat control on experimental plots at Colorado State University. Tall spring and winter triticales, grown experimentally in previous years, produced yields which are only 60–80% of those of wheat varieties (12). The test weights for Rahum were, however, lower than those of the wheat at each of the locations. Test weight is quite sensitive to environmental conditions and will reflect specific moisture and temperature stresses at the time of kernel development.

Only two of the other six semi-dwarf triticales (RF6009 and RF6025) produced satisfactory yields at Fort Collins, which is considered a high-production-potential site. With a decrease in yields, test weights increased. All triticales produced shrivelled kernels, which is one of the major shortcomings of this "man-made" grain.

Flour Extractions

Flour extractions of the wheat and triticale samples are presented in Table I. Extraction rates of the triticales were considerably lower than those of the wheat samples harvested at the three locations, mainly due to the differences in kernel characteristics between the grains. Lower flour extraction rates of triticales have been reported by many investigators (13).

Extraction rates for Colano ranged from 72.5 to 74.4% and for the triticale variety Rahum from 52.5 to 63.0%. The remaining six semi-dwarf triticales produced flour extractions ranging from 55.2 to 65.6%. Ergot infestation, seldom seen in the dry climate of Colorado, was found on each of the triticales. Moderate ergot contamination is partially responsible for the very low flour extraction rates. Lower flour extractions with ergot-contaminated grains have been reported by Shuey *et al.* (14).

With a decrease in flour extraction, bran yields increased proportionately as seen in Table I.

TABLE I
Agronomic Performance of Cultivars and Quadrumat Jr. Milling Data[a]

Location	Grain Sample	Yield bu/acre	Height In.	Test Weight lb/bu	Milling Data Flour %	Milling Data Bran %
Greeley	Colano	46.8	n.d.[b]	56.5	72.8	27.2
	Rahum	64.6	n.d.	45.9	52.5	47.5
Grand Junction	Colano	46.2	n.d.	59.3	72.5	27.2
	Rahum	53.2	n.d.	53.9	58.6	41.4
Fort Collins	Colano	65.2	28	58.9	74.4	25.6
	Rahum	65.9	30	43.3	63.0	37.0
	RF6005	22.0	27	58.0	58.8	41.2
	RF6009	53.1	29	44.3	63.6	36.4
	RF6012	42.6	27	48.4	62.7	37.3
	RF6016	24.0	32	53.6	55.5	44.5
	RF6018	35.3	30	57.2	59.5	40.5
	RF6025	66.4	27	44.6	65.6	34.4

[a]The wheat samples (Colano) were tempered to 15% moisture; the triticales were tempered to 14.5% moisture.
[b]n.d. = not determined.

TABLE II
Proximate Analyses of Grains and Flours[a]

Location	Sample	Grain[b] Moisture %	Grain[b] Protein %	Grain[b] Ash %	Flour[c] Moisture %	Flour[c] Protein %	Flour[c] Ash %	Flour[c] Amylograph viscosity BU
Greeley	Colano	10.7	17.8	1.82	14.1	16.1	0.63	2250
	Rahum	10.5	16.0	1.91	13.3	13.4	0.61	190
Grand Junction	Colano	10.0	9.1	1.55	14.2	7.6	0.62	3030
	Rahum	9.7	9.5	1.73	13.2	7.2	0.61	460
Fort Collins	Colano	11.9	15.8	1.79	14.0	14.0	0.55	2660
	Rahum	12.2	15.4	1.84	10.4	13.0	0.79	120
	RF6005	11.6	17.7	1.95	11.8	13.8	0.69	30
	RF6009	11.5	15.5	2.02	11.5	12.4	0.66	170
	RF6012	11.1	16.1	2.00	12.0	12.9	0.53	300
	RF6016	11.2	17.1	2.00	11.2	14.3	0.68	50
	RF6018	11.5	16.9	2.06	11.8	14.0	0.60	20
	RF6025	12.9	15.9	1.95	12.3	13.3	0.80	90

[a]On a 14% moisture basis.
[b]Grain protein = N × 6.25.
[c]Flour protein = N × 5.70.

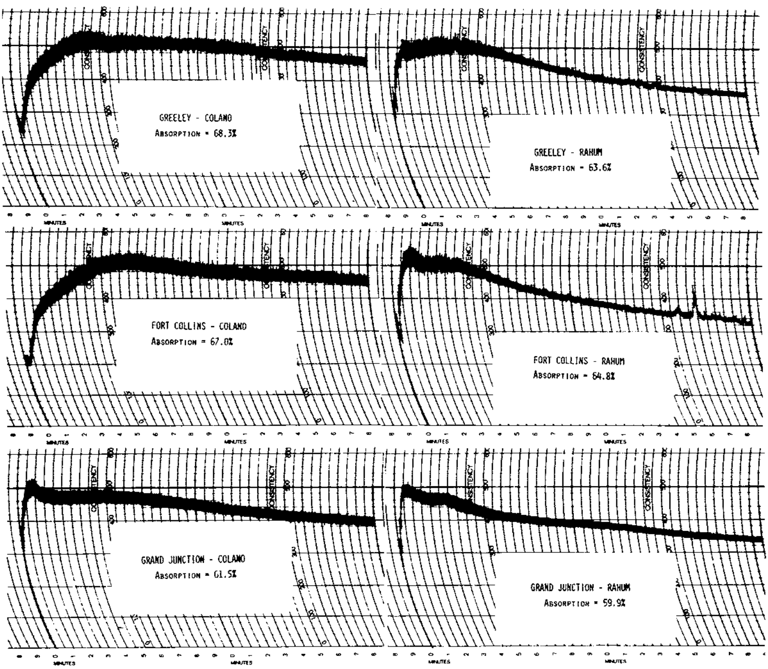

Fig. 1. Farinograph curves of wheat (Colano) and triticale (Rahum) flours from different experimental plots in Colorado.

Proximate Analyses of Grains and Flours

Grain protein contents of the Colano and Rahum samples varied considerably depending upon location, as seen in Table II. Wheat grain protein ranged from 9.1% at Grand Junction to 17.8% at Greeley. Rahum grain protein varied from 9.5 to 16.0% at the respective locations. Except for the Grand Junction samples, the wheats had higher protein contents than the triticales. The other six semi-dwarf triticales, grown at the Fort Collins site, had higher grain proteins than the wheat with the exception of RF6009. Lower test weights in wheat are generally associated with higher grain protein values (12), which also seems to be true with triticales.

Ash contents of all semi-dwarf triticales were higher than those of the wheat samples at each experimental site, which confirms previous reports (4,10,12,13).

Flour proteins reflect flour extraction rates. Flour proteins of the Colanos were higher than those of the Rahum flours and by a wider margin than in the grains before milling. The loss of the protein advantage of triticales over wheat, when milling the grain into flour, becomes apparent when examining the flour protein values of the semi-dwarf triticales from the Fort Collins site. Ash contents of most triticale flours were rather high despite the low flour extraction rates as shown in Table II.

Rheological Properties of Flours

Farinograph curves of Colano and Rahum flours from each of the three test sites are shown in Fig. 1. The difference in farinograph performance of the

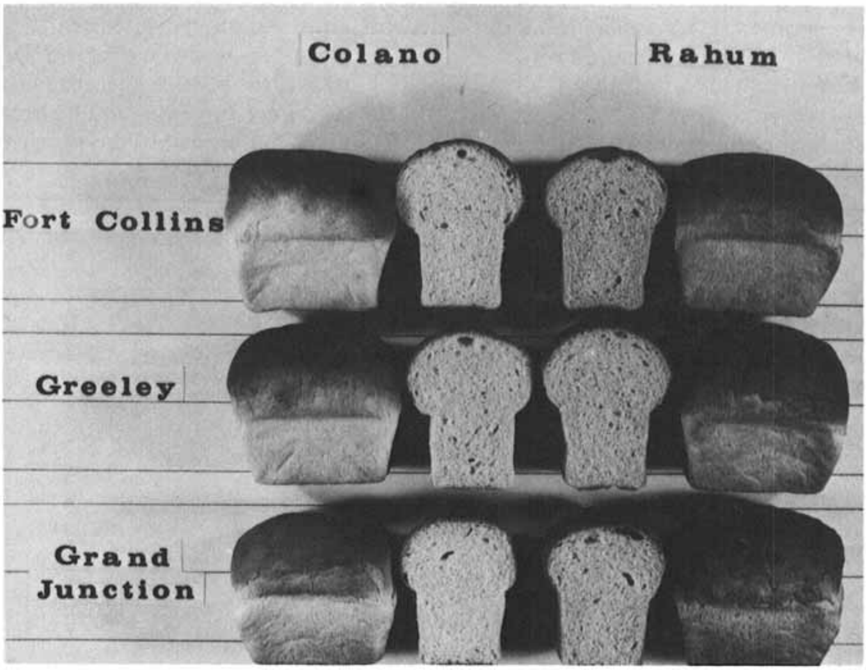

Fig. 2. Pup loaves baked from Colano and Rahum flours.

wheat flours from different locations is due to the considerable difference in protein content of the flours. Shorter arrival times were obtained for the triticale flours compared to the wheat flours, indicating faster uptake of water and faster dough developments. Dough stability values, departure times, and mixing-tolerance indices of the triticales were considerably lower than those of the wheat flours. Shorter mixing times and tolerances of triticales have also been reported by others (5,15,16).

Farinograms of the six other semi-dwarf triticale flours showed mixing characteristics similar to those of the Rahum flours.

Amylograph viscosities of the triticale flours were considerably lower than those of the wheat flours as shown in Table II. The wheat flours from the three locations produced BU values of over 2000, as expected for untreated flours. The low amylograph viscosities of triticale flours indicate a high α-amylase activity, which makes some of these flours completely unsuitable for bread-baking. A high α-amylase activity has been reported in other triticale lines (17).

Bread Baking Performance of Flours

Pup loaves baked from the Colano and Rahum flours are shown in Fig. 2. The wheat flour from Grand Junction performed poorly as would be expected from the low protein content of the flour. The triticale flours milled from the variety Rahum produced breads with very satisfactory volumes, as seen in Table III, using a modified baking procedure. The grain and the texture of these breads were good. The lower total scores of the Rahum breads baked from flours from the Greeley and Fort Collins locations compared to those of the wheat breads were mainly due to considerably darker crumb colors in the triticale breads, as seen in Fig. 2, and measured with a Hunter Color Difference meter (Table III).

Flour milled from the triticale line RF6012 also produced breads of satisfactory quality. The other five flours from the Fort Collins site, however, were unsuitable for bread-baking, as seen in Table III, mainly due to their high α-

TABLE III
Baking Quality of Flours From Semi-Dwarf Triticales

Location	Flour	Absorption %	Mixing Time min	Proof Time min	Sp Vol cc/g	Total Score 100 max	Grain 20 max	Texture 20 max	Crumb Color Difference ΔE
Greeley	Colano	68.3	8	35	4.30	87	15	17	29.85
	Rahum	63.6	6	39	4.48	86	14	17	33.22
Grand Junction	Colano	61.5	8	40	3.83	75	14	14	28.56
	Rahum	57.9	4	41	4.28	80	15	15	33.45
Fort Collins	Colano	67.0	10	36	4.36	90	17	18	29.51
	Rahum	64.8	6	37	4.23	85	14	17	34.83
	RF6005	69.0	4	43	3.40	43	7	7	42.81
	RF6009	67.4	6	39	3.99	62	10	10	34.69
	RF6012	66.4	5	37	4.12	84	16	15	29.34
	RF6016	69.0	6	34	3.92	54	8	8	38.86
	RF6018	69.0	4	38	3.75	53	7	6	38.09
	RF6025	66.2	5	35	3.92	73	14	14	35.95

amylase activity. The grain of these breads was very open and nonuniform, the texture very gummy, and the crumb color quite dark.

CONCLUSIONS

The semi-dwarf triticale Rahum has shown a very satisfactory agronomic performance at each of the three test sites. Grain yields exceeded those of the wheat controls, which is very encouraging considering that the national average yields of triticales are only about 85% of those of wheats (18). Yields of the other semi-dwarf triticales were less satisfactory. Kernel characteristics of all triticales were still rather poor.

Flour extractions of all triticales were lower than those of the wheats. These flours had very low amylograph viscosities making most of them unsuitable for bread-baking. Flours milled from Rahum and variety RF6012, however, produced 100% triticale breads of very satisfactory quality confirming earlier reports (4,12) that good quality triticale breads can be baked from certain varieties after minor modifications in the normal bread-baking process are made.

Recent triticale breeding efforts have produced a variety (Rahum) with very satisfactory yields and baking performances for agronomic and climatic conditions of the high altitude region of the U.S.

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