EFFECT OF BRAN AND HIGH-PROTEIN CONCENTRATE FROM OATS ON DOUGH PROPERTIES AND BREAD QUALITY[1]

B. L. D'APPOLONIA[2] and V. L. YOUNGS[3]

ABSTRACT

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Effects of bran and high-protein concentrate from oats on dough properties and bread were studied. Bran from dry-milled commercial oatmeal increased farinograph absorption and maintained dough stability to a greater degree than did bran from dry-milled oat groats of a pure cultivar. At equal levels of addition, loaf volume was lower for oat than for wheat bran, but panelists preferred oat bran bread over wheat bran bread. Addition of protein concentrate from oats also increased absorption and decreased loaf volume; defatting the concentrate increased the detrimental effect. Bread containing 10 or 20% oat bran was accepted better than was bread containing the corresponding level of wheat bran.

High-protein bread products are not new, and many high-protein concentrates have been used. The Tropical Products Institute (1) recently tabulated work on protein supplementation. Wheat protein concentrates were isolated and their use in breadbaking was studied (2–4). Oat protein concentrates also were isolated (5–8), but their effects on dough properties and their use in breadbaking have not been studied.

Interest has intensified in the production of high-fiber breads, and many are now available commercially. Plant cellulose is the source of fiber in some of these breads, and alternatives are being sought. One possible source would be oat bran. In a study of gastrointestinal response in six elderly women to dietary oat and wheat bran, Meyer and Calloway (9) reported that oat bran significantly increased fecal output when compared with the control diet. Fecal output was less for the oat bran than for the wheat bran diet, but the difference was not significant. Also, oat bran caused less discomfort for the subjects.

This article is a report of the effects of an oat protein concentrate and oat bran on dough properties and bread quality.

MATERIALS AND METHODS

Bran Source

Waldron, a hard red spring (HRS) wheat cultivar, and oat groats (dehulled oats) from the cultivar Dal were tempered to 13% mb and dry milled in a Brabender Quadrumat Junior flour mill (Brabender Instruments, Inc., South Hackensack, NJ). Bran from the millings was shaken on a 60-mesh sieve to

[1]Cooperative investigation, USDA Oat Quality Laboratory, Department of Agronomy, University of Wisconsin, Madison, WI 53706, and Department of Cereal Chemistry and Technology, North Dakota State University, Fargo, ND 58102.

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[2]Professor, Department of Cereal Chemistry and Technology, North Dakota State University, Fargo, ND 58102.

[3]Research chemist, Oat Quality Laboratory, USDA, and adjunct professor, Department of Agronomy, University of Wisconsin, Madison, WI 53706.

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remove additional flour. Two types of bran were obtained from Dal oats: one was from groats that had been treated with 1*N* HCl for 30 sec to inactivate the enzyme lipase, and the other was from groats that had received no prior treatment.

Oat bran also was obtained by dry milling a commercial oatmeal (rolled oat groats) purchased in a supermarket. Oat groats are normally heat-treated with steam before rolling to deactivate the lipase. This bran was designated as oatmeal bran.

Finally, an oat bran designated as residue bran was also used in the study. This water-extracted bran was recovered after centrifugation of a water slurry of oatmeal bran according to the procedure of Youngs (8). The range in nitrogen concentration of the brans was 3.18–3.66% (db), and 3.8–4.2% of the protein (N × 6.25) was lysine.

High-Oat Protein Concentrate

A high-oat protein concentrate was obtained by centrifuging and blending the two concentrates. This concentrate contained 8.3% nitrogen (db), and 3.8% of the protein (N × 6.25) was lysine. For response in physical dough and baking studies, the concentrate was investigated before and after defatting. The concentrate, which originally contained about 18% free lipids (db), was defatted with ethyl ether for 30 min with slow stirring. After this treatment, about 5% free lipids still remained in the defatted concentrate.

HRS Wheat Flour

Flour (Waldron) was obtained by milling the wheat on a pilot mill (Buhler-Miag Co., Minneapolis, MN) according to established procedures (10). The unbleached, unmalted flour had a nitrogen concentration of 2.42% (db) and 2% of the protein (N × 5.7) was lysine.

Preparation of Flour Blends

Blends containing 10, 20, and 30% of the different bran preparations and undefatted and defatted high-oat protein concentrates were prepared with the Waldron flour.

Physical Dough Properties

Physical dough properties of the wheat flour and the flour blends were determined with the farinograph (50 g of flour, 50-g bowl), by the constant flour weight procedure of AACC method 54-21 (11).

Breadbaking

Bread (100-g pup loaves) was baked from the flour blends by a straight-dough baking procedure with a 3 hr fermentation and a temperature of 30° C. During the fermentation period, the dough was removed from the bowl after 1 hr and 45 min and again after an additional 45 min and given the first and second punch (folding over). The baking formula, based on flour weight, was as follows:

Flour	100 g
Salt	2%
Sugar	5%
Shortening	3%

Compressed yeast	3%
Malt	0.05%
Potassium bromate	10 ppm
Sodium stearoyl-2-lactylate (SSL)	0.5% when used
Water	Variable

Doughs were mixed in a National 100–200-g mixer (National Mfg. Co., Lincoln, NE); mixing time was determined by physical examination of the dough. Baking absorption was estimated from the farinograph absorption, and the final decision was based on the feel of the dough.

The fermented doughs were sheeted with a National sheeter, molded in a Roller-Er-Up moulder (National Mfg. Co., Lincoln, NE), and panned. After a 55-min proof time at 30° C, the bread was baked for 25 min at 230° C. Volume of the cooled loaves was measured by rapeseed displacement.

For taste panel evaluation, the same baking formula and procedure were employed, but 1-lb loaves were produced.

Taste Panel Evaluations

Taste evaluation was made by two methods. In the first evaluation, samples from five loaves of bread were presented to a panel of 15 people. Each loaf contained either wheat bran, oat bran (acid treated), residue oat bran, or the undefatted or defatted high-oat protein fraction. Panelists were asked to rate the samples in order of preference from 1 (very acceptable) to 5 (unacceptable). The same number could be used more than once. Breads made with flours containing 5 and 10% of the test material were evaluated in two separate sessions. This evaluation method was used to determine if the taste panels could detect extreme differences in acceptability among the various bread types.

For the second taste evaluation panel, bread samples contained either 10 or 20% of the oat bran (acid treated) and 10 or 20% of the undefatted high-protein concentrate. A triangle test was used with a panel of 25–30 people. For evaluation of the bread containing oat bran, bread containing wheat bran at an equal level was the control. For evaluation of the oat protein concentrate, bread without the additive was the control. In each evaluation, two of the samples were controls and the third was the test sample. The samples were randomly presented to the panel as 1, 2, and 3. Although the panel was not asked to identify specifically the odd samples, the intent was to ascertain if the panel would be able to detect differences among the three samples being tested. The triangle test was used to establish a more definite evaluation of specific bread types than could be achieved by the first method. The panel was asked to evaluate the bread for mastication, rating it as satisfactory, gummy and doughy, tough, or otherwise, and for taste and aroma, rating it as satisfactory, bland and tasteless, bitter, or otherwise.

RESULTS AND DISCUSSION

Physical Dough Tests

Farinograph properties differed among the types of oat bran (Table I). Regardless of the source or method used for preparation, bran increased the farinograph absorption. In general, oat bran increased farinogram absorption to a greater degree than did wheat bran. Oatmeal bran increased absorption most,

and also produced a dough that was more stable as shown by mechanical tolerance index (MTI) values than was the dough with oat groat bran whether acid treated or not. Ash value was almost identical for oatmeal and Dal brans (3.05 and 3.01%, respectively), so the differences should not have been caused by extra starchy endosperm in the oatmeal bran. The heat treatment of the groats before rolling possibly helped to create a stable dough. Treatment of oat groats with hydrochloric acid before milling to inactivate the lipase enzyme reduced the dough development time and increased the MTI value. Incorporation of the oat residue bran produced a dough with good stability, even at the 30% level. Wheat bran also produced a dough with good stability.

High-oat protein concentrate greatly increased farinograph absorption; it was greatest with the material that had been defatted. Dough stability was satisfactory up to the 20% level of usage, but thereafter stability decreased.

Breadbaking

Figure 1 shows the internal and external appearance of bread containing wheat bran, oat bran (acid treated), residue bran, and defatted and undefatted

TABLE I
Farinograph Data for Oat-Wheat Flour Blends

Source	Blend (%)	Absorption (%)	Dough Development Time (min)	MTI[a] (BU)
Control HRS wheat flour	...	63.5	9.0	10
Wheat bran	10	65.6	6.5	20
	20	69.4	6.5	25
	30	71.0	7.0	25
Oatmeal bran	10	67.6	6.5	40
	20	73.6	6.5	60
	30	79.0	6.0	75
Oat bran (acid treated)	10	65.6	5.0	90
	20	69.6	4.5	115
	30	73.8	4.0	130
Oat bran (no treatment)	10	65.6	6.0	85
	20	69.8	6.0	100
	30	74.2	6.0	110
Oat residue bran	10	67.2	7.0	20
	20	72.2	6.5	20
	30	76.8	5.5	20
High-oat protein concentrate (undefatted)	10	67.8	7.5	20
	20	74.4	6.0	20
	30	83.2	2.0	60
High-oat protein concentrate (defatted)	10	73.0	8.0	20
	20	78.6	7.5	40

[a]MTI = mechanical tolerance index expressed in Brabender units.

high-protein concentrate. Addition of bran produced higher loaf volumes than did incorporation of the high-oat protein concentrate, whether defatted or not (Table II). Also, wheat bran appeared to be superior to the oat groat bran (acid treated) or the residue bran in producing a high loaf volume. Oat bran (untreated) and oatmeal bran (data not shown) produced results similar to those with oat bran (acid treated).

Wheat bran produced a brown crumb color characteristic of whole wheat bread, whereas the oat bran bread was light brown at both the 10 and 20% levels of incorporation. The crust color of all oat bran-containing bread was similar,

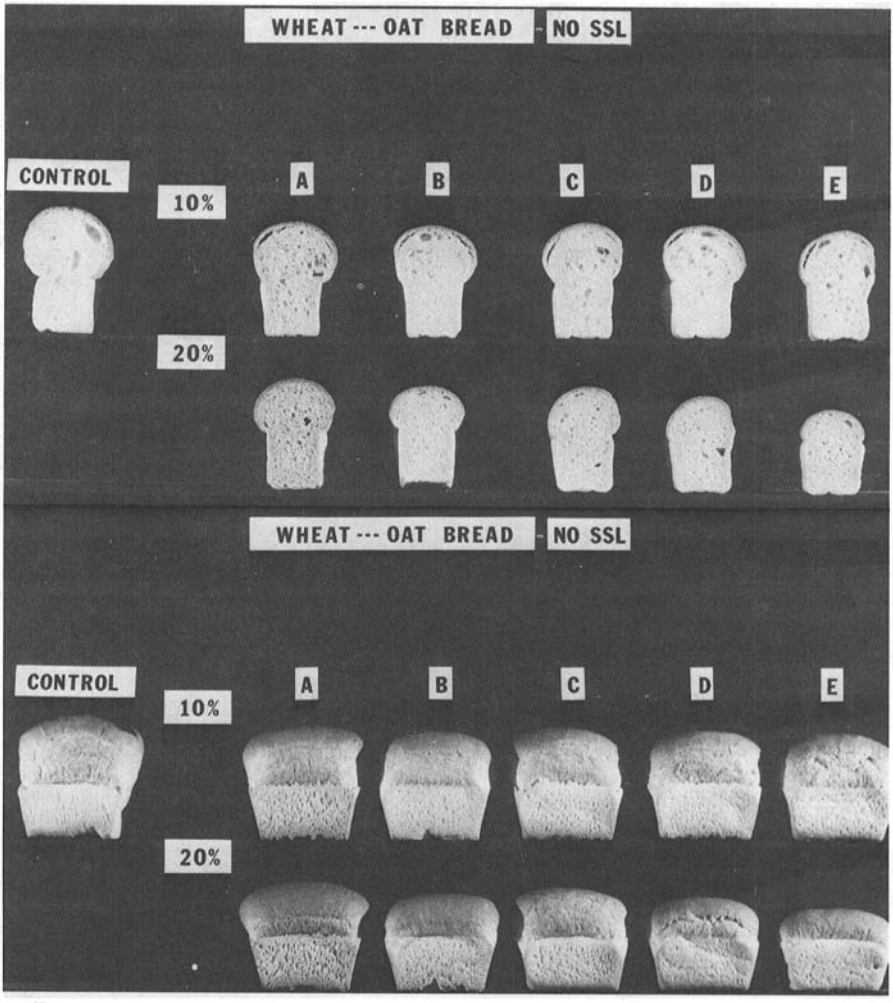

Fig. 1. Internal (top) and external (bottom) bread containing bran and oat protein concentrate. Control, 100% wheat; A, wheat bran; B, oat groat bran; C, residue oat bran; D, undefatted oat protein concentrate; E, defatted oat protein concentrate.

but inclusion of SSL gave a slightly paler crust color. Crust color of bread containing 10% oat protein concentrate, whether defatted or not, was acceptable. At the 20% level, however, the crust color was dull. Defatted high-protein concentrate gave a lower loaf volume than did the undefatted material (Table II). In all cases, inclusion of SSL in the baking formula improved the loaf volume and overall breadbaking characteristics.

Doughs containing 20% oatmeal bran, oat bran, or high-protein concentrate stuck to the sides of the mixing bowl. Stopping the mixer periodically was necessary to scrape the sides of the bowl until a coherent mass of dough was formed. Bread that contained wheat or oat bran was more underoxidized than was the bread containing the high-protein concentrate.

Taste Panel Evaluations

Table III shows the ratings that the first taste panel gave to the bread. The data show that the bread containing 5 or 10% of the oat bran or protein concentrate was well accepted relative to the control containing wheat bran.

Table IV shows the results of the taste panel evaluation by the triangle test of breads containing 10 and 20% oat groat bran and high-protein concentrate. The data indicate that the oat bran bread was well accepted, particularly if the acceptability of the control bread was considered in the test. At both levels of incorporation of oat bran, the percentage of panelists' satisfactory ratings was greater for oat bran bread than for wheat bran bread in both mastication and taste and aroma. For mastication, the percentage of ratings was higher for the 10% oat protein concentrate bread than for the control bread. For taste and

TABLE II
Data for Oat-Wheat Flour Bread

Source	Blend (%)	Absorption[a] (%)	Mixing Time (min)	Volume[b] No SSL (cc)	Volume[b] 0.5% SSL (cc)
Control (HRS wheat flour)	...	62.0	3-1/4	940	960
Wheat bran	10	66.0	2-3/4	835	890
	20	67.0	2-3/4	780	820
Oat bran (acid treated)	10	65.5	2-1/2	783	855
	20	69.6	2-1/4	655	683
Residue bran	10	65.2	2-1/2	798	848
	20	68.0	2-1/4	665	705
High-protein concentrate (undefatted)	10	64.4	2-1/2	775	820
	20	69.4	2-1/4	588	650
High-protein concentrate (defatted)	10	69.0	2-1/4	745	800
	20	71.2	2-1/4	505	578

[a]Expressed on 14.0% mb.
[b]Data reported are average of duplicate bakes.

aroma at both the 10 and 20% levels of concentrate and for mastication at the 20% level, percentage of satisfactory ratings was higher for control bread.

Changes in mixing properties limit the amount of oat bran and high-protein concentrate that can be added to wheat flour for breadbaking. Even at 10 and 20% additions, protein and lysine were increased in the bread. The fact that taste

TABLE III
Taste Panel Evaluation of Bread[a]

Sample	Preference Rating[b]				
	1	2	3	4	5
5% Level					
Wheat bran	3	2	5	1	4
Oat bran (acid treated)	6	4	2	1	2
Residue bran	7	3	3	1	1
High-protein concentrate (undefatted)	9	2	1	1	2
High-protein concentrate (defatted)	5	6	2	1	1
10% Level					
Wheat bran	3	4	2	3	3
Oat bran (acid treated)	7	5	1	1	1
Residue bran	4	4	3	4	0
High-protein concentrate (undefatted)	8	3	2	2	0
High-protein concentrate (defatted)	6	1	4	3	1

[a]Average of two evaluations.
[b]The higher the number, the less acceptable the bread.

TABLE IV
Taste Panel Evaluation of Bread (Triangle Test)

Sample	Percentage of Panel Rating Bread Satisfactory	
	Mastication (%)	Taste and Aroma (%)
10% Level		
Control (wheat bran)	66	59
Oat bran (acid treated)	86	76
Control (white bread)	73	50
High-protein concentrate (undefatted)	73	50
20% Level		
Control (wheat bran)	57	41
Oat bran (acid treated)	72	66
Control (white bread)	58	69
High-protein concentrate (undefatted)	54	46

panels indicated a preference for oat bran over wheat bran in bread at the 10 and 20% levels and relatively high acceptance for high-oat protein concentrate bread at the 10% level indicates that incorporation of these products would not reduce the acceptability of bread. Objective indexes of quality also indicated that the oat-supplemented breads were satisfactory.

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Literature Cited

1. DENDY, D. A. V., KASASIAN, R., BENT, A., CLARKE, P. A., and JAMES, A. W. Composite Flour Technology Bibliography. Ed. 2. Tropical Products Institute: London (1975).
2. FELLERS, D. A., SHEPHERD, A. D., BELLARD, N. J., and MOSSMAN, A. P. Protein concentrates by dry milling of wheat millfeeds. Cereal Chem. 43: 715 (1966).
3. SAUNDERS, R. M., CONNOR, M. A., EDWARDS, R. H., and KOHLER, G. O. Preparation of protein concentrates from wheat shorts and wheat millruns by a wet alkaline process. Cereal Chem. 52: 93 (1975).
4. BETSCHART, A. A., SAUNDERS, R. M., BEAN, M. M., and KOHLER, G. O. Effects of processing on the baking quality of wet alkaline process wheat protein concentrate. Cereal Chem. 52: 812 (1975).
5. CLUSKEY, J. E., WU, Y. V., WALL, J. S., and INGLETT, G. E. Oat protein concentrates from a wet-milling process. Cereal Chem. 50: 475 (1973).
6. WU, Y. V., CLUSKEY, J. E., WALL, J. S., and INGLETT, G. E. Oat protein concentrates from a wet-milling process: Composition and properties. Cereal Chem. 50: 481 (1973).
7. WU, Y. V., and STRINGFELLOW, A. C. Protein concentrates from oat flours by air classification of normal and high-protein varieties. Cereal Chem. 50: 489 (1973).
8. YOUNGS, V. L. Extraction of a high protein layer from oat groat bran and flour. J. Food Sci. 39: 1045 (1974).
9. MEYER, S., and CALLOWAY, D. H. Gastrointestinal response to oat and wheat milling fractions in older women. Cereal Chem. 54: 110 (1977).
10. SHUEY, W. C., and GILLES, K. A. Evaluating wheat quality on a laboratory scale commercial mill. Northwest. Miller 275: 8 (1968).
11. AMERICAN ASSOCIATION OF CEREAL CHEMISTS. Approved methods of the AACC. Method 54-21, approved April 1961. The Association: St. Paul, MN.

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