PROTEIN ENRICHMENT OF COOKIE FLOURS WITH WHEAT GLUTEN AND SOY FLOUR DERIVATIVES[1]

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ABSTRACT

The sugar-snap cookie baking performance of soft red winter (SRW) flour fortified with increasing levels of three vital wheat glutens was compared with results obtained with similar blends using five soy-derived protein concentrates. Cookie spread and top-grain scores were reduced by each supplement at differential rates dependent upon concentration and functionality of the protein source. Reductions in baking quality were least with commercial vital glutens, followed, in order, by laboratory-fractionated SRW gluten, nondispersible soy-protein isolate, modified soy flours, soy-protein concentrate, and dispersible soy-protein isolate. With commercial glutens, cookie-crumb protein (N × 5.7) levels were increased 150% at the point of significant reduction in baking performance, compared with 27% increase with laboratory-fractionated gluten and 10–20% increase with soy derivatives. Lipid extracts from SRW flour, six commercial lecithins from soy, and a commercial safflower lecithin were evaluated at low concentrations as improvers of cookie spread in conjunction with the SRW flour-protein fortified blends. Soy lecithins were most effective, with safflower lecithin equal to, or better than, flour lipids. Maximum crumb protein increases permitted by use of natural surfactants were: 375% with commercial glutens; 83% with laboratory-prepared gluten, and up to 56% with soy derivatives. Satisfactory sugar-snap cookie size, top grain, and internal appearance were maintained.

There is interest in the behavior of baked products at elevated protein levels, although most research has been directed toward functional properties in bread. Fellers and Bean (1) assessed the storage and baking properties of Flour Blend A, composed of 70% straight-grade hard red winter (HRW) flour and 30% wheat protein concentrate (WPC). Ranhotra *et al.* (2) used WPC to fortify bread flour at levels which increased crumb protein by 5, 9, and 14% over the control. Although baking quality declined with fortification, each increment of WPC gave increases in protein efficiency ratio (PER) and in net protein utilization (NPU) when fed to rats. Protein metabolism was higher when diets contained unbaked bread ingredients rather than finished bread, and levels of lysine and threonine were reduced 19 and 11%, respectively, by heat degradation.

To overcome such heating losses, flour was fortified with significant levels of protein concentrates from soy which are naturally higher than wheat gluten in essential amino acids. The functionality of these blends in bread dough systems was improved by use of "conditioners" such as sodium stearoyl 2-lactylate (SSL) and by the use of soy lecithin and fractions thereof, such as glycolipids and phospholipids (3). As a result, Flour Blend K, a soy-fortified wheat flour for export, described by Mecham *et al.* (4) and the wheat-germ bread of Pomeranz

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(5) are realities. Other protein-enriched items are covered by the U.S. Patent of Pomeranz and Finney (6).

Protein enrichment of snack- and dessert-food items from soft wheat has received less attention. Tsen *et al.* (7) have described the successful fortification of soft wheat flour with soy protein in the presence of SSL and related compounds.

The ability of free lipids from wheat flour and lecithins from soy flour to restore the cookie-baking performance of defatted flour has been reported by Cole *et al.* (8). More recently, the relative contributions of polar and nonpolar lipid fractions and the responses of cookies to elevated lipid concentrations have been noted by Kissell *et al.* (9).

As an extension of the last work, this report covers baking results from soft wheat flour blends with soy flour and soy-protein derivatives compared with blends containing vital gluten from laboratory-milled (SRW) flour, and with commercial vital glutens, alone, and in combination with flour lipids, and soy, or safflower lecithins.

MATERIALS AND METHODS

The basic cookie flour used throughout the study was a SRW composite blend of Allis[3]-milled straight-grade flours from the 1969 crop, having above-median

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[3] Allis-Chalmers is a trademark of Allis-Chalmers, Milwaukee, Wis.

TABLE I
Analytical, Water Retention, and Cookie-Baking Data for Flours and Protein Supplements

Flour/Supplement	Protein Content[a] %	AWRC[b] %	Cookie Diam cm × 2
Wheat Flour, st. grade			
SRW Cookie composite	11.4	49	18.0
Nebred (HRW)	12.7	65	16.0
Purkof (Semihard)	10.3	56	16.8
Thorne (SRW)	9.8	52	17.8
Blackhawk (SRW)	11.5	50	18.1
Avon (SWW)	8.5	52	17.7
Wheat Derivatives			
(G) SRW-Gluten	74.2	114	...
(VG-1) Vital gluten (com'l)	76.3	120	...
(VG-2) Vital gluten (com'l)	77.8	114	...
Soy Derivatives			
(A) Mod. soy flour	51.5	188	...
(B) Toasted soy flour	50.9	178	...
(C) Protein concentrate	67.4	223	...
(D) Dispersible protein	87.1	343	...
(E) Nondispersible protein	89.9	220	...

[a] Per cent N × 5.7 (dry wt basis).

[b] Alkaline water retention capacity (14% moisture basis).

baking quality. Lipid responses were also tested using Allis straight-grade flours from HRW Nebred, semihard Purkof, SRW Thorne and Blackhawk, and the soft white variety, Avon.

Free flour lipids for the study were prepared by reflux extraction with hexane of 3-kg lots of the SRW composite flour. Lipid extracts were concentrated by evaporation in air followed by evacuation in a desiccator for 30 min. A mean yield of 0.95% lipid was recovered from this flour.

In addition to the lipid extract from flour, six commercial soy lecithins were obtained from Central Soya, Chicago, Ill., representing generic types used by the food industry. They were: I) a natural lecithin in soybean oil containing 60% phosphatides; II) a liquid lecithin concentrate, 68% phosphatides; III) a modified natural-type lecithin with improved hydrophilic properties, 60% phosphatides; IV) bleached natural (65%) lecithin in soybean oil; V) 62% natural lecithin in oil; and VI) a modified, highly dispersible lecithin. One sample of safflower lecithin was included, courtesy of American Lecithin Co., Atlanta, Ga.

The following soy-protein derivatives were obtained from two sources: A) chemically modified soy flour and B) toasted soy flour, both prepared from hexane-defatted soybean flakes with protein contents of about 50% (N × 5.7, dry basis), ground to pass a 200-mesh screen. Supplement C) was a soy protein concentrate of about 68%, prepared from defatted flakes by solvent extraction to remove carbohydrate and mineral matter and ground to pass 100-mesh screen. Supplement D), a water-dispersible protein isolate (*ca.* 87%), was prepared from

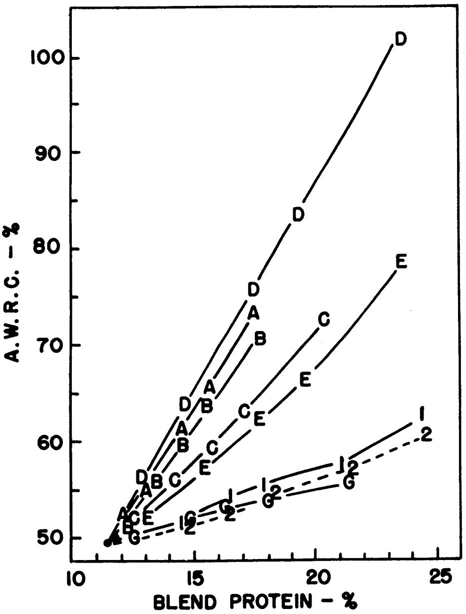

Fig. 1. Relation of hydration capacity (AWRC) to protein content of SRW flour-supplement blends. (1), (2) Commercial vital glutens, (G) laboratory SRW gluten, (A) modified soy flour, (B) toasted soy flour, (C) soy-protein concentrate, (D) dispersible soy-protein isolate, and (E) nondispersible protein isolate.

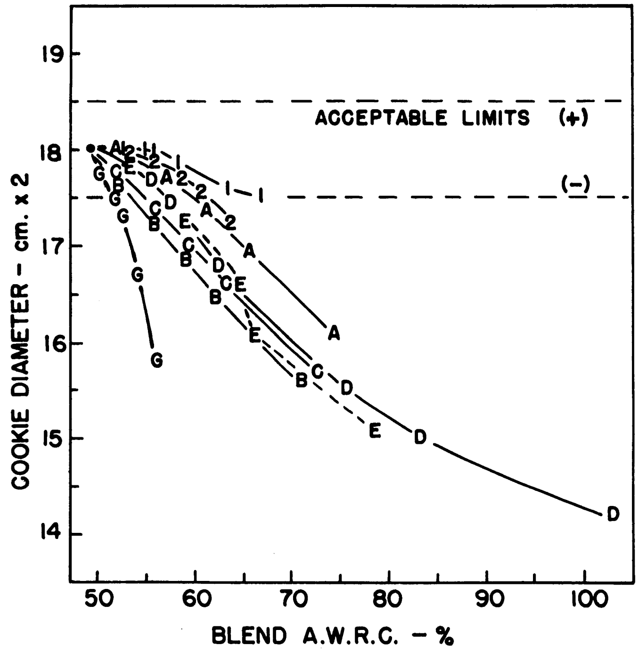

Fig. 2. Relation of cookie diam to hydration capacity (AWRC) of SRW flour-supplement blends.

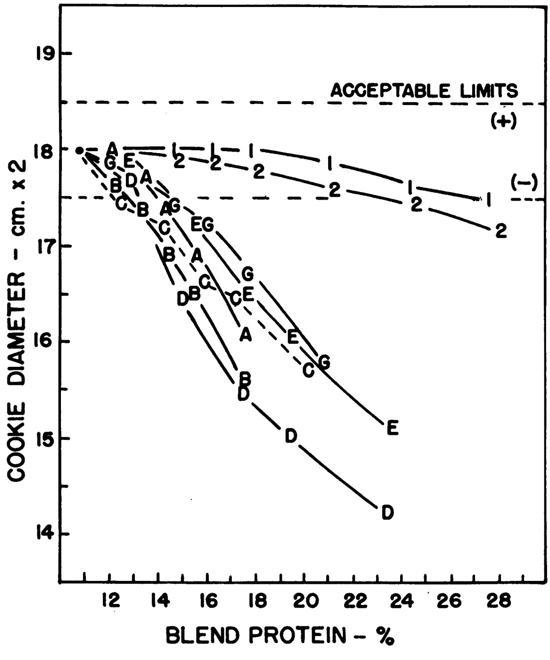

Fig. 3. Relation of cookie diam to protein content of SRW flour-supplement blends.

defatted soy flakes by multiple aqueous extractions at adjusted pH levels to dissolve, precipitate, and redissolve the protein prior to spray drying. Supplement E), an isolate nondispersible in water, had about 90% protein and was prepared at a pH near the isoelectric point of protein. Sample A) was obtained through the courtesy of ADM Company, Minneapolis, Minn., and (B – E) were obtained from Central Soya.

Vital gluten (SRW) was wet-fractionated from straight-grade Thorne variety flour, lyophilized, and ground to approximate flour fineness. Two samples of commercial vital gluten were obtained: (VG-1) from A. E. Staley Co., Columbus, Ohio, and (VG-2) from Hercules Co., Huron, Mich. The water absorptive properties of all components and blends were determined by the micro-alkaline water retention capacity (AWRC) method of Yamazaki *et al.* (10).

Dry blends of cookie flour and each protein supplement were prepared at levels ranging from 5 to 50% supplement by weight. Blends were baked using the Wooster Cookie Test (Micro-Method III) of Finney *et al.* (11), and in the same formulation with 1–2% (flour wt basis) of lipid added directly to the shortening-sugar creamed mass (9) prior to incorporation of leavening solutions in the mixing procedure. Nebred and the other varietal flours were baked directly (without protein supplementation) in the presence of various levels of lipid preparations to illustrate the relative functional properties of the additives.

The baking method produced two cookies per dough. After cooling, cookies were measured in pairs to the nearest 0.02 cm. Data are reported as the rounded mean of measurements in four directions across both cookies and called "cm × 2." Top-grain appearance was graded against selected standards, ranging from 0 = no grain to 9 = maximum, uniform grain definition.

Representative cookies from each treatment were broken, crushed, and ground for 10 sec in a CRC micro[4] mill. Moisture and protein contents of components, blends, and cookie crumb were determined by standard methods (12).

RESULTS AND DISCUSSION

Protein levels and AWRC data for all flours and supplements are given in Table I. Subsequent protein data for flour blends and cookie crumb are given as (N × 5.7) on a dry weight basis. The high negative correlation normally found for AWRC with cookie spread is reflected in diameters of 18.0 cm for two cookies from SRW control flour compared with 16.0 cm for products from Nebred HRW flour. At a given level of protein enrichment, those supplements with higher absorptive capacities were expected to be more detrimental to spread in cookies containing them.

Figure 1 shows an array of curves relating aggregate protein levels of flour-supplement blends to AWRC of each blend. At a given level of fortification, wheat glutens contributed least to water retention, followed, in order, by nondispersible soy protein (E), soy protein concentrate (C), soy flours (A) and (B), and dispersible protein isolate (D).

With the exception of higher-than-expected retentions of blends containing soy flours (A) and (B), this order was in line with relative absorptive capacities of

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[4] CRC is a trade name for Chemical Rubber Company, Cleveland, Ohio.

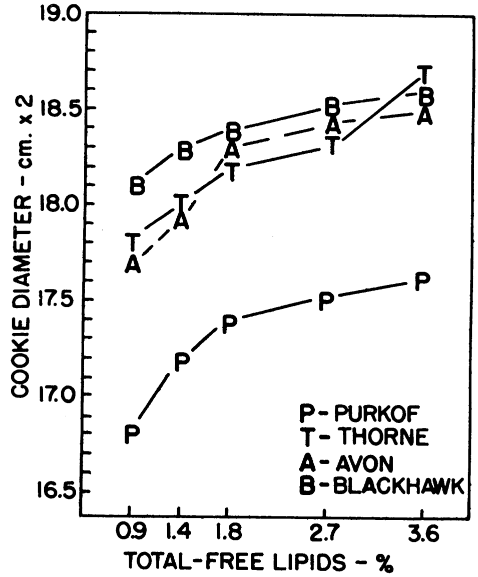

Fig. 4. Cookie spread response of varietal flours to additions of free lipids from wheat flour (flour wt basis).

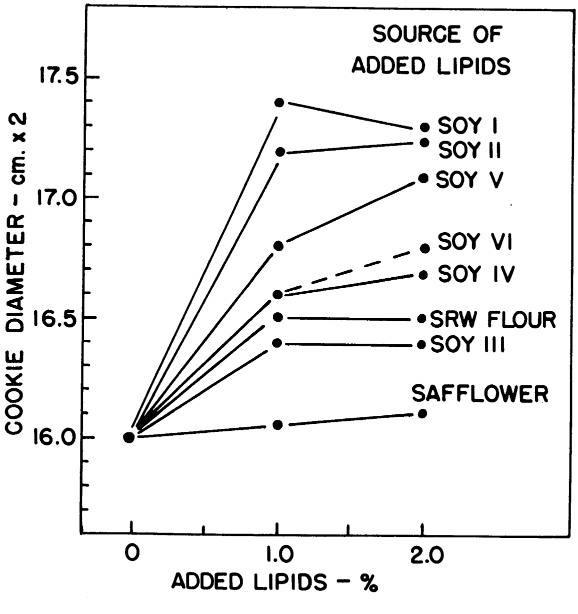

Fig. 5. Cookie spread response of Nebred HRW flour to additions of lipids from wheat, soy, and safflower (flour wt basis).

the supplements shown in Table I. Figure 2 shows the relation of AWRC for each flour-supplement blend to the cookie baking performance of that blend. Curves for soy protein derivatives (A–E) occupy a narrow band in the center of the array, with slopes approximately equal to the regression line for wheat-flour AWRC with cookie diam. For flour-soy blends, the AWRC level had a direct association with cookie spread reduction regardness of the composition of the blend. Commercial vital glutens (1 and 2) had much less influence on cookie spread per unit of absorption, whereas laboratory-prepared gluten (G) gave high response, indicating a large functional difference between products from these sources.

The array of curves in Fig. 3 amplifies the functional difference between vital gluten from commercial sources (VG-1 and -2) and other supplements used in the study when protein levels of enriched flour blends are plotted against spread of the corresponding cookies. In all, five independent samples of commercial vital glutens exhibited the same lack of response in this test-dough system. Laboratory-prepared gluten (G) and all soy proteins reduced cookie spread rapidly with increasing concentration and degree of functionality. Since the major components of sugar-snap cookies are 46% flour, 32% sugar, and 16% shortening, crumb protein is about one-half that of the flour protein. In this study, control cookies had a crumb protein of 5.9%. With commercial glutens, crumb protein levels were raised to 13.3% (125% increase) at the lower limit of acceptable diam (17.5 cm) and top-grain score (6.0). With laboratory-prepared gluten only 30% increase in crumb protein was possible without significant loss in quality and only 10–20% increase could be achieved using the range of soy protein derivatives.

In attempts to increase the level of protein enrichment while maintaining satisfactory product quality, the effects of natural surfactants, such as free lipids from flour (9) and lecithins from soy and safflower, were investigated. Typical responses of varietal cookie flours to increasing concentration of free-flour lipids are shown in Fig. 4. On the abscissa, 0.9% represents the nominal lipid content of control flour; 1.8% represents the addition of 0.9% lipid extract to the control (+1X), etc. The addition of 1X or 2X treatments of free lipids produced significant increases in spread (and concomitant top-grain scores), until, at +3X, the highest level shown, cookies from Purkof compared favorably with control products from Avon and Thorne varieties.

Figure 5 summarizes the relative effectiveness of flour lipid, safflower, and six soy lecithins in improving the baking performance of the HRW variety, Nebred. Although lipids from flour gave a significant increase in spread (and increased top-grain score from 2.5 to 8.0), soy lecithins (I) and (II) were more highly functional in modifying the spread and appearance of the hard wheat dough system.

Based upon the background of improvement responses, all lipids were tested at 1–2% levels (flour wt basis) in combination with SRW cookie flour fortified, in turn, with five soy-protein derivatives and three vital glutens from wheat, over a range of concentrations. Table II summarizes mean cookie-baking data for blends fortified with increasing amounts of SRW gluten (G), alone, and in combination with two levels of each lipid. Limits of acceptability were established by applying ± twice the standard deviation for the test to pair diam and top-grain scores. Thus treatments with diam of 17.5–18.5 cm and grain

TABLE II
Cookie-Baking Data for SRW Flour Fortified with Laboratory-Fractionated Gluten from Thorne (SRW) Flour, in the Presence of Lipids from Wheat, Soy, and Safflower

Flour/Gluten Blend[a]	Source of Added Lipid	Cookie Data at Level of Added Lipid[b]					
		0.0% (Control)		1.0%		2.0%[c]	
		Diam cm × 2	Top Gr	Diam cm × 2	Top Gr	Diam cm × 2	Top Gr
SRW Composite	SRW	18.0	8.0	18.5	9.0	18.2	8.5
+5.0% SRW Gluten	SRW	17.6	6.0	17.9	9.0	17.7	8.0
+7.5% SRW Gluten	SRW	17.4	4.0	17.5	7.0	17.1	6.0
+10.0% SRW Gluten	SRW	16.9	4.5	17.2	5.0	17.2	7.0
SRW Composite	Soy I	18.0	8.0	18.3	9.0	18.6	9.0
+5.0% SRW Gluten	Soy I	17.6	6.0	18.2	9.0	18.0	9.0
+7.5% SRW Gluten	Soy I	17.4	4.0	18.0	8.5	17.8	9.0
+10.0% SRW Gluten	Soy I	16.9	4.5	17.8	8.5	17.7	9.0
+15.0% SRW Gluten	Soy I	16.2	2.5	17.7	6.0	17.4	8.5
SRW Composite	Soy II	18.0	8.0	18.4	9.0	18.7	9.0
+5.0% SRW Gluten	Soy II	17.6	6.0	18.0	8.0	17.6	8.0
+7.5% SRW Gluten	Soy II	17.4	4.0	17.8	9.0	17.8	8.0
+10.0% SRW Gluten	Soy II	16.9	4.5	17.6	7.0	17.5	7.5
SRW Composite	Soy III	18.0	8.0	18.0	9.0	18.4	9.0
+5.0% SRW Gluten	Soy III	17.6	6.0	17.9	9.0	17.5	9.0
+7.5% SRW Gluten	Soy III	17.4	4.0	17.6	9.0	17.6	8.0
+10.0% SRW Gluten	Soy III	16.9	4.5	17.2	8.0	17.4	8.0
SRW Composite	Soy IV	18.0	8.0	18.5	9.0	18.4	8.0
+5.0% SRW Gluten	Soy IV	17.6	6.0	18.2	9.0	17.8	9.0
+7.5% SRW Gluten	Soy IV	17.4	4.0	17.5	7.5	17.5	8.0
+10.0% SRW Gluten	Soy IV	16.9	4.5	17.2	7.0	17.2	7.0
SRW Composite	Soy V	18.0	8.0	18.5	9.0	18.6	8.0
+5.0% SRW Gluten	Soy V	17.6	6.0	17.9	9.0	18.0	8.0
+7.5% SRW Gluten	Soy V	17.4	4.0	17.9	9.0	17.6	8.0
+10.0% SRW Gluten	Soy V	16.9	4.5	17.5	8.0	17.5	8.0
SRW Composite	Soy VI	18.0	8.0	18.5	8.0	18.5	8.0
+5.0% SRW Gluten	Soy VI	17.6	6.0	18.1	9.0	17.7	8.0
+7.5% SRW Gluten	Soy VI	17.4	4.0	17.6	8.0	17.8	8.0
+10.0% SRW Gluten	Soy VI	16.9	4.5	17.4	7.0	17.7	7.0
+15.0% SRW Gluten	Soy VI	16.2	2.5	16.9	6.0	17.0	6.0
SRW Composite	Safflower	18.0	8.0	18.5	9.0	18.8	9.0
+5.0% SRW Gluten	Safflower	17.6	6.0	18.2	7.0	18.5	9.0
+10.0% SRW Gluten	Safflower	16.9	4.5	17.9	8.0	17.8	9.0
+15.0% SRW Gluten	Safflower	16.2	2.5	17.5	6.0	17.6	9.0

[a] Mean crumb protein (dry wt) for cookies from blends were: composite control = 5.9%; + 5.0% gluten = 7.5%; + 7.5% gluten = 8.4%; + 10.0% gluten = 9.2%; and + 15% gluten = 10.8%.
[b] Top-grain score range: 9.0 = max uniform grain definition to 0.0 = no grain formation.
[c] Flour wt basis.

scores of 6.0–9.0 were considered acceptable. Maximum increases in level of crumb-protein fortification obtained with each surfactant were: SRW lipid-42%; soy I-83%; soy II-56%; soy III-42%; soy IV-42%; soy V-56%; soy VI-56%; safflower-83%. Additions of 0.5% of each lipid (data omitted) were partially effective and the presence of 1.0%, incorporated in doughs via the fat phase, produced significant improvements at most levels of protein enrichment.

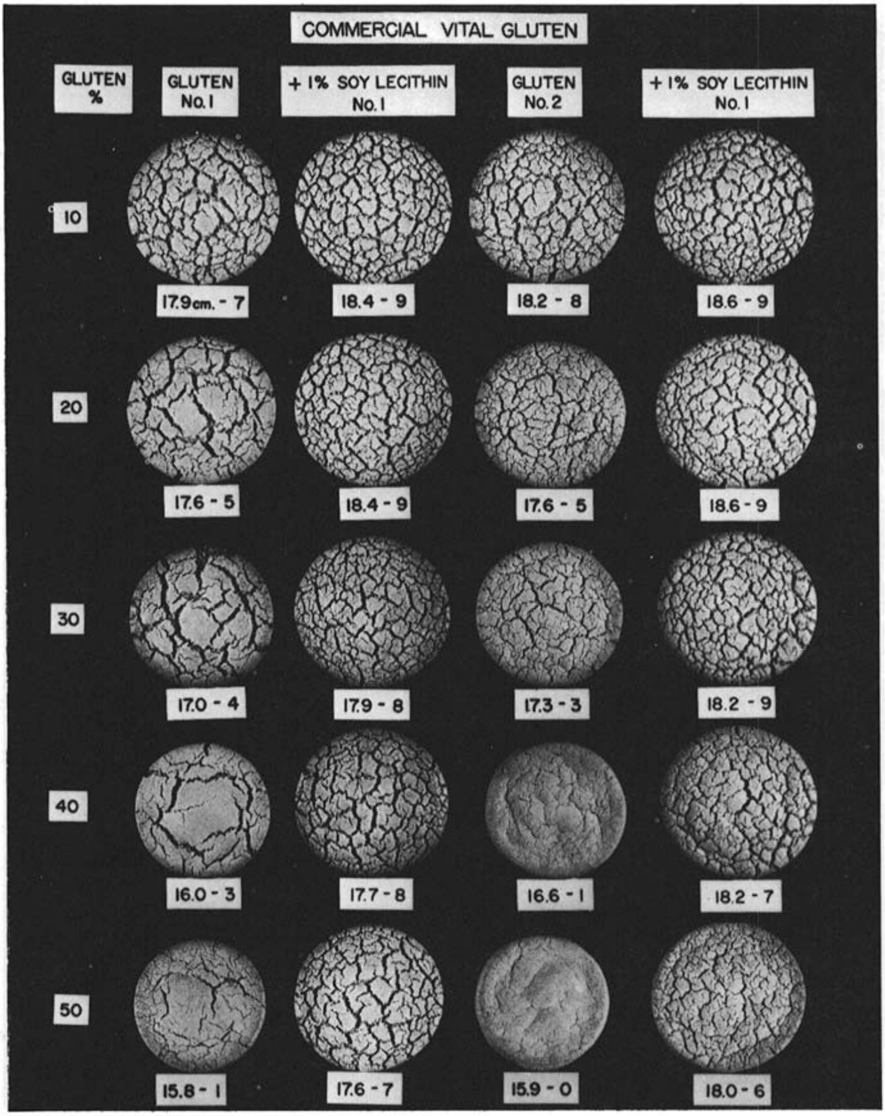

Fig. 6. Cookies from SRW flour blends with commercial vital glutens (1) and (2), alone, and with addition of 1% (flour wt basis) of soy lecithin (I). Data are the combined diam of two cookies and relative top-grain scores.

Figure 6 shows representative cookies from flour fortified with 10 to 50% commercial vital glutens (VG-1 and VG-2), alone, and with the addition of 1.0% soy lecithin (I). At each of the illustrated levels of enrichment both cookie spread and top grain were restored by the simple addition of lecithin. Satisfactory products were obtained at the 50% level of commercial glutens, equivalent to 27.9% crumb protein content, or an increase of 375% of the control.

Some data for treatments with soy protein derivatives are shown in Table III. Diameter responses are given for 1.0% additions of SRW wheat lipid, soy lecithin (I), and safflower lecithin. At each level of enrichment, maximum improvement was obtained with soy lecithin, followed by the surfactants from safflower, and SRW wheat sources. Maximum crumb protein increases with the soy protein derivatives were: soy (A)+37%; soy (B)+27%; soy (C)+51%; soy (D)+17%; and soy (E)+56%.

Table IV summarizes the maximum percentage increase in cookie crumb protein found for each combination of enrichment material and five representative surfactant improvers in the dough system. The data indicate the ability to increase the level of protein in sugar-snap cookies up to 375% of the control, by selection of appropriate protein supplement and lipid additive. Fortification to any lesser extent was achieved easily, while maintaining the size,

TABLE III

Cookie-Baking Data for SRW Flour Fortified with Five Soy-Protein Derivatives in the Presence of Lipids from Wheat, Soy, and Safflower

		Cookie Data at Level of Added Lipid							
		0.0% (Control)		1% SRW Lipid		1% Soy Lecithin(I)		1% Safflower[b]	
Flour/Blend	Cookie-Crumb Protein[a] %	Diam cm × 2	Top Gr	Diam cm × 2	Top Gr	Diam cm × 2	Top Gr	Diam cm × 2	Top Gr
SRW Composite	5.9	18.0	8	18.1	8	18.6	9	18.5	9
+ 5.0% Soy flour (A)	6.9	17.7	6	17.9	7	18.1	8	17.7	8
+ 7.5% Soy flour (A)	7.7	17.4	4	17.3	6	17.8	8	17.3	5
+10.0% Soy flour (A)	8.1	16.9	3	17.0	4	17.6	7	17.2	4
+ 5.0% Soy flour (B)	7.1	17.4	6	17.5	7	17.8	9	17.7	8
+ 7.5% Soy flour (B)	7.5	16.6	3	17.0	8	17.5	8	17.3	8
+10.0% Soy flour (B)	8.1	16.5	2	16.8	4	17.4	9	17.0	6
+ 5.0% Soy prot. conc. (C)	7.4	17.3	7	17.6	7	18.0	9	17.8	8
+ 7.5% Soy prot. conc. (C)	8.3	16.7	4	17.0	6	17.5	8	17.6	7
+10.0% Soy prot. conc. (C)	8.9	16.5	4	17.0	6	17.5	8	17.4	7
+ 5.0% Dispers. isolate (D)	8.0	16.5	4	16.9	6	17.3	7	17.2	6
+ 7.5% Dispers. isolate (D)	9.1	15.5	2	16.2	4	16.9	6	16.7	5
+10.0% Dispers. isolate (D)	9.8	15.0	1	15.7	3	16.4	4	16.3	4
+ 5.0% Nondispers. isolate (E)	8.0	17.2	4	17.4	5	17.9	7	17.4	5
+ 7.5% Nondispers. isolate (E)	9.2	16.4	3	17.0	5	17.6	7	17.1	4
+10.0% Nondispers. isolate (E)	10.4	16.3	3	16.7	3	17.3	5	16.9	3

[a] Crumb protein = N × 5.7 (dry wt basis).

[b] Flour wt basis.

TABLE IV
Maximum Cookie-Crumb Protein Increase at the Limit of Product Acceptability

Source of Added Protein	Source of Added Lipid[a] SRW Wheat	Soy I	Soy II	Soy III	Safflower
Wheat					
SRW gluten (G)	42%	83%	56%	42%	83%
Commercial (VG-1)	300	375	300	375	300
Commercial (VG-2)	195	310	240	240	310
Soy					
Flour (A)	17	37	37	37	17
Flour (B)	20	27	27	27	20
Concentrate (C)	25	51	41	41	41
Dispersible isolate (D)	17	17	36	36	17
Nondispersible isolate (E)	19	56	36	56	19

[a] 1.0% Lipid (flour wt basis) added to the fat phase in cookie mixing.

appearance, and internal structure of the product. Vital gluten, by definition, must contain at least 75% protein as N × 5.7 (dry wt basis) and possess the same functional properties it exhibited in the original flour, as measured by a gluten-development test (13). As a coproduct of starch production, gluten is generally subjected to solvent action and some form of thermal drying. Processing treatments may account for the relatively low order of vitality found for all commercial samples tested, relative to hand-kneaded, freeze-dried SRW gluten, when applied to a soft wheat quality test which does not depend upon gluten development.

From the standpoint of potential nutrition, low gluten vitality is an advantage in the enrichment of soft wheat products, since higher levels of protein can be reached before suppression of product quality below acceptable limits.

In the foregoing experiment, two mechanisms were operating simultaneously. Fortification with supplements having water retention properties higher than wheat flour results in aggregates with increased competitive capacity for the limited free water present in cookie doughs. The rapid partitioning of water to added sites of hydrophilicity during dough mixing results in decreased solution of sugar, increased concentration of the solution, and greater internal dough viscosity. These conditions have been shown (14, 15) to limit cookie spread and top-grain formation.

Introduction to the dough system of surfactants such as natural wheat lipids, soy lecithins, and to a lesser extent, mono- and diglycerides, has the counteractive effect of decreasing dough viscosity and extending the available water for a longer period during the dough expansion process.

Although this paper deals with only a few supplements and surfactants in a single test system, the extension of fortification with dough conditioning to other soft wheat products should be accomplished easily. It is recognized that results from the present study are given in terms of quantitative analysis of nitrogen contents of materials and products; the nutritional availability of essential amino acids surviving the baking process remains to be evaluated.

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Literature Cited

1. FELLERS, D. A., and BEAN, M. M. Flour blend A (I) Origin and history, and (II) Storage studies. Baker's Dig. 44 (6): 40 (1970).
2. RANHOTRA, G. S., HEPBURN, F. N., and BRADLEY, W. B. Supplemental effect of wheat protein concentrate on the quality of white wheat flour. Cereal Chem. 48: 699 (1971).
3. POMERANZ, Y., SHOGREN, M. D., and FINNEY, K. F. Improving breadmaking properties with glycolipids. II. Improving various protein-enriched products. Cereal Chem. 46: 512 (1969).
4. MECHAM, D. K., BEAN, M. M., HANAMOTO, M. M., GUADAGNI, D. G., and FELLERS, D. A. Soy-fortified wheat-flour blends: storage stability of baking performance and flavor. (Abstr. No. 36) Cereal Sci. Today 17: 265 (1972).
5. POMERANZ, Y. Phosphatides in baking wheat germ bread. Food Technol. 24: 91 (1970).
6. POMERANZ, Y., and FINNEY, K. F. U.S. Patent No. 3,679,433.
7. TSEN, C. C., PETERS, E. M., SCHAFFER, T., and HOOVER, W. J. High Protein Cookies. 1. Effect of soy fortification and surfactants. Baker's Dig. 57(4): 34 (1973).
8. COLE, E. W., MECHAM, D. K., and PENCE, J. W. Effect of flour lipids and some lipid derivatives on cookie-baking characteristics of lipid-free flours. Cereal Chem. 37: 109 (1960).
9. KISSELL, L. T., POMERANZ, Y., and YAMAZAKI, W. T. Effects of flour lipids on cookie quality. Cereal Chem. 48: 655 (1971).
10. YAMAZAKI, W. T., DONELSON, J. R., and BRIGGLE, L. W. Micro-tests for soft wheat quality evaluation. Crop Sci. 8: 199 (1968).
11. FINNEY, K. F., MORRIS, V. H., and YAMAZAKI, W. T. Micro versus macro cookie-baking procedures for evaluating the cookie quality of wheat varieties. Cereal Chem. 27: 42 (1950).
12. AMERICAN ASSOCIATION OF CEREAL CHEMISTS. Approved methods of the AACC. The Association: St. Paul, Minn. (1962).
13. HALE, H. E., and CARLSON, W. A. Vital wheat gluten. Baker's Dig. 43 (6): 52 (1969).
14. YAMAZAKI, W. T. The concentration of a factor in soft wheat flours affecting cookie quality. Cereal Chem. 32: 26 (1955).
15. YAMAZAKI, W. T. Laboratory testing of flours and cookie quality research. Cereal Sci. Today 7: 98 (1962).

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