Assessing Wheat Quality with Breads Prepared by Two Formulations [1]

RUTH H. MATTHEWS[2], **C. C. FIFIELD**[3], and **T. F. HARTSING**[3], Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland 20705

ABSTRACT

A comparative study was made on home- and laboratory-type breads prepared from the same flour samples milled from wheats of known history and stored for different times up to 1 year. Bread was scored for aroma, flavor, tenderness, and evenness of grain by a taste panel composed of men and women. Aroma and flavor scores were usually similar for the two types of bread. During the 12-month storage of the wheat, home-type breads had better grain texture and were more tender than laboratory-type breads. Specific volumes of home-type breads were lower than those of laboratory-type breads during the course of this study. Other physical measurements of flours and home-type doughs and breads are discussed.

As far as is known, no research has compared quality of breads prepared by home- and laboratory-type formulas from the same flour with ingredients typical of both. The opportunity to secure some information on this subject arose recently in co-operative research conducted by two different divisions of the U.S. Department of Agriculture. The literature dealing with applications of various test-baking methods or formulas to experimental flour testing is familiar to those engaged in bread-baking (1, 2). The problems of the correlation between laboratory baking tests and commercial results, of which some studies have been made, is one of fundamental importance to those engaged in laboratory as well as large-scale baking (3).

Loaf breads were prepared as part of a 3-year comprehensive research project on the effects of periodic fumigation of wheat in storage to evaluate composition, quality, and baking performance of the wheats. This paper reports a portion of the results and compares quality of home- and laboratory-type breads made from wheat without fumigation treatment. Comparisons between storage periods of wheat are not intended; thus, these statistical analyses were not made. Results of effects of fumigation of wheat in storage will be published after the research is completed. Research was conducted in the Human Nutrition Research Division in co-operation with the Market Quality Research Division. The former group had responsibility for this project, including the preparation of home-type breads, sensory evaluations of both home- and laboratory-type breads, and physical tests on the flours, doughs, and breads. The latter group was responsible for the storage, treatment, and milling of the wheat into flour and for the preparation of laboratory-type breads.

MATERIALS AND METHODS

Experimental Samples

Hard red winter wheat of the Early Triumph variety (11% protein content) was purchased from a farm in Kansas in a quantity large enough to complete all tests. This variety, when milled, produced a flour which simulated family flour in protein content. The wheat was divided into two

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[2] Human Nutrition Research Division.
[3] Market Quality Research Division.

lots without fumigation treatment; one was held at 32°F. at Beltsville, Maryland, and the other at ambient temperatures in Manhattan, Kansas. During the year mean temperatures inside the bin ranged between 40° and 77°F. Moisture content of the wheat samples stored at the two locations ranged between 12.4 and 13.4%. The tempered wheats were milled to 90% patent flours on a Buhler[3] automatic experimental laboratory mill at 3-month intervals for one year.

Physical Measurements of Flour Samples

Amylograms and mixograms of the flour samples were determined by AACC official methods (4). During the course of this research, these measurements reflected changes in wheat quality.

Preparation of Breads

Home-type breads were made by a straight-dough method with formula and ingredients available to household consumers. Ingredients of known history were purchased from the processors in quantities large enough to complete all tests. These breads were compared in quality with breads made by a straight-dough, laboratory-type formula with ingredients available to the commercial baker. Breads were made under experimental laboratory conditions. For both types of bread, three replications were made on different days of each sampling period. The formulas with the proportion of ingredients based on the weight of flour are given below.

Ingredient	*Home-Type* %	*Laboratory-Type* %
Flour	100	100
Fat (hydrogenated)	2	3
Sugar	5	5
Nonfat dry milk	6	4
Salt	2	2
Yeast (See Note 1)	1.4	2
Malted wheat flour (See Note 2)	......	0.25
Potassium bromate (See Note 2)	......	0.002
Water (distilled)	50	variable

Note 1. Active dry yeast was used for home-type breads and compressed yeast for laboratory-type breads.

Note 2. None added to home-type breads since many family flours do not contain this ingredient; the optimum amount was added to laboratory-type bread.

The home-type bread doughs were mixed with a dough hook for 3.5 min. at 144 r.p.m. in a Hobart 10-qt. mixer (Model C-100). Nonfat dry milk (NFDM), flour, sugar, and salt were blended together before the water and other ingredients were added. NFDM is used in many households without reconstitution to save time in food preparation. Ten 550-g. loaves were moulded from the dough that weighed approximately 6 kg. The laboratory-type breads were prepared by a straight-dough rich formula with ingredients shown above and previously described (5). Duplicate pup loaves of bread weighing approximately 180 g. each were made. The proportions and types of ingredients in the two formulas were typical for the two types of bread. The level of 1.4% active dry yeast in the home-type dough formula was within the range of 1.25 to 1.50% reported previously to produce bread

[3]Mention of trade names does not imply endorsement by the U.S. Dept. of Agriculture over similar products not mentioned.

comparable to that made with 3.0% of compressed yeast (6). The active dry yeast doughs also developed more rapidly than the compressed yeast doughs (6). The two formulas also differed in level and type of NFDM. The instantized form of NFDM was used in home-type breads. In the other baking procedure, NFDM processed especially for commercial baking, heat-treated before drying, was used. This forewarming treatment prevents slackening or softening of the dough during the fermentation steps. The functions of the malted wheat flour and the potassium bromate in the laboratory-type doughs are well known (7).

Atmospheric conditions of fermentation for the two types of bread dough were identical: 86°F. (30°C.) and 85% relative humidity. Home-type bread doughs were fermented and proofed until doubled in size, which is customary household practice. The time ranged from 76 to 90 min. for the first fermentation and from 57 to 70 min. for final proofing. Laboratory-type bread doughs were fermented for 180 min. and the loaves proofed for 55 min. Rotary hearth ovens were used for baking, 30 min. at 400°F. for the home-type breads and 25 min. at 440°F. for the laboratory-type breads.

Quality Evaluations of Breads and Doughs

Quality characteristics of the home- and laboratory-type breads were evaluated by seed displacement measurements of volume and by panel scores for aroma, flavor, grain, and tenderness. To compare the two types of bread, specific volumes were calculated. These values are the amount of baked product, in ml., produced from 1 g. of dough. Eating-quality characteristics were scored by a four-member trained panel of men and women on a 5 to 1 scale with 5 considered optimum.

To more clearly define the quality of home-type breads and doughs, during the course of this study, physical measurements of shear and compressibility were made. Tenderness of home-type doughs and breads was measured on a Kramer shear press, with duplicate 6-cm. cubes of material for each replication. This instrument was used previously by Matthews and Dawson for measuring tenderness of baking-powder biscuits (8). Compressibility was determined on duplicate 4-cm. squares of dough (2 cm. thick) with a precision penetrometer equipped with a flat disk and 250 g. of weights; depth of penetration in mm. was recorded after the weights were applied for 10 sec.

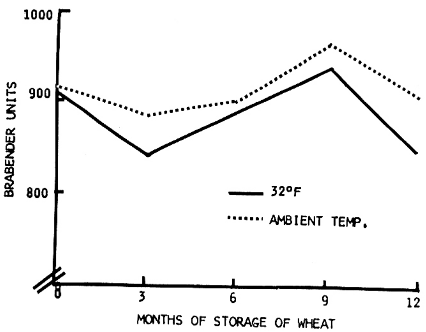
Statistical Analysis of Data

Differences between means for specific volume and for panel scores were analyzed statistically by the "t" test (9).

RESULTS AND DISCUSSION

Physical Measurements of Flour Samples

Amylograph readings of flours milled from wheats stored at 32°F. were consistently lower (higher in enzyme activity) than flours milled from wheats stored at ambient temperatures (Fig. 1). Flours were low in enzyme activity by present standards and appear to be related to storage temperature of the wheat. The addition of malted wheat flour to the laboratory-type bread formula contributed significantly to the enzyme activity in that dough.



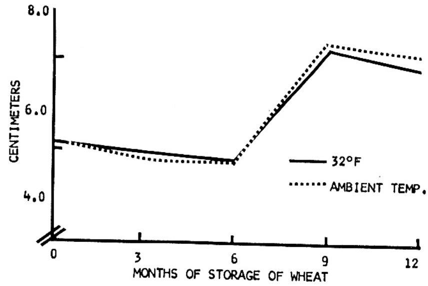


Fig. 1 (left). Maximum viscosity of experimental flour samples milled from wheats during storage for 12 months (amylograph).

Fig. 2 (right). Maximum peak curves of experimental flour samples milled from wheats during storage for 12 months (mixograph).

Amylograms of flours increased and decreased periodically during the course of the study. Since the amylograph method was designed to simulate conditions during the baking of bread, an increase and decrease of bread specific volume with wheat storage might be expected.

Mixogram peak curves were nearly identical for flours milled from wheats from the two storage temperatures (Fig. 2). Readings were about the same during the first 6 months of wheat storage. As expected, dough strength increased with longer storage.

Specific Volumes and Panel Scores of Both Types of Bread

Specific loaf volumes of the home-type breads made from flour milled from the wheat samples were significantly lower than specific volumes of the corresponding laboratory-type breads (Table I). Difference between the two types of bread was greatest at the 3-month storage period of the wheat. Loaf volumes varied during the year's storage of the wheats. There appears to be no obvious reason that would explain this change.

A number of factors caused the reduced volume of the home-type breads. Flour proteins can be damaged by glutathione leaching from active dry yeast cells (6), or from the high (6%) amount of NFDM which had received no special processing treatment, or both. The pH-buffering and water-absorbing capacities of the NFDM cause differences in performance of bread doughs. Mecham and Knapp (10) reported that loss of sulfhydryl groups during dough mixing was affected by the presence of NFDM. Later, Bernardin, Mecham, and Pence (11) showed that a major casein component of NFDM is fragmented rapidly by a protease in flour. They postulated that the nature and complexity of both flour and NFDM proteins suggest that protein-protein interactions may be responsible for some unaccountable deviations in effects of NFDM.

The presence of bromate strengthens doughs and aids in retaining loaf volume. Bromates seem to help create cross-linkages between certain molecules of the dough network (12). Added enzymes in the form of malted wheat flour helped develop volume of laboratory-type bread.

TABLE I

COMPARATIVE QUALITY[a] OF HOME- AND LABORATORY-TYPE BREADS

Storage Time of Wheat	Specific Volume		Score: Aroma		Score: Flavor		Score: Grain Texture		Score: Tenderness	
	Home	Lab.	Home	Lab.	Home	Lab.	Home	Lab.	Home	Lab.
months	*ml./g.*									
	Wheat stored at 32°F.									
0	3.58*	4.06	4.9	4.8	4.7	4.8	4.2	3.5	4.7	4.0
3	3.34*	4.13	4.8	4.9	4.7	4.8	4.5	3.8*	4.4	4.1
6	3.52*	3.89	4.8	4.8	4.6	4.6	4.2	3.7	4.0	3.8
9	3.39*	3.77	4.5	4.7	4.6	4.7	4.3	3.9	4.6	3.9*
12	3.49*	3.97	4.8	4.8	4.3	4.4	3.8	3.6	4.0	4.0
Over-all mean	3.46*	3.96	4.8	4.8	4.6	4.7	4.2	3.7**	4.4	4.0*
	Wheat stored at ambient temperature									
0	3.62*	4.05	4.9	5.0	4.6	4.9	4.4	3.8	4.7	4.2
3	3.33*	4.18	4.8	4.8	4.8	4.3*	4.4	3.9	4.3	4.2
6	3.49*	3.87	4.6	4.8	4.5	4.8	4.2	3.5*	4.0	3.6
9	3.34*	3.78	4.9	4.7	4.6	4.6	4.5	4.0	4.5	3.8*
12	3.45*	3.72	4.3	4.8	4.1	4.5	3.8	3.8	3.8	3.9
Over-all mean	3.45*	3.92	4.7	4.8	4.5	4.6	4.3	3.8**	4.2	3.9*

[a] Mean of 24 values for specific volume determined by (volume of bread, ml.)/(weight of dough, g.); or mean of 12 scores (4 judges × 3 replications).

* Denotes significant differences at 5% level between means of the same storage period of the wheat or for over-all storage.

** Denotes significant differences at 1% level.

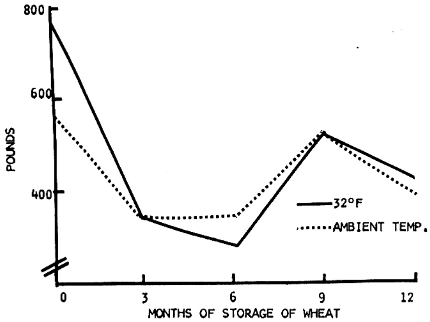
Aroma and flavor of bread were not influenced by the formulas used. Home-type breads had more even grain texture and were more tender than laboratory-type breads when data for all test periods were combined in the analysis. For these two characteristics, mean scores for the home-type breads were usually higher than for the laboratory-type breads.

Differences in techniques of mixing and baking may account for some of the differences between these two types of bread; i.e. the substantially longer proofing and fermentation times of the laboratory-type breads can cause a coarser texture.

Physical Measurements of Home-Type Doughs and Breads

Shear of home-type bread doughs decreased and increased during the study (Fig. 3). Compressibility readings of doughs were in line with shear readings (Fig. 4). These measurements may indicate differences in home-type doughs which may be related to wheat quality.

Readings for shear of home-type breads indicated an over-all increase in tenderness during storage of the wheat. Results of shear on bread parallel those of shear and compressibility of dough (Fig. 5). This finding is in contrast to the panel tenderness scores, which showed some decrease in bread tenderness. It appears that the shear press measures tenderness and texture qualities concomitantly. During the course of this research, panel scores for bread showed decreases in tenderness and increases in coarseness of grain texture.



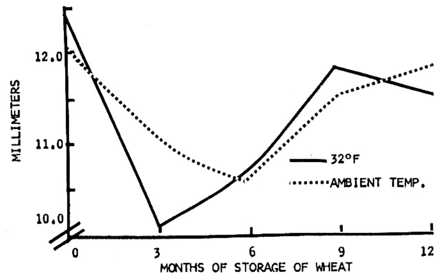


Fig. 3 (left). Shear force of home-type bread doughs made from experimental flours milled from wheats during storage for 12 months (Kramer).

Fig. 4 (right). Compressibility of home-type bread doughs made from experimental flours milled from wheats during storage for 12 months (Precision penetrometer).

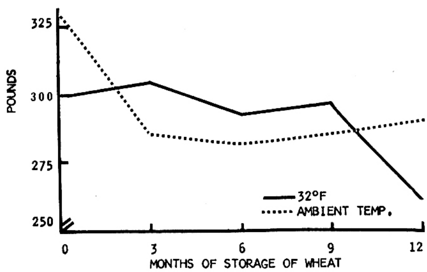


Fig. 5. Shear force of home-type breads made from experimental flours milled from wheats during storage for 12 months (Kramer).

CONCLUSIONS

Although home-type breads were lower in specific volume than laboratory-type breads, the home type usually rated higher scores for grain texture and tenderness. Loaf volume or specific volume of bread, therefore, is not always an index of eating qualities of bread. The complexity of the dough system with its interdependence of ingredients suggests that measurements of wheat grain quality should be made on the doughs and baked breads. Shear or compressibility of dough or shear of bread appears to measure grain texture and tenderness of home-type bread.

Home-type bread is more tender and is likely to have better grain texture than laboratory-type bread. Heretofore, home-type bread had not been used for evaluating quality of different classes of hard wheats intended for yeast-leavened bread products.

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