Bread-Making Potential of Straight-Grade and Whole-Wheat Flours of Triumph and Eagle-Plainsman V Hard Red Winter Wheats[1]

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ABSTRACT

Eagle-Plainsman V blend and Triumph 64 hard red winter wheats (13.1% protein) were chosen to represent varieties that possessed strong and mellow physical dough properties, respectively. Each was milled to provide straight-grade flour, bran, shorts, and red dog. Five blends of flour from each variety varied from straight-grade flour to 100% whole wheat and were compared in optimized laboratory baking tests. Triumph 64's loaf volume potential and ability to carry bran, shorts, and red dog were equal to those of Eagle-Plainsman V. Coarse red and white brans and shorts were compared in breadmaking to those that were finely ground. Finely ground bran and shorts produced somewhat higher loaf volume than that for coarse bran and shorts. Bread crumb grain for fine bran and shorts was better than that for the coarse components, and crumb grain for white bran and shorts was better than that for the red components. Crumb color was darker in bread made with finely ground red bran than that in bread made with coarse red bran and shorts, but crumb colors for the finely ground and coarse white brans and shorts were essentially equal. Reconstituted whole-wheat flours containing hard white winter wheat bran, shorts, and red dog produced substantially lighter bread crumb colors than flours containing the feed components from hard red winter wheats.

Cereal Chem. 61(4): 269-273

During the last decade, the production of whole wheat and other variety breads has grown from a relatively minor portion of the bread industry to about 46% of all bread sales (Anonymous 1980). The dramatic increase raises the question of whether some wheats currently grown will adequately meet the requirements demanded in the production of variety breads.

Many baking technologists believe that wheat varieties with mellow to weak physical dough properties may not be as capable of carrying the bran, shorts, and red dog present in whole wheat bread as those with strong physical dough properties. The present study had two purposes: to compare the bread-making potential of physically mellow and strong straight-grade wheat flours to carry varying amounts of the feed components up to 100% whole-wheat breads; and to determine the effects of coarse and finely ground red and white bran and shorts on loaf volume, crumb grain, and crumb color.

MATERIALS AND METHODS

Wheats and Their Fractions

The unbleached, unmalted, straight-grade flours were milled on a Miag Multomat from samples of Triumph 64, Eagle, and Plainsman V hard red winter wheats. The Triumph 64 wheat was a composite of samples from five Kansas locations and contained 13.1% protein (14% mb). Eagle and Plainsman V were also grown in Kansas and were selected to produce a whole-wheat flour with a

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protein content identical to that of Triumph 64. All wheats were harvested during the years 1977–1979.

Triumph 64, a characteristically mellow variety, has short mixing time, poor mixing tolerance, a relatively high oxidation requirement, and relatively low water absorption per unit of protein. Eagle and Plainsman V are both physically strong varieties with a medium-long to long mixing time, good mixing tolerance, a low oxidation requirement, and high absorption per unit of protein.

Straight-grade flour, bran, shorts, and red dog were milled from each of the Triumph 64 and Eagle-Plainsman V wheat blends. Each reconstituted whole wheat flour was blended with appropriate amounts of the corresponding straight-grade flour to give five blends ranging from 100–0 (100% straight-grade flour to 0% whole wheat) to 0–100 (0% straight-grade flour to 100% whole wheat). Intermediate levels were 75–25, 50–50, and 25–75.

A hard white winter wheat sample (KS 75-216, a good-quality sister of Newton), obtained from the Department of Agronomy, Kansas State University, was the source of white bran, shorts, and red dog fractions used in the study of red versus white bran and shorts. Red feed fractions were replaced with equal amounts of the corresponding white feed fractions.

Aliquots of the bran and shorts of each variety were ground on a Weber hammer mill so that 97–98% passed a 100-mesh sieve for the study of coarse versus finely ground bran and shorts. Two grindings were through a Weber 0.6-mm screen, and two were through a 0.2-mm screen. After each grinding, the overs of the 100-mesh sieve were recovered for additional grinding until only 2–3% remained.

TABLE I
Mill Fractions of Triumph 64 and Eagle-Plainsman V Hard Red Winter Wheats and a Hard White Winter Wheat, Their Yields, and Ash and Protein Contents[a]

Wheat and Mill Fractions	Yield (%)	Ash (%)	Protein (%)
Eagle-Plainsman V			
Wheat	...	1.69	13.1
Flour (SG)[b]	72.91	0.42	12.2
Bran	18.84	5.69	15.0
Shorts	6.60	3.47	14.3
Red dog	1.64	2.25	13.5
Total	99.99		
Triumph 64			
Wheat	...	1.48	13.1
Flour (SG)	74.68	0.37	12.1
Bran	18.21	5.01	15.9
Shorts	5.82	3.12	16.5
Red dog	1.28	1.77	14.0
Total	99.99		
Hard white winter			
Wheat	...	1.41	10.5
Flour (SG)	71.39	0.46	9.5
Bran	18.94	4.35	13.4
Shorts	8.14	3.32	15.2
Red dog	1.53	2.59	14.3
Total	100.00		

[a]Chemical data are on a 14% moisture basis.
[b]SG = straight grade.

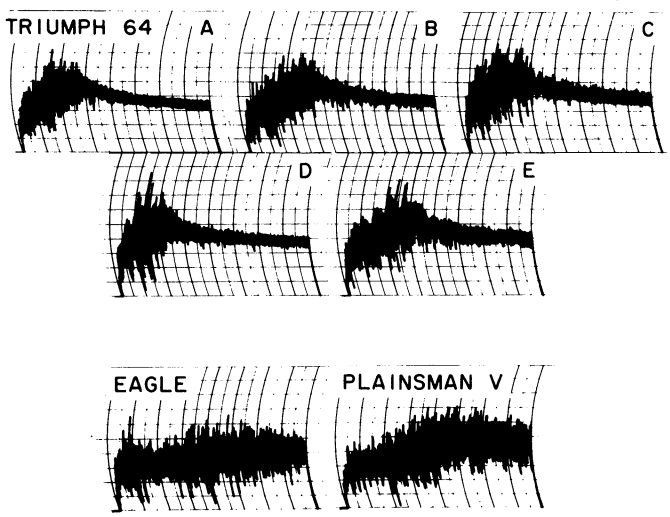

Fig. 1. Mixograms of straight-grade flours (10 g) from five wheats (A, B, C, D, E) that made up the Triumph 64 (physically mellow) blend and from two wheats that made up the Eagle-Plainsman V (physically strong) blend.

Mixograms

Recordings of the rheological properties of the straight-grade flours of Triumph 64, Eagle, and Plainsman V were made on the 10-g mixograph (Finney and Shogren 1972) to determine that they were typical.

Breadmaking

The straight-dough bread-making method included mixing to minimum mobility (optimum), optimum water, and 2.5 (Eagle-Plainsman V) or 75 ppm (Triumph 64) of ascorbic acid. Additional formula ingredients were 100 g of flour (14% mb), 1.5 g of salt, 6 g of sucrose, no shortening or 3 g of shortening or 1 g of diacetyl tartaric acid esters of monoglycerides and diglycerides (DATE), 0.25 g of barley malt (104 SKB per gram, 30°C), and 5.4 ± 0.1 g of compressed yeast. Compressed yeast was a 50:50 blend of weekly shipments from Anheuser-Busch, Inc., and from Standard Brands, Inc. Doughs were punched after 53 and 78 min and panned after 90 min of fermentation. Average time to proof doughs to 7.8 cm at 30°C was 35 min for no added shortening and 3 g of shortening, and was 32 min when 1 g of DATE was in the formula. Loaves were weighed as they came from the oven, and immediately thereafter volumes were determined by dwarf rapeseed displacement. Baking time was 24 min at 215°C. Additional related details are given by Finney (1945, 1984) and Finney et al (1976).

In the bread-making studies on the effect of no added shortening, 3% shortening, and 1% DATE on straight-grade and whole-wheat flour blends, each treatment was baked in duplicate on each of two

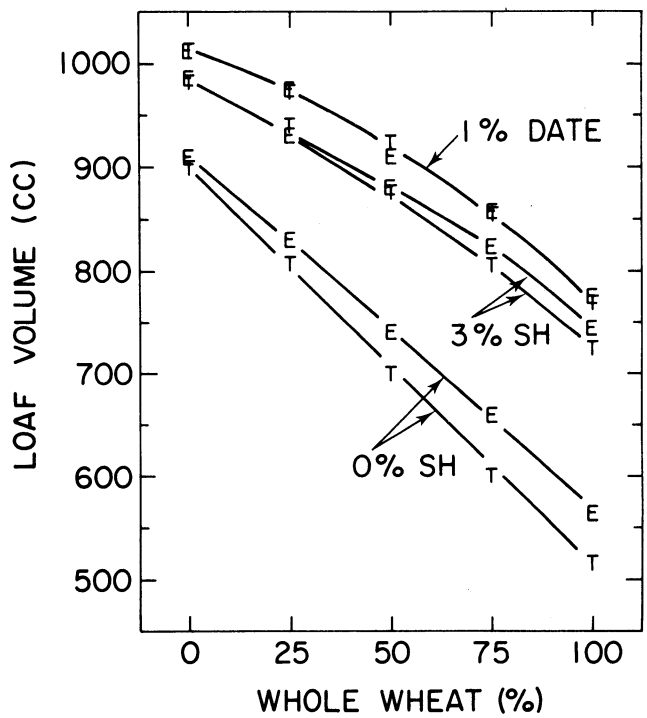

Fig. 2. Effect of 0 and 3% of shortening (SH) and 1% of diacetyl tartaric acid esters of monoglycerides and diglycerides (DATE) on volume of bread made with varying percentages of Eagle-Plainsman V (E) and Triumph 64 (T) whole-wheat flours in blends with the corresponding straight-grade flours.

days. The loaf volume difference between any two treatment means required for significance was 32 cc ($P = 0.05$). In the bread-making studies with coarse versus finely ground bran and shorts and red versus white bran and shorts, each treatment was triplicated. The loaf volume difference between any two treatment means required for significance was 27 cc ($P = 0.05$).

Preliminary studies indicated the desirability of 1% DATE, which was used, except when stated otherwise, in the bread-making formula for whole-wheat flours and their blends with straight-grade flours.

Bread Crumb Color

Bread crumb color was objectively measured on an Agtron multichromatic abridged reflectance spectrophotometer model M-400A equipped with the blue mode (436 nm). The scale was standardized with standard disks 24 and 63 to read 0 and 100% relative spectral reflectance, respectively. Measurements on eight replications were averaged.

RESULTS AND DISCUSSION

The yields and ash and protein contents of the straight-grade flours and other wheat fractions of Triumph 64, Eagle-Plainsman V, and the hard white winter are relatively comparable when all data are considered (Table I).

Mixograms

The physical dough properties of all five wheats that made up the Triumph 64 blend were typical (Fig. 1) of a medium-short mixing time and poor mixing tolerance. In contrast, the physical dough properties of both the Eagle and Plainsman flours were strong; that is, they had a long mixing time to the peak and a very good mixing tolerance.

TABLE II
Protein Composition, Baking Absorptions and Mix Times, and Ascorbic Acid Requirements of Blends of Straight-Grade and Whole-Wheat Flours of Eagle-Plainsman V and Triumph 64 Hard Red Winter Wheat Varieties[a]

Variety	Whole Wheat (%)	Protein (%)	Functional Protein[b] (%)	Baking Absorption (%)	Baking Mix Time (min)	Ascorbic Acid (ppm)
Eagle-Plainsman V	100	13.1	8.9	75.5	9	2.5
	75	12.9	9.7	73.5	8⅛	2.5
	50	12.7	10.5	71.5	7½	2.5
	25	12.4	11.4	69.5	7⅜	2.5
	00	12.2	12.2	68.5	7⅜	2.5
Triumph 64	100	13.1	9.0	70.2	4½	75.0
	75	12.9	9.8	67.2	4	75.0
	50	12.6	10.6	64.2	3½	75.0
	25	12.4	11.3	62.2	3	75.0
	00	12.1	12.1	61.2	2½	75.0

[a]Chemical data are on a 14% moisture basis.
[b]Functional protein is defined as the protein content contributed by the straight-grade flour.

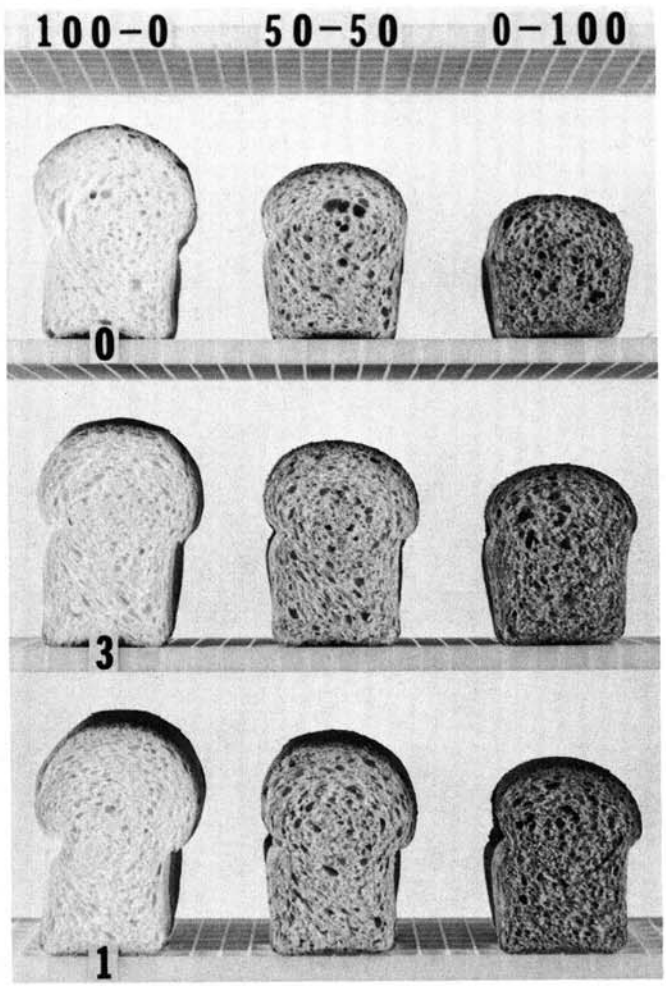

Fig. 3. Effect of 0 and 3% of shortening (top and center rows) and 1% of diacetyl tartaric acid esters of mono- and diglycerides (bottom row) on volume, crumb grain, and crumb color of bread made with (left to right) 100:0, 50:50, and 0:100 ratios of Eagle-Plainsman V straight-grade and whole-wheat flours, respectively.

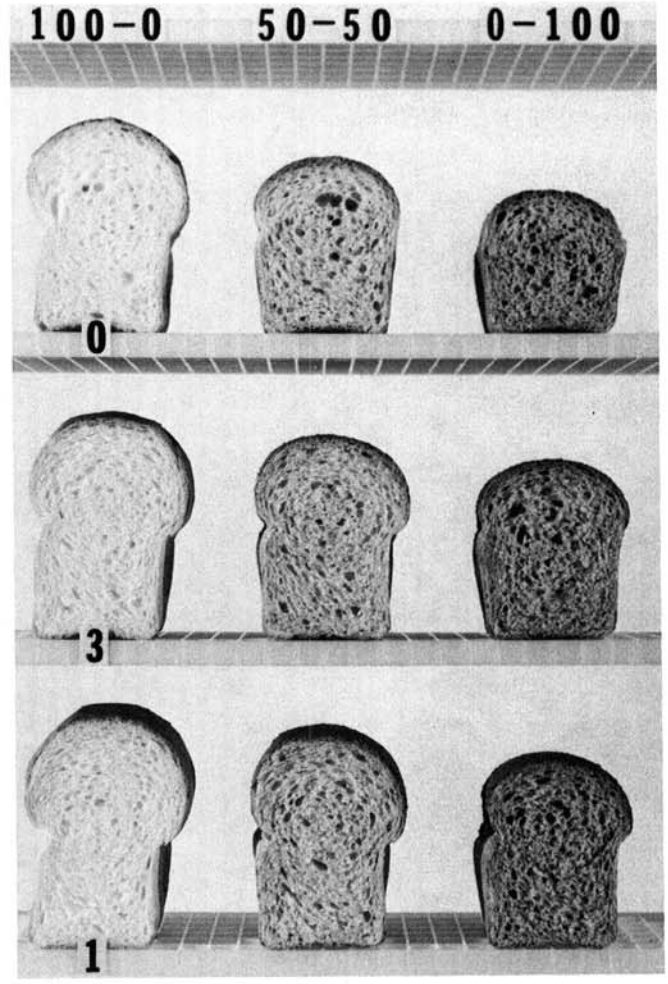

Fig. 4. Effect of 0 and 3% of shortening (top and center rows) and 1% of diacetyl tartaric acid esters of mono- and diglycerides (bottom row) on volume, crumb grain, and crumb color of bread made with (left to right) 100:0, 50:50, and 0:100 ratios of Triumph 64 straight-grade and whole-wheat flours, respectively.

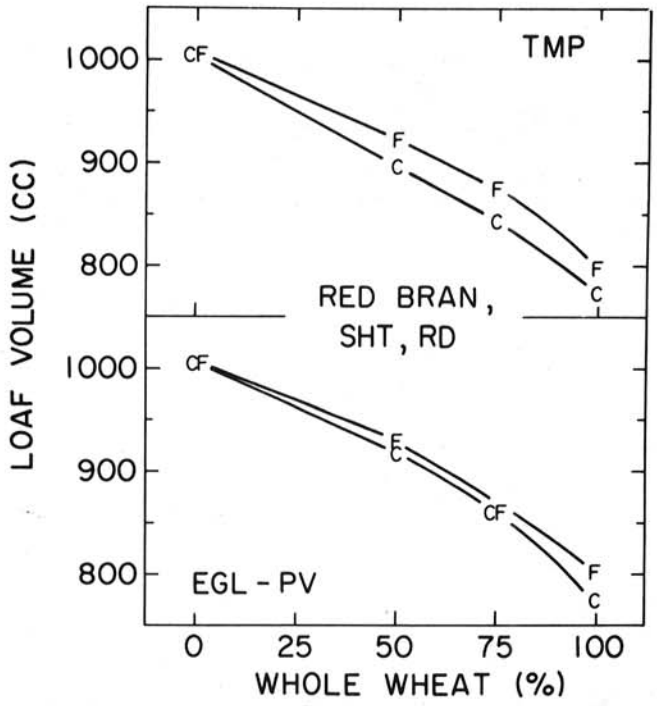

Fig. 5. Volume of bread made with varying percentages of Eagle-Plainsman V (Egl-PV) and Triumph 64 (Tmp) whole-wheat flours in blends with the corresponding straight-grade flours. C = coarse bran and shorts; F = finely ground bran and shorts; SHT = shorts; and RD = red dog.

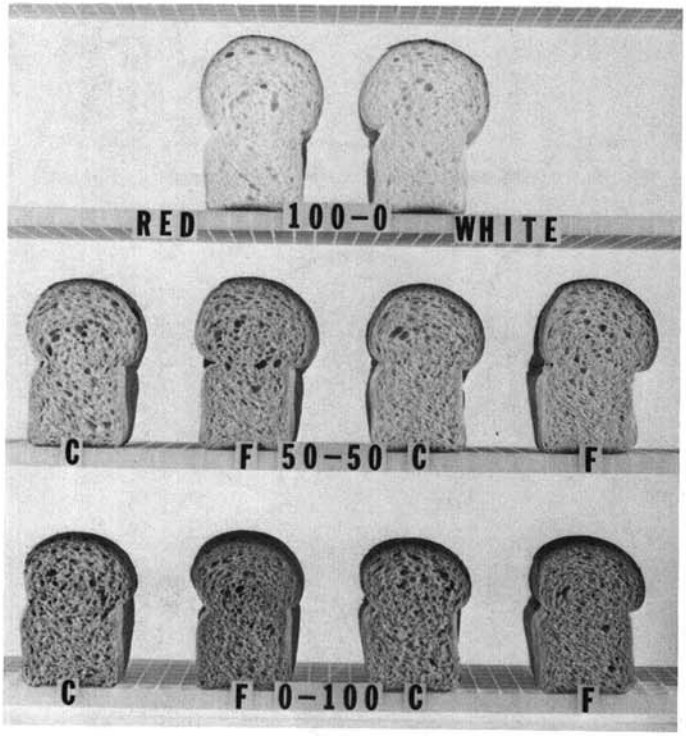

Fig. 6. Volume, crumb grain, and crumb color of bread made with (center row, two loaves on left) a 50:50 ratio of Eagle-Plainsman V straight-grade and whole-wheat flours, and (bottom row, two loaves on left) 100% whole-wheat flour. Hard white wheat bran, shorts, and red dog replaced the corresponding hard red wheat fractions in the two loaves on the right of the center and bottom rows. C = coarse bran and shorts; F = finely ground bran and shorts. The two loaves on the top row are duplicate controls of 100% Eagle-Plainsman V straight-grade flour.

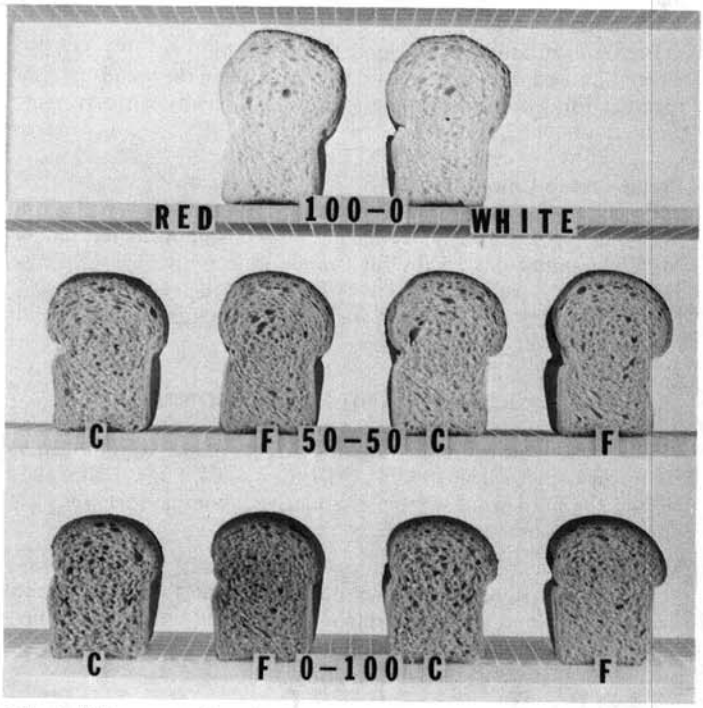

Fig. 7. Volume, crumb grain, and crumb color of bread made witn (center row, two loaves on left) a 50:50 ratio of Triumph 64 straight-grade and whole-wheat flours, and (bottom row, two loaves on left) 100% whole-wheat flour. Hard white wheat bran, shorts, and red dog replaced the corresponding hard red wheat fractions in the two loaves on the right of the center and bottom rows. C = coarse bran and shorts; F = finely ground bran and shorts. The two loaves on the top row are duplicate controls of 100% Triumph 64 straight-grade flour.

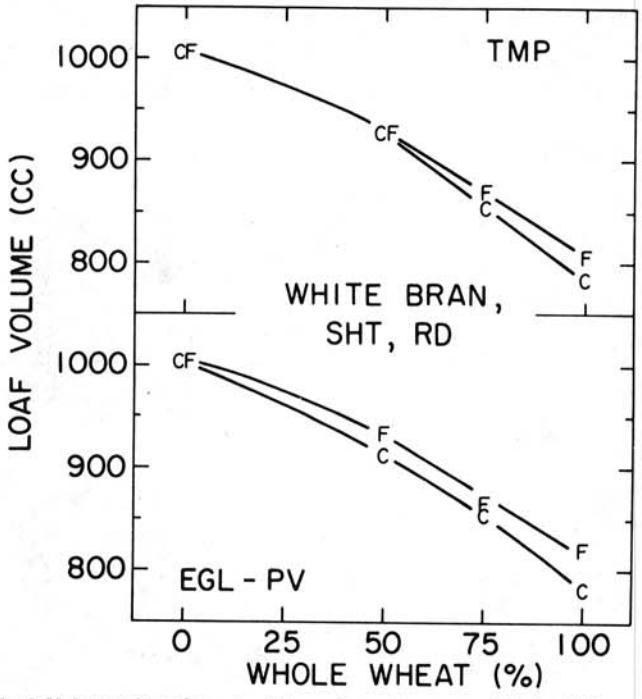

Fig. 8. Volume of bread made with varying percentages of Eagle-Plainsman V (Egl-PV) and Triumph 64 (Tmp) whole-wheat flours in blends with the corresponding straight-grade flours, except that hard white wheat bran, shorts, and red dog replaced the corresponding hard red wheat fractions. C = coarse white bran and shorts; F = finely ground white bran and shorts; SHT = shorts; RD = red dog.

TABLE III
Agtron Readings on the Crumb of Bread Baked from Eagle-Plainsman V and Triumph 64 Straight-Grade Flours in Blends with Their Respective Hard Red Wheat Bran, Shorts, and Red Dog Fractions or in Blends with the Hard White Wheat Bran, Shorts, and Red Dog[a]

Variety	Whole Wheat (%)	Bran, Shorts, and Red Dog Derived from	Size of Bran and Shorts	Agtron Reading
Eagle-Plainsman V	50	Eagle-Plainsman V	Coarse	39
	50		Fine	28
Triumph 64	50	Triumph 64	Coarse	38
	50		Fine	31
Eagle-Plainsman V	50	KS75-216[b]	Coarse	52
	50		Fine	50
Triumph 64	50	KS75-216	Coarse	56
	50		Fine	54
Eagle-Plainsman V	100	Eagle-Plainsman V	Coarse	15
	100		Fine	7
Triumph 64	100	Triumph 64	Coarse	12
	100		Fine	6
Eagle-Plainsman V	100	KS75-216	Coarse	30
	100		Fine	29
Triumph 64	100	KS75-216	Coarse	33
	100		Fine	34

[a]Bran and shorts were either coarse or finely ground.
[b]A Kansas hard white winter wheat sister of Newton.

Response to Shortening and DATE

Loaf volumes of Eagle-Plainsman V whole-wheat blends were significantly higher (5% level) than the corresponding volumes of Triumph 64 when shortening was omitted in the bread formula (Fig. 2). The large decrease in the volume of bread as the percentage of whole wheat increased is largely attributable to the decrease in functional protein (Table II). For example, 100% of whole-wheat Triumph 64 contained 74.68% of straight-grade flour (Table I) that contributed only 9.0% of functional protein, 4.1% less than the wheat protein content.

The addition of 3% shortening increased the volumes of both Eagle-Plainsman V and Triumph 64 blends over those of their respective loaves with no shortening (Fig. 2). The positive volume responses to shortening of Eagle-Plainsman V progressively increased from 73 cc for 100% straight-grade flour to 180 cc for 100% whole wheat. The corresponding responses of Triumph 64 were from 81 to 208 cc. The crumb grains of the loaves for Eagle-Plainsman V (Fig. 3) and for Triumph 64 (Fig. 4) also were materially improved by the addition of 3% shortening. However, the crumb grains of the corresponding loaves of Eagle-Plainsman V and Triumph 64 were essentially equal.

When 1% DATE was added to the blends of each variety (Fig. 2), the lines for Eagle and Triumph were essentially superimposed. Thus, one can conclude that, under relatively optimal bread-making conditions, there is no significant difference in the volume potentials and carrying powers of Eagle-Plainsman V and Triumph 64 wheats. Finney and Barmore (1944) demonstrated that a flour's carrying power is a function of volume potential (protein quality) and quantity of protein, regardless of whether the physical dough properties were mellow or strong.

Loaf volumes of either Eagle-Plainsman V or Triumph 64 blends with 1% DATE or 3% shortening were significantly higher (1% level) than those of their respective blends with no added shortening (Fig. 2). The crumb grain of bread made with 1% DATE was superior to that of the corresponding bread made with 3% shortening in that it had a more finely developed cell structure (Figs. 3 and 4).

Coarse Versus Finely Ground Red and White Bran and Shorts

Loaf volumes of breads that contained the finely ground red bran and shorts were somewhat higher than those of breads made with the coarse red bran and shorts obtained during the milling of Eagle-Plainsman V and Triumph 64 wheats (Fig. 5). Also, bread made with the finely ground red bran and shorts had a finer, more uniform crumb grain structure but a darker crumb color than the bread made with the coarse red bran and shorts (Figs. 6 and 7, left). Shetlar and Lyman (1944) reported similar results.

Loaf volumes of breads that contained the finely ground white bran and shorts were likewise somewhat higher and crumb grains finer and more uniform than those of breads made with the coarse white bran and shorts (Fig. 8 and Figs. 6, 7, right). The results for white bran and shorts, however, differed from those for the red components in that the crumb colors of breads that contained the finely ground white bran and shorts were essentially equal to those of bread made with the coarse white components (Figs. 6 and 7, right). The differences in bread color scores observed, and to a large extent reproduced in Figs. 6 and 7, are verified by the objective Agtron readings (Table III).

Thus, it appears that bread made with either coarse or finely ground white bran and shorts may be more acceptable to consumers than the comparable (equal amount of whole wheat) breads made with the red components and that Eagle-Plainsman V and Triumph 64 are equal in optimized bread-making potential, regardless of the large differences in their physical dough properties.

CONCLUSIONS

In an optimized bread-making method that included diacetyl tartaric acid esters of monoglycerides and diglycerides, the physically mellow Triumph 64 straight-grade flour carried whole-wheat flour as effectively as the physically strong Eagle-Plainsman V straight-grade flour. Thus, physical dough properties were not an index of carrying power.

Bread baked from blends of straight-grade and whole-wheat flours that contained finely ground red or white bran and shorts had finer crumb grains and somewhat to significantly (5% level) higher loaf volumes than did the corresponding loaves containing coarse red or white bran. However, red bran and shorts darkened crumb colors more than did the coarse red bran and shorts.

Bread made from 50% whole-wheat flour that contained white bran and shorts had a relatively light crumb color that probably would be accepted by some individuals who usually dislike the crumb color and flavor of whole wheat bread containing red bran and shorts.

The increases in bake mixing time with increasing percentages of whole-wheat flour was largely attributable to decreasing functional protein, which created an increasing difficulty in forming a continuous phase of protein. Thus, more work input, obtained by increasing mix time, was required to reach the point of minimum mobility (optimum mix time).

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[Received October 18, 1983. Revision received January 30, 1984. Accepted January 31, 1984]