A NOTE ON POLAR AND NONPOLAR LIPIDS IN HARD RED SPRING AND HARD RED WINTER WHEAT FLOURS[1]

MARY ANN STEVAN AND DAVID F. HOUSTON

The general recognition that the small amount (1–2%) of lipids in flours affects their baking characteristics is matched by the acknowledgment that relations between lipid composition and flour properties are far from understood (1–4). The complex composition of lipids of differing flours is being actively studied (5–9), and regularities or differences therein are being sought to aid in explaining composition-property relations. As part of this search some regularities are here reported for the polar and nonpolar fractions of flour lipids from hard red spring (HRS) and hard red winter (HRW) wheats.

The HRS wheat flours were all untreated long patent, two commercially milled and three experimentally milled from single varieties. The HRW flours were also untreated long patent, four experimentally milled from single varieties and one commercial flour. All flours were held at 0 to −10°C. in closed containers until sampled for lipids.

[1]Manuscript received August 4, 1965. Presented at the 50th annual meeting, Kansas City, Mo., April 1965. Contribution from the Western Regional Research Laboratory, Western Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture, Albany, Calif.

In a blender at medium speed, lipids were extracted from 25-g. samples of flour with three consecutive 100-ml. portions of water-saturated butanol. The extract was freed of solvent in a rotary evaporator at reduced pressure below 40°C. and the residue dried at 4°C. over phosphorus pentoxide. The sample was then taken up in petroleum ether, centrifuged to remove solids, freed of solvent, and dissolved in 2:1 chloroform-methanol. Remaining nonlipids were washed out by the process of Folch *et al.* (10) with 0.04% calcium chloride in the wash. Recovered solvent-free lipids were dissolved in chloroform for chromatographic separation.

Silicic acid chromatographic columns were prepared from Mallinckrodt's silicic acid for chromatography that had been water-washed, dried, and washed with chloroform-methanol. Columns 1 cm. in diam. × 30 cm. were prepared from 15 g. of silicic acid sludged in 45 ml. chloroform. The neutral-to-weakly polar fraction (compounds equal to or less polar than free fatty acids) from an approximately 0.3-g. lipid sample was eluted at about 1.5 ml./min. with 100 ml. chloroform and the more strongly polar fraction with 100 ml. of methanol. These fractions are hereafter referred to as nonpolar and polar. Each fraction was freed from solvent and dissolved in 25 ml. chloroform. Lipid content was determined in aliquots.

Values in Table I show that total washed lipids of HRS wheat flours

TABLE I

WASHED LIPIDS OF HRS AND HRW WHEAT FLOURS

WHEAT VARIETY	LOCATION	CROP YEAR	WASHED LIPIDS [a]			LIPID RATIO:	
			Polar	Nonpolar	Total	Nonpolar / Polar	
			%	%	%		
			Hard red spring — untreated				
Selkirk	N. Dak.	1962	0.62	0.92	1.54	1.20	
Chinook	N. Dak.	1962	0.61	0.85	1.46	1.15	
Commercial No. 1	N. Dak.	1962	0.65	0.92	1.57	1.13	
Commercial No. 2	N. Dak.	1958	0.64	0.96	1.60	1.10	
Justin	N. Dak.	1962	0.66	0.86	1.52	1.04	
					Av. 1.54	(SD 0.041) 1.12	(SD 0.053)
			Hard red winter — untreated				
Pawnee	Kansas	1961	0.62	0.81	1.43	0.98	
Commercial No. 3	Kansas	1963	0.68	0.62	1.30	0.90	
Wichita	Kansas	1961	0.69	0.60	1.29	0.89	
Comanche	Kansas	1961	0.69	0.55	1.24	0.79	
Triumph	Kansas	1961	0.75	0.50	1.25	0.68	
					Av. 1.30	(SD 0.068) 0.85	(SD 0.107)

[a] Percent of dry flour; figures based on two to four replications.

examined are higher than those of HRW flours. The averages for washed HRS and HRW lipid contents, 1.54% and 1.30%, differ markedly ($P < 0.001$).

Similar differences in total washed lipids of the two classes occur in the results of N. Fisher and co-workers (ref. 6 and unpublished data). Their analytical data on flours from the same two HRS and three HRW U.S. wheat varieties for four crop years showed that the HRS flours contained more washed lipid than HRW flours each year, with the single exception of one high-lipid HRW in one year. However, the very recent results of Pomeranz and co-workers (11) for butanol-soluble washed lipids of eight HRW and five HRS wheat flours showed no distinction between the two classes, which suggests that the ranges overlap.

The ratios of nonpolar-to-polar fractions in Table I are significantly higher for HRS than for HRW flour lipids. However, the results of Pomeranz and co-workers (11), who used essentially the same technique on a different series of flours, show the opposite. Interlaboratory comparisons of samples by Pomeranz and by us determined that the analytical procedures agreed, so that the differences found must result from differences in the flours examined. Apparently, then, no general class difference exists in the ratio.

However, one regularity in lipid compositions emerged. Examina-

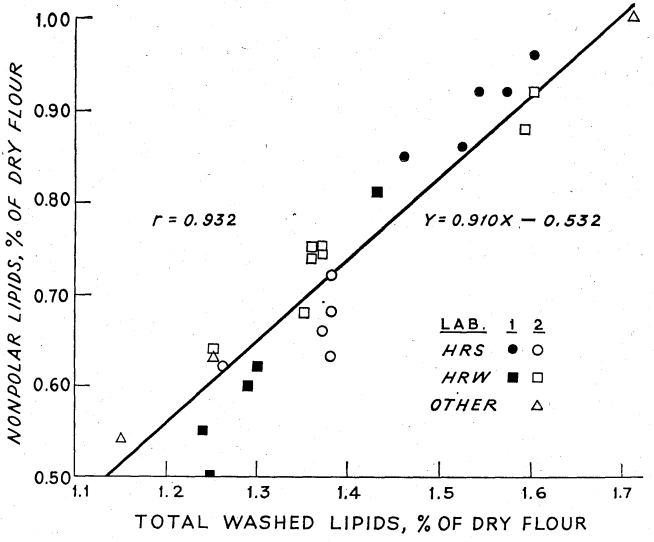

Fig. 1. Regression of nonpolar lipid content of wheat flours on total washed lipid content. Laboratory 1, Western Regional Research Laboratory; Laboratory 2, Kansas State University.

tion of data from our work and from that of Pomeranz discloses that the amounts of total washed lipids correlated with the nonpolar-to-polar ratios. For the total of 26 flours (13 HRW, 10 HRS, one soft red winter, one soft white, and one durum) the total lipids and the ratio showed positive correlation, with $r = 0.73$.

The polar lipid contents of HRS and HRW flours are very similar, and their total range is only 0.61 to 0.75% of the dry flour. Accordingly, the correlation of polar with total lipids is low, with $r = 0.13$.

Conversely, the nonpolar lipids of the flours vary over the much wider range of 0.50 to 1.04% of dry flour, and the correlation between nonpolar and total lipid contents shows $r = 0.93$ (Fig. 1) for the 26 flours examined at our laboratory and at Kansas State University. This is evidence that a regularity occurs in the lipid compositions of differing wheat flours, and that it arises chiefly from variation in the content of nonpolar lipids.

Acknowledgments

We thank K. A. Gilles of North Dakota State University for supplying us three HRS flours milled from single varieties, and E. L. Griffin of the Northern Utilization Research and Development Division for four flours from single HRW wheat varieties. We also thank Y. Pomeranz of Kansas State University for permission to use his data prior to publication.

Literature Cited

1. FISHER, N. Wheat lipids. *In* Recent advances in food science, J. Hawthorn and J. M. Leitch, eds.; vol. 1, pp. 226–245. Butterworths: London (1962).
2. GLASS, R. L. Flour lipids and breadmaking. Baker's Dig. **36** (6): 40–42, 92 (1962).
3. MECHAM, D. K. Lipids. *In* Wheat: Chemistry and technology, I. Hlynka, ed.; pp. 353–396. American Association of Cereal Chemists: St. Paul, Minn. (1964).
4. BLOKSMA, A. H., and HLYNKA, I. Basic considerations of dough properties. *In* Wheat: Chemistry and technology, I. Hlynka, ed.; pp. 465–526. American Association of Cereal Chemists: St. Paul, Minn. (1964).
5. HOUSTON, D. F. The phospholipids of wheat flour. Cereal Sci. Today **6**: 288, 290–291, 300 (1961).
6. FISHER, N., BROUGHTON, M. E., PEEL, D. J., and BENNETT, R. The lipids of wheat. II. Lipids of flours from single wheat varieties of widely varying baking quality. J. Sci. Food Agr. **15**: 325–341 (1964).
7. MCKILLICAN, M. E. Studies of the phospholipids, glycolipids and sterols of wheat endosperm. J. Am. Oil Chemists' Soc. **41**: 554–557 (1964).
8. WREN, J. J., and SZCZEPANOWSKA, A. D. Separation and composition of "polar" wheat-flour lipids. J. Sci. Food Agr. **16**: 161–169 (1965).
9. BURKWALL, M. P., JR., and GLASS, R. L. The fatty acids of wheat and its milled products. Cereal Chem. **42**: 236–246 (1965).
10. FOLCH, J., LEES, M., and SLOANE-STANLEY, G. H. A simple method for the isolation and purification of total lipides from animal tissues. J. Biol. Chem. **226**: 497–509 (1957).
11. POMERANZ, Y., CHUNG, O., and ROBINSON, R. J. The lipid composition of wheat flours varying widely in breadmaking potentialities. Submitted to J. Am. Oil Chemists' Soc.