Effects of Wheat Bran in Breadmaking[1]

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ABSTRACT

Wheat bran, as distinct from shorts and other wheat milling by-products, is more detrimental to loaf volume than would be expected from simple dilution of gluten protein. This effect appears to be a function of bran-water interaction. A combination of increased absorption, addition of shortening and sodium stearoyl lactylate, and fine grinding of added wheat bran will allow the baker to overcome the detrimental effect of adding wheat bran to white pan bread dough.

Wheat bran is a component of whole wheat flour that has been identified as detrimental to loaf volume (Smith and Geddes 1942, Pomeranz et al 1976, Pomeranz 1977, Birch and Finney 1980, Shogren et al 1981, Rogers and Hoseney 1982, Moder et al 1984, and Finney et al 1985). The effect of bran on loaf volume has been reported to vary with the source of the bran (Finney et al 1985). Various effects of bran on flour absorption have been cited in the literature (Pomeranz 1977, Shogren et al 1981, Moder et al 1984). There are also reports that the effects of bran on functional properties of flour vary with the particle size of the bran. These reports, while agreeing that bran does affect flour properties, contradict each other as to the specific nature of the effect (Pomeranz et al 1977, Finney 1979, Finney et al 1985). A possible explanation for this discrepancy is the definition of bran used in various studies. As detailed below, bran varies depending upon the mill producing it. In the milling process the pericarp and aleurone layer are removed from the wheat kernel. To a greater or lesser degree these anatomical structures are separated into the milling fractions known as bran and shorts, respectively. The effects of the two fractions on the functional characteristics of flour are quite different, as outlined in this and a companion paper (Lai et al 1989). These differences, when coupled with the inherent variation in completeness of separation of the two fractions during the milling process, may explain much of the variation in the reported effects of bran. This is especially true of work done with undefined bran which may have been a mixture of bran and shorts.

This study was intended to determine and overcome the effects of a specific bran fraction (primarily pericarp) as separated in a conventional milling process.

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MATERIALS AND METHODS

Bran

Bran was collected from the pilot flour mill in the Department of Grain Science and Industry at Kansas State University. A blend of hard red winter wheat varieties was milled using the normal mill flow. Bran was defined as the material that remained on a 1,050-μm wire screen following the fifth break rolls and then passed as the overs of the bran duster. The bran was stored at 4°C after milling and used without further grinding unless otherwise specified.

Flours

Four flours, flour A (12.4% protein [N × 5.7], 12.9% moisture), flour B (11.6% protein, 12.0% moisture), flour C (11.8% protein, 11.8% moisture), and flour D (11.8% protein, 12.4% moisture) were used in this study. They were donated by Ross Mills, Wichita, KS. All flours were medium long mixing with good loaf volume potential.

Pup Loaf Baking

A straight dough procedure with optimum mixing time and 3 hr fermentation at 30.6°C, 88% rh was used (Finney 1984). Doughs were mechanically punched at 105, 155, and 180 min, then molded and panned. Panned doughs were proofed 55 min and baked at 218.3°C for 24 min. The breadmaking formula, if not specified otherwise, included 100 g of flour, 1.5 g of salt, 6 g of sugar, 4 g of nonfat dried milk, and 3 g of shortening. In certain cases, bran was used to replace part of the formulated flour.

Resistance Oven Baking

Resistance oven baking was carried out as described by Moore and Hoseney (1986).

TABLE I
Effects of Bran and Extracted Bran on Breadmaking

Treatment	Loaf Volume (cm^3)	Standard Deviation (cm^3)	V[a] (cm^3)
Control (flour A)	900[b]	11.8	...
Bran (14%)	720	7.1	80
Control (flour B)	846	17.1	...
Bran (14%)	716	18.4	30
Bran plus 2% additional water	737	3.5	9
Control (flour C)	884	14.9	...
Bran (14%)	743	19.9	60
Bran (14% bran was added to a sponge)	739	12.4	64

[a] V is the difference between the dilution value and the observed effect.
[b] Numbers are averages of six observations. $LSD_{0.95}$ = 28 cm^3.

TABLE II
Loaf Volumes of Breads Containing Coarse and Fine Bran

Treatment	Loaf Volume (cm^3)	Standard Deviation (cm^3)	V[a] (cm^3)
Control (flour D)	878[b]	10.6	...
14% bran	698	9.6	180
14% bran + 10% additional water	794	22	84
Control (flour D)	855	13.2	...
14% soaked bran (in 21 ml of water)	830	7.1	25
Control (flour D)	868	7.6	...
22% soaked fine bran (soaked in 35 ml of water)	855	18.3	13
22% soaked coarse bran (soaked in 31 ml of water)	822	2.9	46
Control (flour D)	866	8.5	...
22% soaked fine bran	910	4.1	+34
22% fine bran (driest addition)	884	14.4	+17.8

[a] V is the difference between the dilution value and the observed effect.
[b] Numbers are averages of six observations. $LSD_{0.95}$ = 28 cm^3.

Calculation of Dilution Value

Our standard baking test involved the replacement of 14% of the formula flour with wheat bran. This dilution of gluten protein with an inert ingredient would be expected to reduce the loaf volume of the resulting bread. We calculated a potential loaf volume value for each of our flours based on this dilution and the known linear relationship between protein and loaf volume. This value is referred to as the dilution value for a given trial. Our calculation of effect of various treatments was based on the difference between the dilution value, the value expected if the added bran were truly inert, and the loaf volume value actually achieved.

RESULTS AND DISCUSSION

The initial trials clearly showed that wheat bran as separated in a conventional milling process had a far greater effect on loaf volume than would be expected from an inert ingredient (Table I). The effect of bran was essentially linear, with a greater volume-depressing effect on flours with a higher loaf volume potential (Tables I and II). With this information, we are confident that although absolute values may differ between flours, the actual effects are the same and that valid comparisons between flours can be made.

Extraction of bran with either water or 80% isopropanol failed to produce an extract with a significant volume-depressing effect. Beta-glucosidase digestion did not alter the effects of bran on loaf volume. Heat treatment likewise had no effect. Steeping the bran in either KIO_3 or alkali tended to increase the loaf volume-reducing effect. The effects of KIO_3 and alkali were not pursued in this study.

Shortening

Bran-containing doughs baked in the resistance oven (Fig. 1) showed expansion and setting characteristics similar to those observed for doughs made without shortening (Moore and Hoseney 1986). If bran were in some way altering shortening availability to other dough ingredients, especially gluten, then timing of the addition of bran during mixing should change the effect of bran on loaf volume. Also, if the above hypothesis were true, additional increments of shortening should eventually restore loaf volume to the dilution value. In our trials, the timing of bran addition made no difference in the final loaf volume. Addition of shortening improved loaf volume, but the effect was far greater for the first 3% shortening added, with additional amounts having far less effect (Fig. 2). Control doughs containing shortening levels above 3% gave no further increases in volume. The shortening addition curve levels off significantly below the dilution value, which suggested that something other than shortening effects were responsible for a major part of the effect of bran on loaf volume.

Doughs formulated with the level of water indicated by mixograph absorption appeared dry. An additional 2% water had

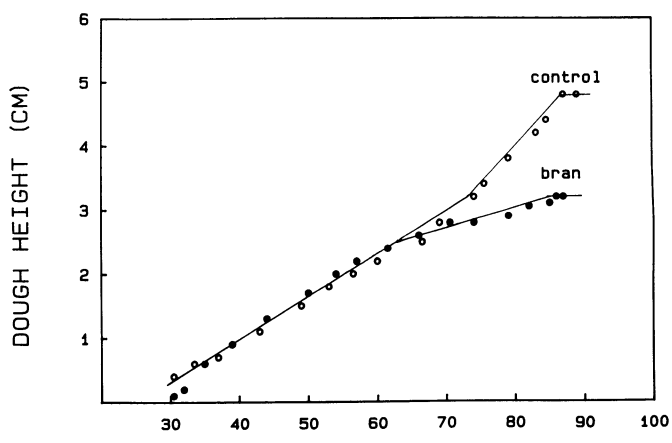

Fig. 1. Dough height versus dough temperature of doughs with and without bran.

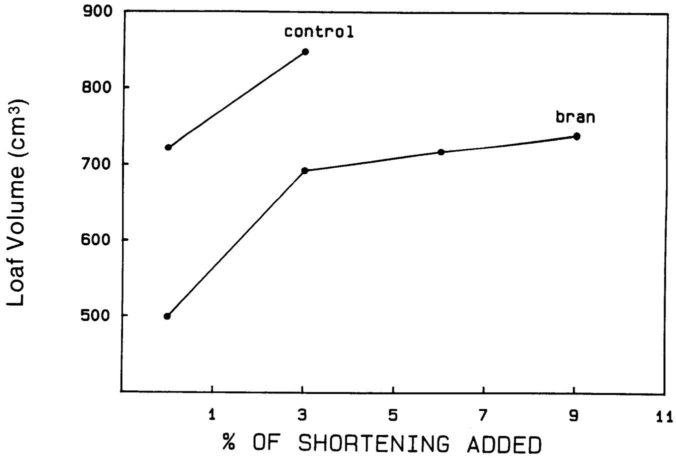

Fig. 2. Effects of shortening on the loaf volume of breads with or without added bran.

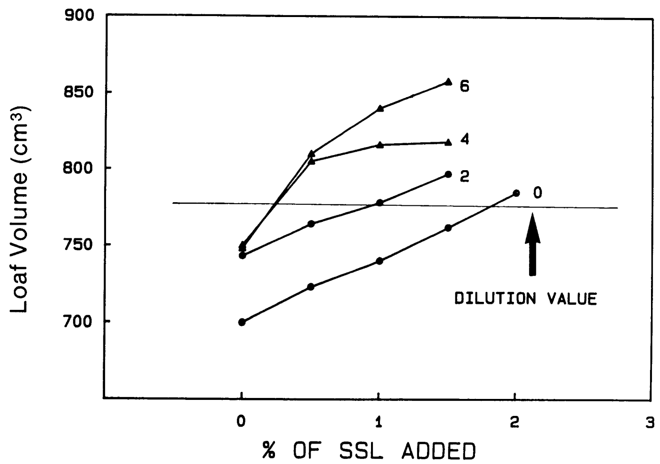

Fig. 3. Loaf volume of breads containing bran plus various amounts of additional water (numbers on graph are additional water in percentages) and sodium stearoyl lactylate (SSL).

a beneficial effect on loaf volume (Fig. 3). Additional water in the absence of sodium stearoyl lactylate (SSL) had little effect. With the addition of SSL the effect of added water was marked. Even without additional water the addition of 2% SSL resulted in loaf volumes at or slightly above the dilution value (Fig. 3). Loaves with 6% additional water and 2% SSL were nearly equal to the nonbran containing control. These doughs were wet, sticky, and difficult to handle. They had pitted bottoms and sides, but their internal structure was normal.

The addition of water in excess of that expected from the mixogram curve could produce a manageable, though sticky, dough with up to 10% bran. With bran in excess of 10%, we were unable to maintain a manageable dough when sufficient water was added to overcome the effect of the bran. Assuming that the rate of water uptake by bran was relatively slow, we tried presoaking the bran in an appropriate amount of water, then adding it to the dough during mixing (Table II). With this system we were able to produce loaves of near dilution volume with 14% bran.

In a further attempt to increase the rate of water absorption by bran, we tried fine grinding the bran with a Udy mill. Doughs containing the finely ground bran were much superior to those with coarse bran (Table II). Presoaking the fine ground bran improved loaf volumes even further. Finally, we were able to add 22% presoaked, fine ground bran to a dough, have the dough remain manageable, and produce a loaf with a volume significantly above not only the dilution value but also significantly above the volume of a control loaf that did not contain bran.

From this work, it appears that the effects of bran on loaf volume, which are greater than would be expected from a totally inert ingredient, can be overcome. A combination of grinding and presoaking the bran and additional water and SSL will produce a dough that can be handled and will produce an acceptable loaf volume.

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