ENVIRONMENTAL INFLUENCE ON MILLING AND BAKING QUALITY OF TRITICALE

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ABSTRACT

Sixteen samples comprised of three triticale selections were obtained from six locations in three states. Milling, rheological, and baking data were collected on the samples to determine the influence of environment on the quality factors measured. Flour ash was related to grain ash and environment. Bake absorption, dough characteristics, and loaf volume were related to the protein content of the flour which was influenced by the environment.

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Several papers in recent years have discussed the milling and baking properties of triticales (1,2,3,4,5, 6). Generally, triticales have not had a good bread-baking properties (1,2,7) or produced satisfactory bread by regular baking procedures, but with special additives and major adjustments in the mixing procedure, triticale breads without supplementation of other flours have been reported (3,4,5,6). The study was initiated to determine the effect of environment on the quality of triticales, because to date the triticales grown in the Upper Midwest have failed to produce satisfactory bread.

MATERIALS AND METHODS

Origin of Samples

Three selections of triticale (TR-203, TR-204, and TR-419) were grown at five locations in three states: Ft. Collins, CO, Redfield, SD, and Fargo, Minot, and Williston, ND. An additional sample of TR-204 was received from Davis, CA, as well as a second sample of TR-204 grown at Ft. Collins, CO but from the Ft. Collins seed stock.

Milling Procedure

Patent flour samples were milled on a Buhler mill as described by Shuey *et al.* (8). The triticales were initially tempered to 12 per cent moisture for 18 hours, with an additional 1 per cent one-half hour before milling. This gave a rolled triticale moisture of 13 per cent to the first break roll.

The flour from the Brabender Quadrumat Jr. mill was milled by the procedure described by Lorenz *et al.* (3), except a lower rolled moisture of 13 per cent was used.

Analyses

The analytical data, moisture, ash, and protein, were obtained by conventional methods (9).

Baking Procedures

A conventional straight dough baking procedure described by Shuey *et al.* (10) and designated "National," was used for all of the tests. One series was baked by the procedure of Lorenz *et al.* (3), and was designated as "Hobart."

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TABLE I
GRAIN DATA FOR TRITICALE SELECTIONS

Location	T.W.	1000 Kwt.	Kernel Size Lg.	Kernel Size Sm.	Ash[a]	Protein[a]
	#/Bu.	g.	%	%	%	%
TR-203						
Ft. Collins, CO	48.6	48.3	83	1	1.95	13.3
Williston, ND	48.2	34.5	35	3	1.61	16.0
Minot, ND	50.0	47.6	75	0	1.44	11.9
Fargo, ND	47.8	41.3	45	1	1.97	14.6
Redfield, SD	49.1	43.1	60	1	1.97	11.9
TR-204						
Ft. Collins, CO	48.8	48.8	83	0	1.97	13.6
Williston, ND	47.6	33.2	33	4	1.62	16.1
Minot, ND	50.1	44.1	75	0	1.52	10.1
Fargo, ND	47.5	44.2	59	1	2.34	14.8
Redfield, SD	48.8	45.8	67	0	1.93	12.9
Davis, CA	52.2	43.3	66	1	1.81	11.3
TR-419						
Ft. Collins, CO	48.2	43.3	67	1	1.87	12.4
Williston, ND	46.2	32.1	22	6	1.62	16.0
Minot, ND	48.5	38.0	42	2	1.47	11.7
Fargo, ND	44.5	35.0	22	5	2.09	15.3
Redfield, SD	48.9	39.1	35	2	1.95	12.4

a 14% Moisture basis.

RESULTS AND DISCUSSION

The physical data for the grain are given in Table I for the three selections from the five stations, and the average data for each selection are given in Table II. There was a significant range in all of the characteristics for each of the selections grown at the five stations. The Williston samples consistently had the lightest 1000 kernel weight, smallest kernel size distribution, and highest protein content, and the Ft. Collins samples had the heaviest 1000 kernel weight and largest kernel size distribution. The Minot samples had the lowest protein.

The average date (Table II) did not show any significant difference in test weight and protein content among the three selections. Selections TR-203 and TR-204 had significantly heavier 1000 kernel weight and larger kernel size distribution than did selection TR-419. Selection TR-203 had the lowest ash content, and TR-204 had the highest ash content.

TABLE II
AVERAGE GRAIN DATA FOR TRITICALE SELECTIONS FOR 5 STATIONS

Selection	T.W.	1000 Kwt.	Kernel Size Lg.	Kernel Size Sm.	Ash[a]	Protein[a]
	#/Bu.	g.	%	%	%	%
TR-203	48.7	43.0	60	1	1.79	13.5
TR-204	48.6	43.2	63	1	1.88	13.5
TR-419	47.3	37.5	38	3	1.80	13.6

a 14% Moisture basis.

The milling data are given in Table III for the three selections from the five stations, and the average data for each selection are given in Table IV. The flour ash is adjusted to a common extraction of 65 per cent. A correlation coefficient of 0.58 was found between the flour ash at 65 per cent extraction and the whole grain ash. The three selections showed significant differences in the per cent flour extraction, flour ash, flour protein, and a difference between the whole grain and the flour protein content. The Fargo samples had the highest ash for both the flour and whole grain, while the Minot samples had the lowest. The average data showed the same relation between whole grain ash and flour ash; TR-203 had the lowest grain ash and flour ash, and TR-204 had the highest values for both. Although there was only 0.1 per cent difference in grain protein content (Table II), there was 0.5 per cent difference in flour protein content which was also reflected in the difference between whole grain and flour protein content among selections.

TABLE III
MILLING DATA FOR TRITICALE SELECTIONS

Location	Flour Extraction	Flour Ash @65% Ext.[a]	Flour Protein[a]	Protein Difference
	%	%	%	%
TR-203				
Ft. Collins, CO	58.4	.59	11.4	1.9
Williston, ND	54.9	.57	14.0	2.0
Minot, ND	60.7	.50	10.4	1.5
Fargo, ND	58.6	.60	12.7	1.9
Redfield, SD	56.8	.50	9.9	2.0
TR-204				
Ft. Collins, CO	58.6	.58	11.4	2.2
Williston, ND	54.0	.57	14.1	2.0
Minot, ND	61.6	.50	8.8	1.3
Fargo, ND	58.6	.73	12.2	2.6
Redfield, SD	57.6	.50	10.5	2.4
Davis, CA	65.2	.49	9.4	1.9
TR-419				
Ft. Collins, CO	62.5	.55	10.9	1.5
Williston, ND	54.7	.58	14.2	1.8
Minot, ND	63.2	.50	10.3	1.4
Fargo, ND	58.6	.64	13.4	1.9
Redfield, SD	59.4	.52	10.6	1.8

a 14% Moisture basis.

TABLE IV
AVERAGE MILLING DATA FOR TRITICALE SELECTIONS FOR 5 STATIONS

Selection	Flour Extraction	Flour Ash @65% Ext.[a]	Flour Protein[a]	Protein Difference
	%	%	%	%
TR-203	58.9	.55	11.7	1.9
TR-204	58.1	.58	11.4	2.1
TR-419	59.7	.56	11.9	1.7

a 14% Moisture basis.

A comparison of the milling results between the two types of mills is given in Table V. The flour ash was much lower for the Buhler-milled flour, although the extraction was 13 per cent higher than for the Quadrumat-milled flour.

TABLE V
COMPARISON OF MILLING RESULTS ON SELECTION TR-204 GROUND ON TWO DIFFERENT MILLS

Mill	Flour Extraction	Flour Ash[a]	Flour Protein[a]	Protein Difference
	%	%	%	%
Buhler	58.6	.54	11.4	2.2
Quad.	45.6	.68	12.2	1.4

a 14% Moisture basis.

Table VI is a comparison of the TR-204 flour baked by the procedure described by Lorenz *et al.* (3), and the regular straight dough method with two levels of bromate and two fermentation times. The data showed a slight advantage for the conventional method, but neither of the methods produced satisfactory bread as shown in Fig. 1.

TABLE VI
EFFECT OF BAKING PROCEDURE ON BAKING CHARACTERISTICS OF TR-204

Mixer	Mix. Time	Ferm. Time	Bromate	Abs.	Dough Charac.[a]	Crumb Color[b]	Crumb Grain[c]	Loaf Vol.
	min.	hr.	p.p.m.	%				
Hobart	8	2	15	68	20	40	Soggy	525
Hobart	8	3	15	68	20	40	Soggy	445
National	1	2	15	59	8	40	Soggy	580
National	1	3	15	59	8	40	Soggy	525
Hobart	8	2	30	68	20	40	Soggy	550
Hobart	8	3	30	68	20	40	Soggy	465
National	1	2	30	59	8	40	Soggy	580
National	1	3	30	59	8	40	Soggy	525

a 1 = Bucky, 3 = Elastic, 6 = Pliable, 9 = Weak, 30 = Dead.
b 100 = Standard for normal spring wheat. Decreasing numbers indicate greater dullness and poorer color.
c Decreasing numbers indicate more open and harsher grain and inferior quality. Soggy = Too poor for numerical rating.

Because of the poor baking results from the Buhler-milled samples, a sample of TR-204 was milled on the Quadrumat Jr. Mill to see if the mill and extraction could be a factor. Although there was a significant difference in the milling results, there was essentially no apparent advantage in one flour over the other, except for bake absorption as shown in Table VII. Neither of the flours produced an acceptable loaf of bread with a conventional baking formula and procedure.

TABLE VII
EFFECT OF EXTRACTION ON BAKING CHARACTERISTICS OF TR-204

Mill	Mix. Time	Ferm. Time	Bromate	Abs.	Dough Charac.[a]	Crumb Color[b]	Crumb Grain[c]	Loaf Vol.
	min.	hr.	p.p.m.	%				cc.
100% TR-204								
Buhler	1.00	3.0	20	64.0	7	40	Soggy	610
Quad.	1.25	3.0	20	66.0	8	40	Soggy	605
80% TR-204 + 20% HRS FLOUR								
Buhler	1.33	3.0	20	63.8	6	95	50	700
Quad.	1.33	3.0	20	66.6	7	95	50	740

a 1 = Bucky, 3 = Elastic, 6 = Pliable, 9 = Weak, 30 = Dead.
b 100 = Standard for normal spring wheat. Decreasing numbers indicate greater dullness and poorer color.
c Decreasing numbers indicate more open and harsher grain and inferior quality. Soggy = Too poor for numerical rating.

A series of blends were made with spring wheat flour and triticale flour to find a blend which would reflect a difference in baking quality of the triticale flour, but with a minimum amount of spring wheat flour in the blend. The baking data (Table VIII) showed that a blend containing 20 per cent spring wheat flour and 80 per cent triticale flour was the minimum amount of spring wheat needed in the blend to give doughs with distinguishable characteristics, and to produce loaves with significant differences in crumb grain and loaf volume.

TABLE VIII
EFFECT OF BLENDING SPRING WHEAT ON BAKING CHARACTERISTICS OF TR-204

% Spring	% TR-204	Mix. Time	Abs.	Dough Charac.a/	Crumb Colorb/	Crumb Grainc/	Loaf Vol.
		min.	%				cc.
0	100	1.00	64.0	8	40	Soggy	545
10	90	1.00	63.9	7	90	40	635
20	80	1.33	63.8	6	95	50	700
30	70	1.50	63.6	7	97	55	695

a 1 = Bucky, 3 = Elastic, 6 = Pliable, 9 = Weak, 30 = Dead.
b 100 = Standard for normal spring wheat. Decreasing numbers indicate greater dullness and poorer color.
c Decreasing numbers indicate more open and harsher grain and inferior quality. Soggy = Too poor for numerical rating.

A bromate series was also baked to determine the best level to evaluate all of the samples. The data in Table IX indicate that 20 ppm was a satisfactory level.

The baking data for the flours are shown in Table X for the three samples from the five stations, and the average data for each selection are shown in Table XI. Significant differences were found for all factors. Those samples which tended to have better or more desirable characteristics usually had the higher protein content. A correlation coefficient of 0.61 was found between protein content and bake absorption, and 0.59 between protein content and loaf volume. The crumb grains of all the loaves were open and harsh as shown in Fig. 2, and none of the loaves were considered acceptable.

TABLE IX
EFFECT OF BROMATE ON BAKING CHARACTERISTICS OF TR-204 IN AN 80-20 BLEND WITH SPRING WHEAT FLOUR

Bromate	Mix. Time	Abs.	Dough Charac.a/	Crumb Colorb/	Crumb Grainc/	Loaf Vol.
p.p.m.	min.	%				cc.
0	1.33	63.8	7	90	40	750
20	1.33	63.8	6	95	50	700
60	1.33	63.8	6	96	45	700

a 1 = Bucky, 3 = Elastic, 6 = Pliable, 9 = Weak, 30 = Dead.
b 100 = Standard for normal spring wheat. Decreasing numbers indicate greater dullness and poorer color.
c Decreasing numbers indicate more open and harsher grain and inferior quality.

TABLE X
BAKING DATA FOR TRITICALE SELECTIONS

Location	Bake Absorption	Dough Charac.a/	Crumb Colorb/	Crumb Grainc/	Loaf Vol.
	%				cc.
TR-203					
Ft. Collins, CO	62.3	8	97	40	740
Williston, ND	64.1	4	99	75	940
Minot, ND	59.7	7	99	70	870
Fargo, ND	62.3	6	96	40	765
Redfield, SD	54.9	30	101	50	685
TR-204					
Ft. Collins, CO	62.3	8	95	50	770
Williston, ND	64.6	4	97	60	935
Minot, ND	53.7	30	100	55	720
Fargo, ND	60.4	8	50	40	765
Redfield, SD	54.7	30	100	50	655
Davis, CA	62.1	8	100	65	835
TR-419					
Ft. Collins, CO	61.6	7	97	70	860
Williston, ND	64.8	5	98	85	965
Minot, ND	59.7	7	100	80	905
Fargo, ND	63.6	4	97	70	885
Redfield, SD	60.5	8	101	65	860

a 1 = Bucky, 3 = Elastic, 6 = Pliable, 9 = Weak, 30 = Dead.
b 100 = Standard for normal spring wheat. Decreasing numbers indicate greater dullness and poorer color.
c Decreasing numbers indicate more open and harsher grain and inferior quality.

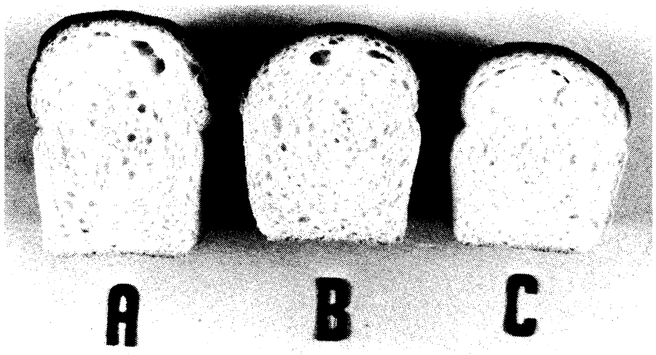

Figure 1. Loaves baked by: A = "Hobart" method — 100% triticale flour, B = "National" method — 100% triticale flour, and C = "National" method — 80% triticale flour and 20% HRS flour.

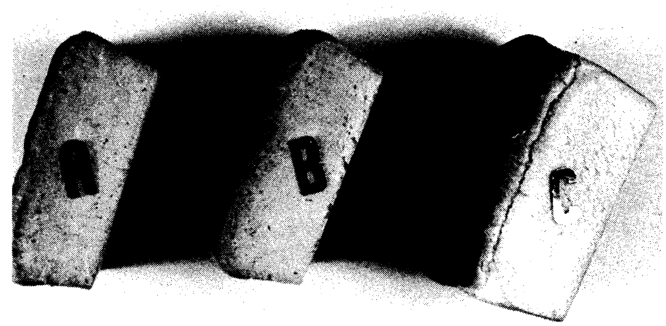

Figure 2. Interior of loaves baked by "National" method (80% triticale flour and 20% HRS flour): A = 14.1% flour protein, B = 12.2% flour protein, and C = 8.8% flour protein.

TABLE XI
AVERAGE BAKING DATA FOR TRITICALE SELECTIONS FOR 5 STATIONS

Selection	Bake Absorption	Dough Charac.[a]	Crumb Color[b]	Crumb Grain[c]	Loaf Vol.
	%				cc.
TR-203	60.7	11.0	98	55	800
TR-204	59.1	16.0	88	51	769
TR-419	62.0	6.2	99	74	895

a 1 = Bucky, 3 = Elastic, 6 = Pliable, 9 = Weak, 30 = Dead.

b 100 = Standard for normal spring wheat. Decreasing numbers indicate greater dullness and poorer color.

c Decreasing numbers indicate more open and harsher grain and inferior quality.

The average data (Table XI) showed that selection TR-419 had the best overall baking quality, and TR-204 the poorest. Selection TR-203 was more like TR-204 than TR-419, and both were considered to be totally unacceptable.

The lack of agreement or ability to duplicate the results obtained by other authors on the same cultivar (TR-204) suggested the possibility of different triticale selections with the same number. A second sample of TR-204 was obtained from Ft. Collins, CO which was grown in the proximity of the first sample but which was from the Colorado seed stock. The milling and baking results for the two samples with different seed stock origin but the same TR number are given in Tables XII and XIII, respectively.

TABLE XII
WHEAT AND MILLING RESULTS FOR TWO TR-204 TRITICALE SAMPLES FROM DIFFERENT SEED SOURCES GROWN AT FT. COLLINS, CO.

Seed Source	T.W.	1000 KWT	Kernel Size		Wheat		Flour Extr.	Flour	
			Lg.	Sm.	Ash[a]	Protein[a]		Ash[a]	Protein[a]
	#/Bu.	g	%	%	%	%	%	%	%
Ft. Collins, CO	49.6	43.1	70	0	1.72	12.6	63.8	0.55	11.9
Fargo, ND	48.8	48.8	83	0	1.97	13.6	58.6	0.58	11.4

a 14% Moisture Basis.

The wheat and milling data indicate that the two triticales are not the same, though they have the same number, TR-204. The original seed stock from Ft. Collins had a 5.2 per cent greater extraction and a protein difference on only 0.7 per cent between flour and whole grain protein contents, compared with a 2.2 per cent difference for the seed stock originating in North Dakota.

The baking data showed a more striking difference than the wheat or milling data. The Ft. Collins seed stock triticale (TR-204-FC) had 1.5 per cent higher baking absorption, more elastic dough character, brighter crumb color, a numerical crumb structure, and 90 cc's more loaf volume than the seed stock sample originating from North Dakota (TR-204-ND). The TR-204-FC, though not satisfac-

TABLE XIII
BAKING RESULTS FROM TWO TR-204 TRITICALE SAMPLES FROM DIFFERENT SEED SOURCES GROWN AT FT. COLLINS, CO.

Seed Source	Mix. Time	Abs.[a]	Dough Charac.[b]	Crumb Color[c]	Crumb Grain[d]	Loaf Vol.
	min.	%				cc.
Ft. Collins, CO	1.33	59.3	20	50	40 Harsh	645
Fargo, ND	1.33	57.8	30	40	Soggy	555

[a] *14% Moisture Basis.*
[b] *1 = Bucky, 3 = Elastic, 6 = Pliable, 9 = Weak, 20 = Slightly dead, 30 = Dead.*
[c] *100 = Standard for normal spring wheat. Decreasing numbers indicate greater dullness and poorer color.*
[d] *100 = Perfect crumb grain. Decreasing numbers indicate more open and inferior quality. Soggy = Too poor for numerical rating.*

tory, did produce a loaf with some character and was much better than the TR-204-ND sample, which was totally unsatisfactory. The data intimate that the TR-204-FC would produce a more satisfactory bread if baked by the procedure of Lorenz *et al.* (3).

CONCLUSIONS

The physical data of the grain showed much greater ranges in values for a single selection grown at different locations than the average values among selections. However, there was a consistency which prevailed between the grain ash and the flour ash that could be attributed to the selection and the environment. High ash content in the grain gave a high ash in the flour.

Higher test weight and 1000 kernel weight and larger kernel size distribution did not yield more flour. This was contrary to what was expected from the data.

It was necessary to blend hard red spring wheat flour with the triticale flour to produce breads by conventional baking procedures which reflected differences in dough and baking characteristics between samples. The general quality may be attributed, in part, to the flour protein content. There was an increase in absorption, dough stength, crumb grain, and loaf volume with increased protein content.

The sample of TR-204 which had been grown from the seed stock maintained at Ft. Collins suggested that there were differences in triticale selections with the same number. Both of these seed stocks from Colorado and North Dakota originally had been obtained from the same plant breeder. This implies that outcrossing, natural selection, mutation or other phenomenon may have occurred and could help explain some of the conflicting data found in the literature. These phenomena may also help explain some of the influence environment has on the milling and baking quality. Nevertheless, there is a wide range in the quality of triticales and both the selection and environment will affect the performance of the sample.

The weak gluten characteristics of triticale doughs had suggested that triticale flour may be similar to soft wheat. However, Kissell and Lorenz (11) found a marked reduction in cake quality unless it was blended with soft wheat flour. The present quality of triticale would indicate that acceptable specialty baked products can be made from triticale flour, but the quality of the product is dependent on the amount and quality of the wheat flour added in the blend.

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