Effect of Wheat Variety, Flour Grinding, and Egg Yolk on Whole Wheat Bread Quality[1]

P. L. FINNEY,[2] S. HENRY,[3] and H. JEFFERS[2]

Cereal Chem. 62(3):170–173

ABSTRACT

Seventeen wheat varieties grown as drill strips in 1980 at either Lind or Pullman, WA, were milled into straight-grade bakers flours and ground into a relatively coarse whole wheat flour with a Hobart grinder or a relatively fine flour with a Udy mill. Breads produced from the straight-grade flours and from each of the whole wheat flours were formulated both with and without 5% dried egg yolk. Relatively poor correlation coefficients for loaf volume between the whole wheat and the straight-grade breads indicated that bran and germ fractions of different varieties have varying effects on breadmaking properties.

During the past decade in the United States the production of whole wheat and other higher extraction variety breads has continued to increase. In fact, variety breads now occupy about one-third of the entire U.S. bread market (Miller 1981). Many articles have been published on fiber sources, availability, and effects on bread functionality. Most commonly discussed have been the effects of wheat bran on bread quality (Pomeranz et al 1976, Pomeranz et al 1977, Birch and Finney 1980, Shogren et al 1981) and the effects of brewers' spent grain (Pomeranz et al 1976, Prentice and D'Appolonia 1977) or oats, corn, or triticale bran on bread quality (D'Appolonia and Youngs 1978, Lorenz 1976). Uses of soybean hulls and powdered cellulose in bread have also been studied (Pomeranz 1977, Dubois 1978).

It has been reported that comparatively fine granulation of wheat bran (Pomeranz et al 1977) or triticale bran (Lorenz 1976) produced somewhat better bread quality. However, Finney (1979) reported finer bran granulation was more detrimental to bread quality. Kirwin (1974) reported that effectiveness of bran as a source of dietary fiber was related to particle size. Coarse brans absorbed and carried nearly three times as much water to the colon as the finer brans. When coarse bran was reground, its water-binding capacity was reduced from 6.15 g/g to 3.54 g/g, and that of reground fine bran was reduced from 2.63 to 2.16 g/g.

Shogren et al (1981) reported that the adverse effects of 15 parts wheat bran per 85 parts of wheat flour were essentially eliminated by adding 2% vital gluten and one of several surfactants to the bread formula, including diacetyl tartaric acid esters of monoglycerides, ethoxylated monoglycerides, lecithin, sucrose monopalmitate, or sodium stearoyl-2 lactylate. Birch and Finney (1980) found that increasing levels of fresh egg yolk overcame the deleterious effects of a 50% whole wheat formulation. Increasing levels of egg yolk above 5–6% resulted in increased loaf volume greater than the straight-grade controls.

A literature search failed to reveal any information on the effect of different wheat brans and germs on breadmaking properties. The question remains whether bran and germ fractions of different wheat varieties have different effects on bread quality of a common bakers flour and whether interactions among endosperm, bran, and germ fractions from different varieties have varied effects on bread quality.

[1]Scientific Paper 6942, College of Agriculture Research Center, Washington State University, Pullman 99163.

[2]Research food technologist and food technologist, respectively, ARS-USDA Western Wheat Quality Laboratory, Department of Food Science and Human Nutrition, Washington State University, Pullman 99163. Present address of P. L. Finney: Research Leader, Soft Wheat Quality Laboratory, Department of Agronomy, Ohio State University, Ohio Agricultural Research and Development Center, Wooster 44691.

Mention of firm names or trade products does not constitute endorsement by the U.S. Department of Agriculture over others not mentioned.

[3]Undergraduate, Department of Foods, Nutrition, and Institutional Management, Washington State University.

MATERIALS AND METHODS

Wheat and Flours

Seventeen wheat varieties grown in 1980 as drill strips at Lind and Pullman, WA, were studied. A commercial straight-grade bakers' flour was supplied by Centennial Mills, Spokane, WA.

Milling and Grinding

Straight-grade flours were prepared by milling the 17 wheats on a Buhler experimental mill 24 hr after tempering the hard wheats to 16% and the soft wheats to 15% moisture content. Whole wheat flours were produced by grinding the untempered wheat on a Hobart grinder or a Udy cyclone mill.

Analytical Procedures

Moisture and protein were determined by AACC methods 44-15A and 46-11, respectively (1983). Mixograms of the whole wheat flours were prepared by the method of Bruinsma et al (1978) using the 10-g mixograph (Finney and Shogren 1972). "Pup" loaves of 100 g were produced using a straight-dough method (Finney 1984) with 90-min fermentation (30° C, 5% fresh bakers' yeast) and no added sugar. Additional ingredients included (flour basis): 1.5% NaCl, 4% shortening (Crisco), 0.6 g barley malt extract (50 D.U./g, 20° C), 40 ppm ascorbic acid, 5% dried egg yolk (for some loaves), and varied (optimum) water and $KBrO_3$.

RESULTS AND DISCUSSION

Protein contents (N × 5.7) ranged from 10.5% for wheat varieties Hatton and Urquie to 13.2% for Cheyenne, and straight-grade flour protein ranged from 9.6% for Sprague to 11.8% for Sawtell. Buhler experimental flour yield ranged from 68.5% for variety 77-99 to 72.4% for Wared (Table I).

Straight-Dough Breads

Straight-grade flours from hard wheats produced breads with greater loaf volume and more satisfactory crumb grain compared to straight-grade flours from soft wheats. The exceptions were Marfed, a soft white spring variety that produced 1,037-cc loaf volume, and Hatton, a hard red winter variety that produced a loaf volume of 843 cc (Table I). Generally as loaf volume decreases crumb grain becomes less satisfactory. In this study Hatton was the only exception to that rule (Table I).

Mixograms

Mixograms from the Hobart-ground whole wheat flours are presented in Figure 1 from top left to bottom right by largest to smallest loaf volume produced using straight-grade flours. The poor bread flours (77-99 through Sprague) produced curves that dropped to zero (no resistance to extension) soon after reaching optimum mix time (point of maximum height and width of curve). Bruinsma et al (1978) observed the same phenomenon.

TABLE I
Protein, Flour Yield, Loaf Volume, and Crumb Grain of Wheat Varieties Harvested in 1980 at Lind and Pullman, WA

Variety	Class[a]	Wheat Protein[b] (%)	Flour Yield (%)	Flour Protein[b] (%)	Loaf Volume[c] (cc)	Crumb Grain Score[d]
Lind						
Wampum	HRW	12.6	71.4	11.4	1,076	S
Wared	HRS	12.8	72.4	11.8	1,053	S
Sawtell	HRS	12.0	71.1	11.1	1,049	S
Borah	HRS	12.4	71.5	11.2	1,045	S
Marfed	SWS	11.7	70.4	10.2	1,037	S
Pullman						
Wampum	HRS	11.5	71.0	10.7	1,010	S
WA6510	HRS	12.2	72.0	11.2	979	S
Wanser	HRW	11.8	70.8	11.0	975	S
Cheyenne	HRW	13.2	72.0	11.5	955	S
Urquie	SWS	10.5	72.3	9.8	950	Q-S
77-99	HRW	13.0	68.5	11.0	948	S
Fielder	SWS	11.3	68.7	9.7	910	Q-U
Waverly	SWS	11.6	71.6	10.2	905	Q-S
Fieldwin	SWS	11.3	71.3	9.7	875	Q-U
Twin	SWS	11.6	71.0	10.2	865	U
Hatton	HRW	10.5	71.8	9.8	843	S
Sprague	SWW	10.6	71.5	9.6	720	Q-U

[a] HRS = Hard red spring, HRW = hard red winter, SWS = soft white spring, and SWW = soft white winter.
[b] 14% Moisture basis.
[c] Mean values of duplicate tests (LSD = ±18 cc).
[d] S = Satisfactory, Q = questionable, and U = unsatisfactory crumb grain.

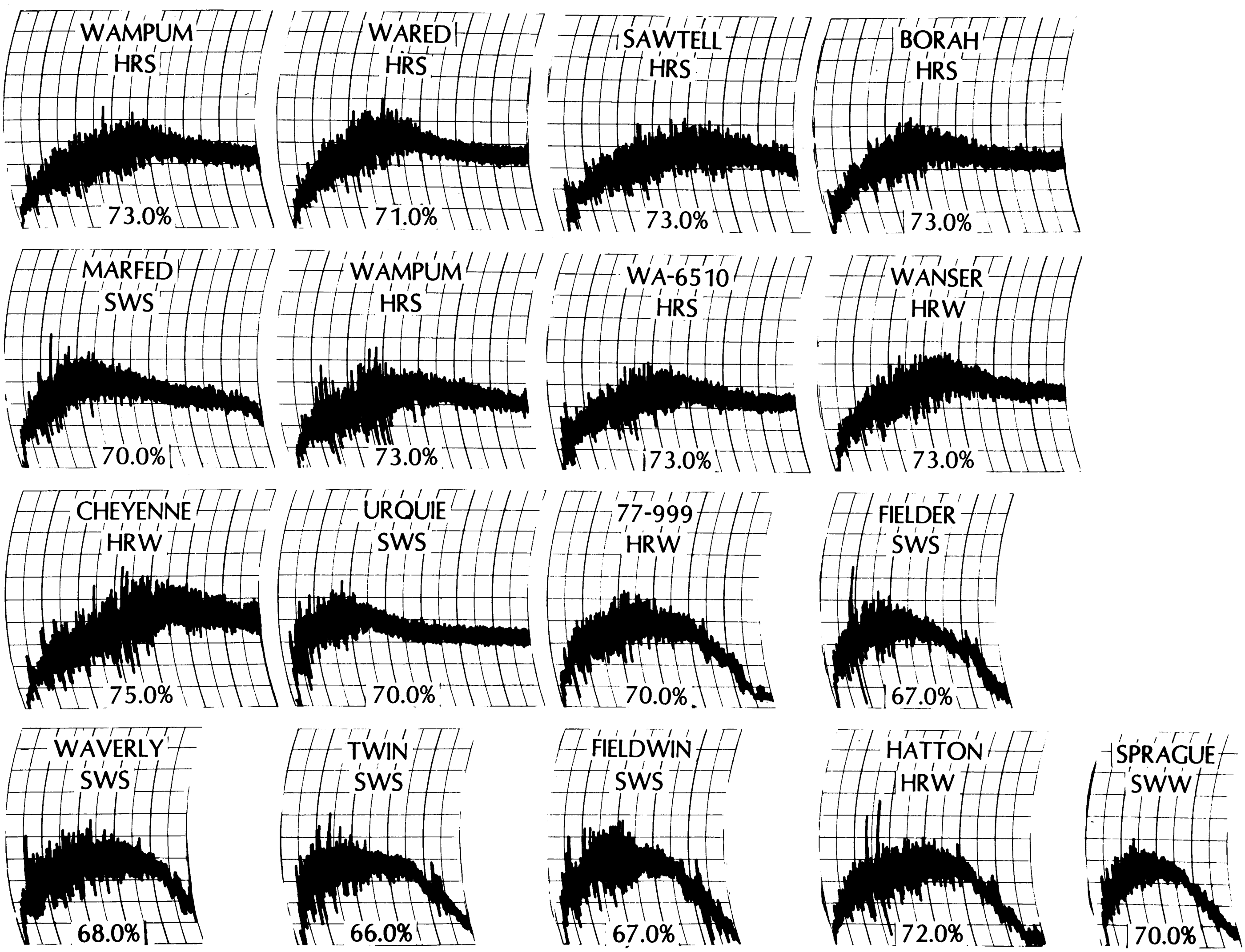

Fig. 1. Mixograms of 10-g Hobart-ground samples (from 17 wheat varieties harvested in 1980 at Lind or Pullman, WA) ordered from top left to bottom right in descending order of bread functionality or "strength" according to the breads produced from straight-grade flours. HRS = hard red spring, HRW = hard red winter, SWS = soft white spring, SWW = soft white winter.

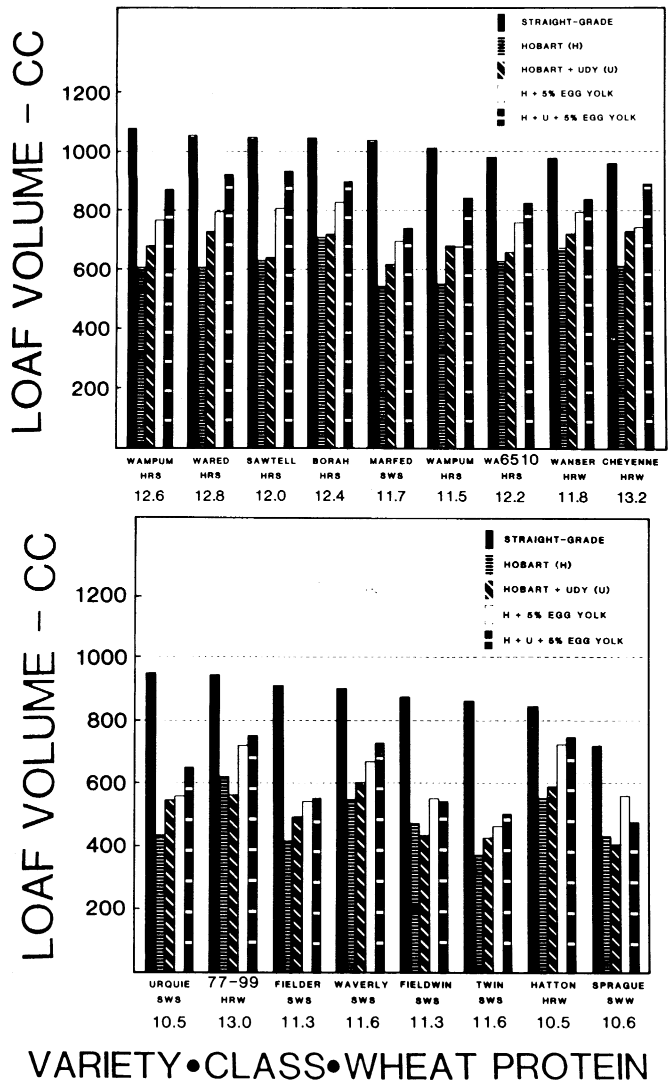

Fig. 2. Bar graphs of bread loaf volumes from straight-grade, Hobart-ground, and Hobart-ground + Udy-milled flours (with or without dried egg yolk) of 17 wheat varieties harvested in 1980 at Lind or Pullman, WA.

Hobart-Ground Whole Wheat Breads

Loaf volume for the 17 Hobart-ground flours ranged between 370 and 705 cc, the volumes for Twin and Borah, respectively (Table II). A number of varieties produced a whole wheat bread with an unexpectedly large or small loaf volume compared to the volume found for straight-dough bread. When loaf volume of breads produced from straight-grade flours was correlated with volume of whole wheat Hobart-ground loaves, the coefficient value (r) was 0.644. Addition of 5% dried egg yolk increased loaf volume from Hobart-ground flour for all 17 varieties, from 90 cc for Twin to 175 cc for Wared (Table II). The addition of the egg yolk only

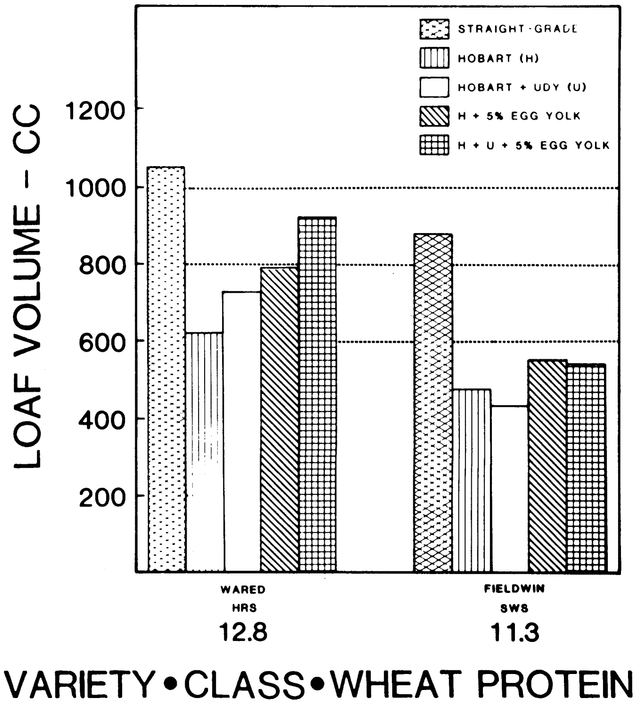

Fig. 3. Bar graph of bread loaf volumes from straight-grade, Hobart-ground, and Hobart-ground + Udy-milled flours (with or without dried egg yolk) of Wared and Fieldwin wheat varieties. HRS = hard red winter, SWS = soft white spring.

TABLE II
Loaf Volumes of Bread Produced (with or without dried egg yolk) from Straight-Grade, Hobart-Ground, or Hobart-Ground +Udy-Ground Flours from 17 Wheat Varieties Harvested in 1980 at Lind or Pullman, WA

Variety	Straight-Grade Flour (cc)	Hobart (cc)	Hobart + Udy (cc)	Hobart + Egg (cc)	Hobart + Udy + Egg (cc)
Lind					
801292 Wampum	1,072	605	765	675	870
801287 Wared	1,053	615	790	725	920
801290 Sawtell	1,049	630	805	640	930
801263 Borah	1,045	705	825	720	895
801284 Marfed	1,037	545	695	615	740
Pullman					
801266 Wampum	1,010	550	675	680	840
801293 WA6510	979	625	755	655	825
801274 Wanser	975	670	795	720	835
801271 Cheyenne	955	610	740	725	885
801289 Urquie	950	435	555	545	650
801257 77-99	948	625	720	560	750
801288 Fielder	910	415	540	490	550
801268 Waverly	905	560	670	600	725
801291 Fieldwin	875	475	550	430	540
801285 Twin	865	370	460	425	500
801281 Hatton	843	555	720	585	745
801277 Sprague	720	435	560	400	475
Means	953	554	599	684	746
Straight-grade flour coefficients		0.644	0.679	0.786	0.813

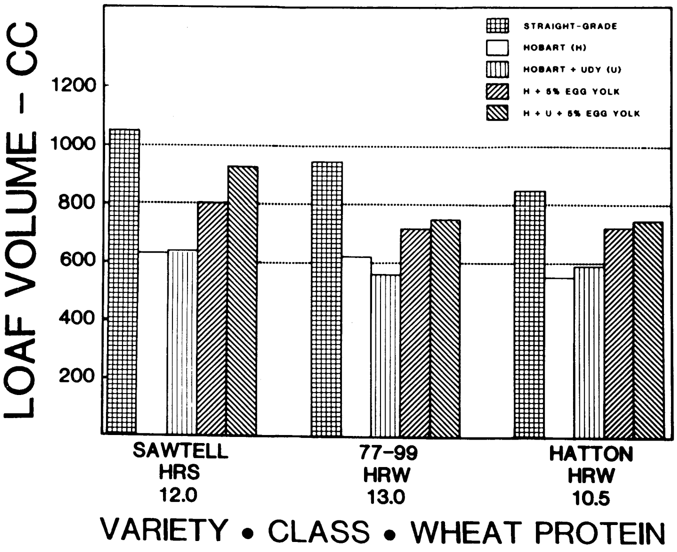

Fig. 4. Bar graph of bread loaf volumes from straight-grade, Hobart-ground, and Hobart-ground + Udy-milled flours (with or without dried egg yolk) of Sawtell, 77-99, and Hatton wheat varieties. HRS = hard red spring, HRW = hard red winter.

slightly increased the correlation of loaf volume with the straight-dough breads (0.679).

A sublot of each of the Hobart-ground whole wheat flours was ground on a Udy mill, and straight-dough breads were produced without added sugar. Loaf volume ranged from a low of 400 cc for Sprague to a high of 725 cc for Wared and Cheyenne (Table II). Generally the finer granulation caused by Udy grinding enhanced loaf volume and crumb grain scores, with the exception of varieties 77-99, Fieldwin, and Sprague. The formulation of 5% egg yolk increased loaf volume of all varieties, very substantially in some cases. For instance, Sawtell increased from 640 to 930 cc and Wared from 725 to 920 cc. The correlation coefficients between loaf volume of bread made from straight-grade and Hobart + Udy or Hobart + Udy + 5% egg yolk were 0.786 and 0.813, respectively.

The mean loaf volume for the 17 varieties increased from 554 to 599 cc when the Hobart flour was reground on the Udy grinder (Table II). Five percent dried egg yolk increased the Hobart-ground flours to a mean loaf volume of 684 cc and Hobart + Udy to 746 cc.

The bar graphs in Figure 2 show that the germ and bran fractions of the varieties are inconsistent in their effects on loaf volume and other breadmaking properties. The straight-grade bread volumes are presented in descending order from left to right; the effects of flour granulation and egg yolk are quite variable. Two strikingly different patterns, enlarged in Figure 3, show how finer granulation and egg yolk enhanced loaf volume of breads produced with Wared but not with Fieldwin. Figure 4 also illustrates how different varieties produced greatly varied breads, depending on the germ/bran fraction. Although Hatton and 77-99 responded similarly when dried egg yolk was added to the formula, their straight-dough breads were different. The overall quality of whole wheat breads produced without egg yolk from Sawtell, 77-99, and Hatton was nearly equal (Fig. 4). However, straight-grade breads from Sawtell formulated with and without egg yolk were far superior to those produced from either 77-99 or Hatton (Fig. 4).

CONCLUSIONS

The relatively poor correlation coefficients between whole wheat and straight-grade breads for loaf volume indicate that the functions of bran and germ fractions of different varieties vary in bread. Thus we conclude that the evaluation of wheat varieties in breeder programs for whole wheat bread suitability is not completely satisfactory with the usual straight-grade experimental bread test.

LITERATURE CITED

AMERICAN ASSOCIATION OF CEREAL CHEMISTS. 1983. Approved Methods of the AACC. Method 44-15A, approved October 1975; method 46-11, approved October 1976. The Association: St. Paul, MN.

BIRCH, R. E. W., and FINNEY, P. L. 1980. Note on fresh egg yolk in 50% whole wheat bread. Cereal Chem. 57:448-449.

BRUINSMA, B. L., ANDERSON, P. D., and RUBENTHALER, G. L. 1978. Rapid method to determine quality of wheat with mixograph. Cereal Chem. 55:732.

D'APPOLONIA, B. L., and YOUNGS, V. L. 1978. Effect of brown and high-protein concentrate from oats on dough properties and bread quality. Cereal Chem. 55:736.

DUBOIS, D. K. 1978. The practical application of fiber materials in bread production. Bakers Dig. 5(2):30.

FINNEY, K. F. 1984. An optimized, straight-dough, bread-making method after 44 years. Cereal Chem. 61:20.

FINNEY, K. F., and SHOGREN, M. D. 1972. A ten gram mixograph for determining and predicting functional properties of wheat flours. Bakers Dig. 46(2):32.

FINNEY, P. L. 1979. Potential for the use of germinated wheat and soybeans to enhance human nutrition. Adv. Exp. Med. Biol. 105:681.

KIRWIN, W. O. 1974. Action of differing bran preparation on colonic function. Br. Med. J. 4:187.

LORENZ, K. 1976. Triticale bran in fiber breads. Bakers Dig. 50(6):27.

MILLER, B. S., ed. 1981. Variety breads in the United States. Am. Assoc. Cereal Chem.: St. Paul, MN.

POMERANZ, Y. 1977. Fiber in breadmaking; a review of recent studies. Bakers Dig. 51(5):94.

POMERANZ, Y., SHOGREN, M. D., and FINNEY, K. F. 1976. White wheat bran and brewers spent grains in high-fiber bread. Bakers Dig. 50:35.

POMERANZ, Y., SHOGREN, M. D., FINNEY, K. F., and BECHTEL, D. B. 1977. Fiber in breadmaking—effects on functional properties. Cereal Chem. 54:25.

PRENTICE, N., and D'APPOLONIA, B. L. 1977. High-fiber bread containing brewer's spent grain. Cereal Chem. 54:1,084.

SHOGREN, M. D., POMERANZ, Y., and FINNEY, K. F. 1981. Counteracting the deleterious effects of fiber in breadmaking. Cereal Chem. 58:142.

[Received August 6, 1984. Revision received December 17, 1984. Accepted December 18, 1984.]