FLOUR FRACTIONS AFFECTING FARINOGRAPH ABSORPTION[1]

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ABSTRACT

Fractionation and reconstitution techniques applied to a study of farinograph absorption showed that simple blends of fractions gave farinograph curves that closely matched those from the parent flours. When the fractions were reconstituted to flours, the farinograph dough mixing characteristics did not match those from the parent flours, but the absorptions were close and unaltered. When one-fraction-at-a-time interchanges were made with blends of fractions and with reconstituted flours, the tailings fraction always accounted for the largest effect, usually about half, of the difference in absorption between soft wheat and hard wheat flours. The rest of the absorption difference was divided among the water-soluble, gluten, and starch fractions.

Three tests, alkaline water retention capacity (AWRC), farinograph absorption, and baking absorption, are currently used to measure different aspects of the water-holding properties of wheat flours. In this laboratory, all three are applied to most samples tested (1), and all appear to be essential to characterize a flour completely. Ideally, a single test for water-holding properties would be desirable, but such a test is not available because of the lack of knowledge of the chemical and/or physical mechanisms controlling the water-holding properties of flour. The present study was begun with the purpose of gaining a better understanding of the contribution each of the flour fractions contribute to the water-holding capacity of wheat flours.

A recent investigation, using fractionation and reconstitution (F&R) techniques, showed that the tailings fraction of flour accounted for half of the difference in water-retention capacity (WRC) between soft and hard wheat flours (2). The water-soluble, gluten, and starch fractions shared somewhat equally in accounting for the remaining half. As part of this study, F&R techniques were applied to a study of farinograph absorption. This paper reports the results.

MATERIALS AND METHODS

Flours

Three straight-grade flours were milled from single-variety wheat composites on a Buhler[2] mill. Rio was a typical hard red winter (HRW) flour, Gaines was a typical soft white winter (SWW) flour, and Omar was a typical club wheat flour. These flours conformed to the varietal ratings previously established in this laboratory. Table I gives the analytical data.

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[1]Cooperative investigations of the Agricultural Research Service, U.S. Department of Agriculture, and the Department of Agricultural Chemistry, College of Agriculture, Washington State University. Scientific Paper No. 4204, College of Agriculture, Pullman.

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[2]Buhler is a trademark name of Buhler-Miag, Inc., 8925 Wayzata Blvd., Minneapolis, MN 55426.

Flour Fractionation

Flours were separated into fractions by kneading a mechanically mixed dough (2). Kneading and other procedures were under ambient room conditions. The water-extract was concentrated under reduced pressure and freeze-dried. Gluten, tailings, and starch were air-dried and ground on a coffee grinder. Recoveries of dry matter and protein were 98 and 99%.

Blends of Fractions

The amounts of dry fractions, in the proportions obtained in fractionation, required to give 50-g samples (5 g for the WRC test) were weighed into a bottle, mixed thoroughly, and introduced directly into the farinograph. Some simple blends were prepared from the fractions of a single flour whereas other blends were prepared from three fractions of one flour and one fraction of another flour.

Flour Reconstitution

Batches of 100-g fractions in the proportions obtained in fractionation were blended and mixed with distilled water in a 100-g dough mixer for 4 min after formation of a dough. The doughs were freeze-dried and ground to flours on a coffee grinder. Following grinding, the reconstituted flours were hydrated in a humidity cabinet for 6–8 hr, which achieved a moisture content of 12.5–14.0%. Moisture, WRC, and farinograms were determined for these flours.

Analytical Tests

Moisture was determined by Method 44–15 in AACC Approved Methods (3). The WRC test has been described (2). Farinograms were determined for 50-g flour samples by AACC Method 54–21 (3).

RESULTS AND DISCUSSION

Farinograms of Blends and Reconstituted Flours

In some studies using F&R, a blend (a simple mechanical mixture) of the fractions has given good results in some tests as WRC (4) and breadmaking (5, 6). In other studies, particularly with chemically-leavened baked products, such as cookies (7, 8) and cakes (9, 10), it has been necessary to mix the fractions with

TABLE I
Analytical Data for Flours

Wheat Class	Variety	Moisture %	Protein[a, b] %	WRC %	AWRC %	Farinograph Absorption %
Club	Omar	13.4	9.53	50.6	51.4	54.9
SWW	Gaines	12.4	9.65	52.1	53.2	57.8
HRW	Rio	13.2	10.04	64.0	65.9	64.0

[a]All data are on a 14% mb.
[b]N × 5.7.

water to a dough and prepare a flour in a preliminary step to achieve satisfactory results.

Simple blends and flours reconstituted from the same fractions were tested in the farinograph. Figure 1 shows typical results. The SWW blend had a curve and absorption very similar to that of the SWW normal flour. The HRW normal flour gave a curve with a sharp initial rise and then a slow steady increase to a maximum at 8 to 10 min. The HRW blend of fractions at the correct absorption had first an initial rise that was less than that of the HRW normal flour; then it had a slower but consistent rise to a maximum at about 11 min. The absorption of the blend was close to that of the normal flour. Both Hyldon (11), working with a high-vitality gluten-starch blend, and Murthy and Dahle (12), working with glutenin, gliadin, and starch systems, have reported similar farinograph curves, which showed the initial rise and then a slow increase to a maximum.

Both the SWW and the HRW reconstituted flours gave farinograph curves that differed markedly from those for the normal flours, but the absorptions

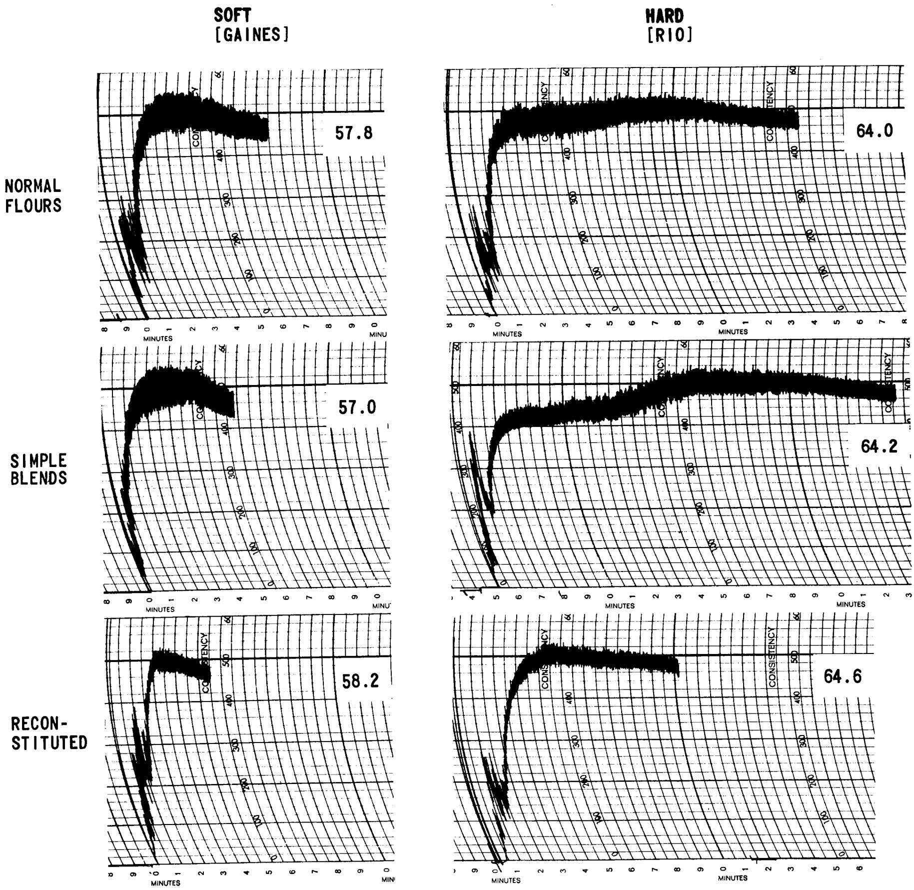

Fig. 1. Farinograms of normal flours, simple blends of fractions, and reconstituted flours for HRW and SWW wheat flours.

required to center the curves were close to those of the normal flours. For the farinograph test, the reconstitution procedure damaged the mixing properties but not the water-holding properties of the fractions, as compared with the simple blends of fractions.

Absorption of Blends with One Fraction Interchanged

Figure 2 shows a typical series of farinograph curves for blends in which one fraction at a time had been interchanged. In the series containing three SWW and one HRW fractions, the HRW tailings raised the absorption 3%, the HRW

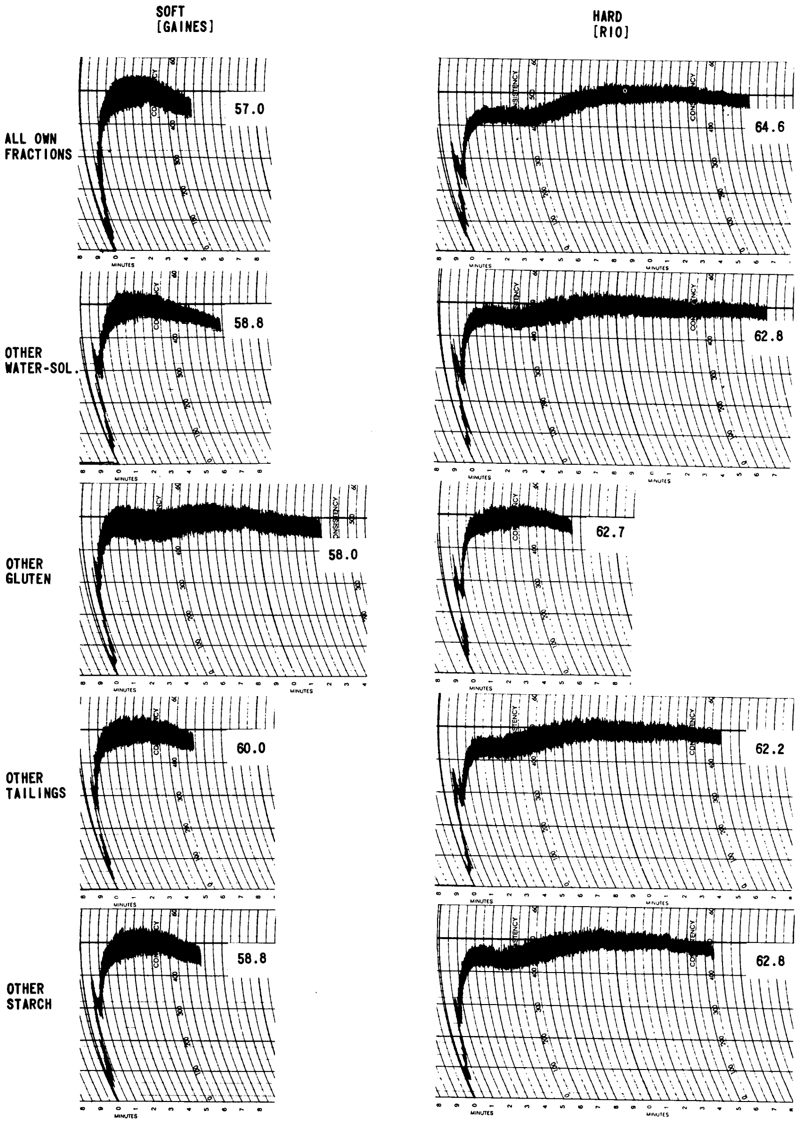

Fig. 2. Farinograms of simple blends with one fraction interchanged.

water-solubles and starch raised absorption nearly 2% each, and the HRW gluten raised it 1%. In the series with three HRW and one SWW fractions, the SWW tailings caused the absorption to drop more than 2%, and each of the other three fractions caused a drop of nearly 2%.

Although outside the scope of this study, it was clear that the gluten fraction had the greatest effect on all other characteristics of the farinograph curve.

Absorptions of Reconstituted Flours with One Fraction Interchanged

Table II lists the absorption for reconstituted flours in which one fraction at a time had been interchanged. Here the tailings fractions, with effects of nearly 4%, accounted for about half of the difference in absorption in both series. The Rio starch introduced into the SWW flour raised the absorption nearly 2%, and both water-solubles had effects of about 1.5%. Both gluten fractions and the SWW starch affected absorption about 1%.

Fraction Interchanges between Blends of Club and HRW Fractions

Table III gives the farinograph absorptions obtained when one fraction was interchanged between blends of club wheat flour fractions and HRW fractions. For the blends with three club and one HRW fractions, the HRW tailings increased absorption more than 4%, the HRW starch nearly 3%, and the gluten

TABLE II
Farinograph Absorption Values for Normal Flours, Reconstituted Flours, and Reconstituted Flours with One Fraction Interchanged

	Farinograph Absorption					
		Reconstituted Flours				
	Normal Flours %	All one variety %	Other water-solubles %	Other gluten %	Other tailings %	Other starch %
SWW Gaines	57.8	58.4	59.8	59.4	62.0	60.3
HRW Rio	64.0	65.0	63.4	64.2	61.2	64.0

TABLE III
Farinograph absorption Values for Normal Flours, Blends of Fractions, and Blends with One Fraction Interchanged

	Farinograph Absorption					
		Blends of Fractions				
	Normal Flours %	All one variety %	Other water-solubles %	Other gluten %	Other tailings %	Other starch %
Club Omar	54.9	54.3	54.8	55.5	58.6	57.0
HRW Rio	64.0	64.2	62.6	61.8	60.4	61.6

1%. For the blends with three HRW and one club fractions, the club wheat tailings gave an absorption 4% lower, the club wheat starch and gluten caused the absorption to drop 2.5%, and the club wheat water-solubles lowered it 1%. Perhaps because of the nearly 10% difference in absorption of the parent flours, fraction interchanges in these blends had good, strong effects.

Comparison of Farinograph Absorption with WRC

The relation between farinograph absorption and WRC for all of the blends and reconstituted flours was close, but not absolute, as shown in Fig. 3. For the predominantly soft wheat samples, the two were nearly the same, but in the hard wheat range, WRC tended to be decidedly larger, and the variation was greater.

GENERAL DISCUSSION

Blended wheat flours, prepared from separated water-solubles, gluten, tailings, and starch, gave very satisfactory farinograph curves, which may prove useful in future F&R studies. Use of such blends eliminates the time-consuming doughing, freeze-drying, and grinding steps required for reconstituting flours

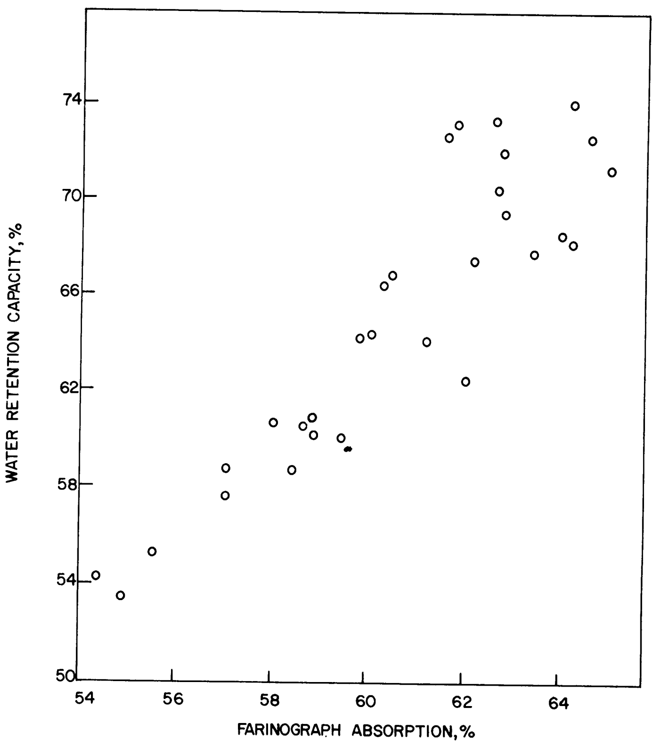

Fig. 3. The relation between farinograph absorption and water retention for the blends of fractions and the reconstituted flours. Correlation coefficient is 0.87 with a standard deviation (S_{xy}) of 1.46.

TABLE IV
Average Effect of Each Fraction on Farinograph Absorption in Blends of Fractions and Reconstituted Flours

Increases in SWW Samples Caused by			
HRW Water-solubles %	**HRW Gluten** %	**HRW Tailings** %	**HRW Starch** %
1.2	1.1	3.4	2.1
Decreases in HRW Samples Caused by			
SWW Water-solubles %	**SWW Gluten** %	**SWW Tailings** %	**SWW Starch** %
1.7	1.6	3.3	1.8

from these fractions. The poorer performance of reconstituted flours on the farinograph, as compared with that of the blends shown in Fig. 2 and Table II, indicates that some of the unsatisfactory characteristics of reconstituted baked products may be caused by the reconstitution procedure rather than by the fractionation.

From fraction-interchange experiments it was concluded that no one fraction accounted for all of the difference in farinograph absorption between SWW and HRW flours (Table IV). The tailings fraction always had the largest effect and often accounted for about half of the differences. The other three fractions had lesser effects, the starch apparently having a larger effect than the water-solubles or gluten. The water-solubles, which amounted to only 4% of the flour, had an effect as large as that of the gluten fractions and almost as large as that of the SWW starch.

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[Received June 10, 1974. Accepted November 5, 1974]