Evaluation of Distillers' Dried Grain Flour as a Bread Ingredient[1]

C. C. TSEN, J. L. WEBER, and W. EYESTONE,[2] Department of Grain Science and Industry, Kansas State University, Manhattan 66506

Cereal Chem. 60(4):295–297

ABSTRACT

The potential use of distillers' dried grain flour (DDGF) as an ingredient for preparing grain-type breads was studied. Two DDGF samples, designated as DDGF-B and DDGF-F and representing typical dark and light DDGF samples collected from distillers, were used in this study. When wheat flour was supplemented with DDGF-B or DDGF-F at a 10 or 20% (w/w) replacement level and mixed into dough with water, the replacement reduced dough development time and stability. Breads supplemented with 10% DDGF-B or DDGF-F were superior to whole wheat bread in loaf volume, crumb grain, and color. They contained less ash and fiber than whole wheat bread, but far more than white bread. The supplemented breads had about the same amount of protein and fat as whole wheat bread. They compared favorably with white bread in softness during storage for one, three, and five days. However, they retained softness much better than did whole wheat bread.

Distillers' dried grain with solubles (DDG), a major by-product of distillers, has been used widely in feeds. During fermentation, most grain starch is converted to alcohol, carbon dioxide, and other fermented products; the remaining nutrients (such as protein, fat, fiber, minerals, and vitamins) undergo an almost threefold concentration, mainly in DDG. There are several reports on the use of brewers' spent grain in bread and cookies (Kissell and Prentice 1979, Prentice and D'Appolonia 1977, Prentice et al 1978). Brewers' spent grain is different from DDG in that distillers use corn as their major raw materials, whereas brewers use barley or rice. Little information concerning the use of DDG as a bakery ingredient is available, however.

[1]Contribution 81-291-J, Department of Grain Science and Industry, Kansas Agricultural Experiment Station, Kansas State University, Manhattan 66506.

[2]Professor and research assistants, respectively, Department of Grain Science and Industry, Kansas State University, Manhattan 66506.

DDG is rich in protein and fiber but is dark in appearance. It could be used as a partial replacement for wheat flour for preparing dark bakery products such as chocolate chip and bar cookies and grain type bread to increase their protein and fiber contents. In an extensive study, we found distillers' dried grain flour (DDGF) suitable as a supplement to wheat flour in preparing dark cookies to enrich their protein and fiber contents, as reported previously (Tsen et al 1982). In this report, we report effects of DDGF on dough properties and bread quality.

MATERIALS AND METHODS

Materials

Two DDG samples, designated DDG-B and DDG-F and representing typical dark and light DDG samples, respectively, were supplied by the Distillers' Research Council. The DDG samples were obtained from original mashes predominately composed of corn. DDG-F was medium brown, and DDG-B was very dark brown, almost black. We assumed that DDG-B had been subjected to more intensive heating conditions during the drying process than DDG-F had been. The samples were ground through an Alpine pin mill and then sifted once through a 28 LW sieve to remove large particles. The flours thus obtained were designated as DDGF-B and DDGF-F, respectively.

Whole wheat and white flours were milled from the same batch of hard red winter wheat by a pilot mill (roller). They were stored in a cold room (5–8°C) until used.

Chemical and Color Determinations

Fresh bread was sliced and dried in a fan dryer at 37°C for 24 hr, then ground for analysis. Compositional analyses of flour and bread samples were by standard AACC methods, except that fat was determined by AOCS method Aa 4-38 (1971) with petroleum ether as the extracting solvent. Neutral detergent fiber (NDF) was determined by the method of Van Soest and Robertson (1977). The analysis was run on a Tecator Fibertec System M apparatus. The colors of DDG flour samples and bread slices were evaluated with an Agtron multichromatic, abridged, reflectance spectrophotometer model M-500-A (for flour samples) and a model M-300-A wide-area viewer (for bread slices). AACC method 14-30 (1961) was used to evaluate the flour samples, except that 35 ml of water was added to make a slurry. Only the central portion (6.4×6.4 cm) of the slices were exposed for the reflectance measurement. The chemical characteristics and colors of the flours are shown in Table I.

TABLE I
Chemical Characteristics and Colors of Wheat Flours and Distillers' Dried Grain Flours (DDGF)

Sample	Moisture (%)	Protein[a] (%)	Ash (%)	Fat (%)	Fiber: Crude (%)	Fiber: Neutral Detergent (%)	Color[b] Agtron unit (%)
White flour	14.1	11.3	0.4	1.2	0.3	1.9	92
Whole wheat flour	11.2	12.8	1.6	1.8	2.6	11.0	70
DDGF-B	7.2	27.0	4.2	10.4	6.9	35.7	2
DDGF-F	6.9	27.2	4.2	7.7	6.8	31.2	35

[a] Protein content was calculated as percent (N × 5.7) for wheat flours and percent (N × 6.25) for DDGFs.

[b] The Agtron multichromatic, abridged, reflectance spectrophotometer model M-500 A was standardized with disks M-19 and M-97 at 640 nm (red mode) to read 0 and 100, respectively.

TABLE II
Farinograph Properties of White Flour (WF), Whole Wheat Flour, and White Flour Supplemented with Distillers' Dried Grain Flours (DDGF)

Sample	Absorption[a] (%)	Development Time (min)	Stability Time (min)
White flour (WF)	55.1	6.3	9.2
Whole wheat flour	65.2	4.2	3.1
10% DDGF-B + 90% WF	54.1	4.5	4.8
10% DDGF-F + 90% WF	56.3	4.5	4.0
20% DDGF-B + 80% WF	54.7	3.8	4.6
20% DDGF-F + 80% WF	59.3	4.3	3.5

[a] Absorption calculated on a 14% moisture basis.

TABLE III
Characteristics of Breads Prepared from White or Whole Wheat Flour and White Flour Supplemented with Distillers' Dried Grain Flours (DDGF)

Bread	Weight (g)	Volume (cm^3)	Specific Volume (cm^3/g)	Grain Score
White	443.0	3142	7.1	9-OH[a]
Whole wheat	449.4	2250	5.0	6
10% DDGF-B	445.3	2784	6.2	8
10% DDGF-F	444.3	2811	6.3	8
20% DDGF-B	455.3	1887	4.1	6
20% DDGF-F	452.3	1943	4.3	6

[a] O = Open; H = holes.

Farinograms

Farinograms were obtained by the constant flour weight method by using 50 g of sample with a farinograph (AACC method 54-21).

Baking Tests

The Kansas State University Process (Tsen and Tang 1971) was used, except DDG flour was used in place of soy flour; a combination of 0.25% sodium stearoyl-2 lactylate (SSL) and 0.25% ethoxylated monoglycerides (EMG) in water suspension at 55°C was used instead of 0.5% SSL; and 2.0% fat was added in addition to other ingredients used in the K-State process. Loaf weight (expressed in grams) and volume (in cubic centimeters by seed displacement) were measured within 10 min after baking and averaged from duplicates.

The grain of finished (baked) breads was scored from 1 to 10. A bread scoring less than 5 was regarded as unsatisfactory. The rating was arbitrary, however, in that there are no standards for grain scoring in the baking industry.

Storage Test

Crumb firmness during storage was tested by following changes in the pressure (g) required to depress 4 mm depth on a slice 1 in. thick by a Bloom gelometer equipped with a plastic plunger 1 in. in diameter (Tsen and Hoover 1973). Three slices were taken from each of the two loaves, which had been wrapped, sealed, and stored at room temperature (about 25°C) for one, three, or five days. Three gelometer (compressimeter) readings, in grams, were made on the top, center, and bottom of each slice. The storage test was repeated once, and readings were averaged.

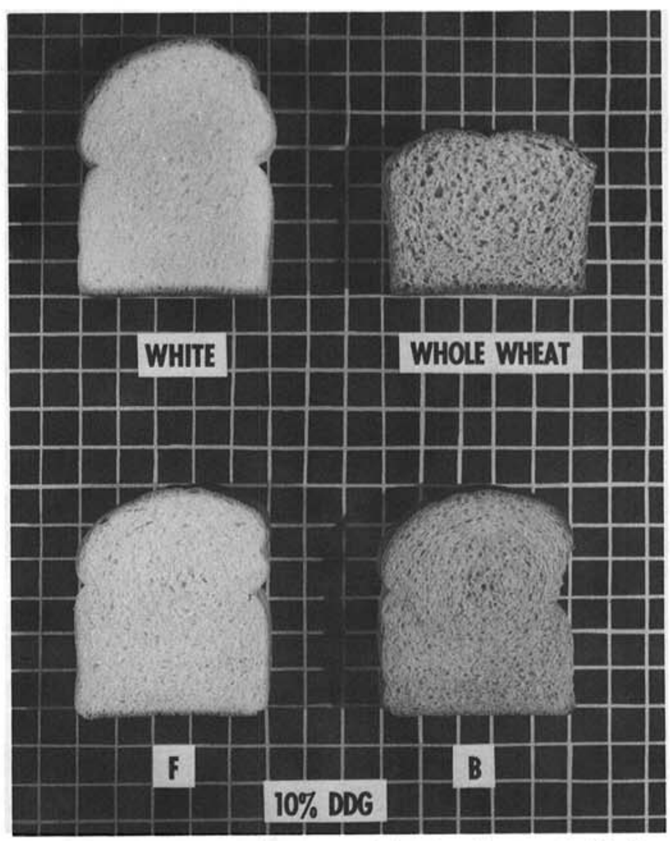

Fig. 1. Breads made from white flour, whole wheat flour, and white flour supplemented with 10% distillers' dried grain-B and distillers' dried grain-F flour samples.

RESULTS AND DISCUSSION

Effect of DDGF on Dough Properties

To evaluate the functionality of DDGF for breadmaking, we first investigated the effect of DDGF on dough properties. When white flour was supplemented with DDGF at a 10 or 20% replacement level and mixed into dough with water, the replacement was found to reduce dough development time and stability, as shown by the farinograph data listed in Table II. DDGF-B reduced the absorption of white flour, whereas DDGF-F increased it. The variation in their effects on flour absorption reflects the qualitative difference between DDGF-B and DDGF-F. Also, comparing of the farinograph dough properties of white flour, whole wheat flour, and DDGF supplemented flours clearly revealed that white flour supplemented with DDGF behaved more like whole wheat flour than white flour. That indicated that DDGF could effectively weaken the dough structure.

Effect of DDGF on Bread Quality

As shown in Table III and Fig. 1, breads made from white flour supplemented with 10% DDGF-B or DDGF-F had acceptable specific volume and grain score. In our study, bread was rated acceptable when its specific volume exceeded 6.0 (cc/g) and it had normal appearance, crumb texture and grain, taste, and flavor (Tsen and Tang 1971). The rating is, of course, arbitrary. The specific volume and grain score of 10% DDGF supplemented breads were much better than those of whole wheat bread. However, the replacement at 20% greatly reduced the loaf volume and grain score of the finished bread (Table III).

Composition of Breads

Analytical data (Table IV) show the similarity in protein and fat contents between whole wheat bread and bread supplemented with 10% DDGF-B or DDGF-F. The ash and fiber contents of the DDGF breads were lower than those of whole wheat bread, but much higher than those of white bread.

The breads supplemented with DDGF appeared darker than white bread. At a 10% replacement level, DDGF-supplemented breads were lighter than whole wheat bread. At the 20% level, however, DDGF-F supplemented bread was still lighter than whole wheat bread, whereas 20% DDGF-B bread was not. The difference in crumb color between the two supplemented breads can be traced back to their difference in flour color; DDGF-B was found to be much darker than DDGF-F (Table I).

Storage Test

Storage tests were conducted to evaluate their shelf life, with white bread used as a reference. Table V shows average gelometer readings for loaves stored one, three, and five days. Breads supplemented with 10% DDGF compared very favorably with white bread and retained softness much better than did whole wheat bread.

TABLE IV
Protein, Ash, and Fat, and Fiber Contents (dry basis) and Colors of Breads Prepared from White or Whole Wheat Flour, and from White Flour Supplemented with Distillers' Dried Grain Flours (DDGF)

Bread Sample	Protein (N × 5.7, %)	Ash (%)	Fat (%)	Fiber: Crude (%)	Fiber: Neutral Detergent (%)	Color[a] Agtron Unit
White	12.2	2.4	1.8	0.6	3.2	88.7
Whole wheat	13.8	3.5	3.3	2.7	12.2	16.7
10% DDGF-B	13.2	2.9	3.4	1.2	6.5	20.3
10% DDGF-F	13.6	2.8	3.2	1.2	6.3	50.3
20% DDGF-B	16.2	3.0	4.2	2.2	9.7	<0
20% DDGF-F	16.4	2.9	3.7	2.1	9.1	26.3

[a]The instrument was standardized with disks M33 and M81 at 640 nm (red mode) to read 0 and 100, respectively.

TABLE V
Average Gelometer Reading (g) of Stored Breads Prepared from White or Whole Wheat Flour, and White Flour Supplemented with Distillers' Dried Grain Flours (DDGF)

Bread	Days Stored: 1	3	5
White	85.5	148.3	167.5
Whole wheat	132.6	183.9	213.3
10% DDGF-B	87.7	137.8	171.9
10% DDGF-F	91.9	136.4	177.8

DISCUSSION AND CONCLUSION

White bread, which long dominated in the United States baking industry, accounted for 76% of all the country's bread-type products in 1972 but dropped to 67% in 1977 and is estimated to drop to 56% in 1982. On the other hand, variety breads are expected to nearly double their share of bread production—from 18 to 34%. The shift in types of breads produced between 1972 and 1982 (Bakery Production and Marketing 1980) indicates that today's consumers look for variety breads made from whole wheat and other grains.

We found that breads supplemented with 10% DDGF were superior to whole wheat bread in loaf volume, crumb grain and color, and shelf life. They contained about the same amount of protein and fat that whole wheat bread did. The supplemented breads had less ash and fiber than whole wheat bread, but far more than white bread. All these findings indicate that a new variety-grain type bread can be prepared from white flour supplemented with selected DDGF samples. Such supplementation will not only expand the array of variety breads, but will also increase the use and value of DDG, a major by-product from distillers.

ACKNOWLEDGMENTS

We thank the Distillers' Research Council for its financial support and William N. Isgrigg for his helpful suggestions and collecting samples.

LITERATURE CITED

AMERICAN ASSOCIATION OF CEREAL CHEMISTS. 1961. Approved Methods of the AACC. 7th ed. Method 08-01, approved April 1961; Method 14-30, approved October 1974; Method 32-15, approved April 1961; Method 44-15A, approved April 1967; Method 46-11, approved October 1976; and Method 54-21, approved April 1961. The Association; St. Paul, MN.

AMERICAN OIL CHEMISTS' SOCIETY. 1971. Official and Tentative Methods. 3rd ed. The Society, Chicago, IL.

BAKERY PRODUCTION AND MARKETING. 1980. Campaigning for bakery foods—Trends '80. Bakery Prod. Mark. 15(6):93.

KISSELL, L. T., and PRENTICE, N. 1979. Protein and fiber enrichment of cookie flour with brewers' spent grain. Cereal Chem. 56:261.

PRENTICE, N., and D'APPOLONIA, B. L. 1977. High-fiber bread containing brewers' spent grain. Cereal Chem. 54:1084.

PRENTICE, N., KISSELL, L. T., LINDSAY, R. C., and YAMAZAKI, W. T. 1978. High-fiber cookies containing brewers' spent grain. Cereal Chem. 55:712.

TSEN, C. C., EYESTONE, W., and WEBER, J. L. 1982. Evaluation of the quality of cookies supplemented with distillers' dried grain flour. J. Food Sci. 47:684.

TSEN, C. C., and HOOVER, W. J. 1973. High-protein bread from wheat flour fortified with full-fat soy flour. Cereal Chem. 50:7.

TSEN, C. C., and TANG, R. T. 1971. K-State process for making high-protein breads. I. Soy bread. Baker's Dig. 45(5):26.

Van SOEST, P. J., and ROBERTSON, J. B. 1977. What is fiber and fiber in food? Nutr. Rev. 35:12.

[Received February 26, 1982. Accepted March 9, 1983]