Fortification of Some Egyptian Foods with Soybean

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ABSTRACT

Flours from full fat and defatted soybeans were made in the laboratory and used as supplements to Egyptian bread and two popular legume foods (lentil soup and falafil). The effect of fortification level on water absorption, dough rheology, loaf quality, and major chemical constituents of fino (pulp) and Arabic (flat) breads were investigated. Water absorption was slightly affected, dough mixing time, stability, and valorimetric values increased, but the mixing tolerance index decreased by adding defatted soy flour to wheat flour. Loaves were slightly smaller in volume than the control at high levels of defatted soy flour. Morover, bread score and panel evaluation showed deterioration of fino bread characteristics above 6% and Arabic bread above 8% defatted soy flour, but above 3% full fat soy. Organoleptic properties of the enriched lentil soup and falafil were similar to those of control at a level of 25% and 50% full fat soy and of 40% and 60% defatted soy flour, respectively. The most favorable change of the chemical composition of lentil soup and falafil is the increased protein content. Also, increasing the level of defatted soy flour increased ash content and decreased the level of fat absorption by fried falafil. On the other hand, increasing the level of full fat soy may replace the addition of shortening to lentil soup to make it more palatable.

INTRODUCTION

The growing awareness of protein nutrition and the animal protein shortage along with the world's increasing population should provide an impetus for extensive use of soy protein. Refined soy proteins in the form of flours, concentrates, isolates, and texturates are finding increasing applications in foods. They are used as extenders in the form of patties, meatballs, meat loaf, chili, and spaghetti sauce or in combination with fish, cooked vegetables, and fruits. The taste of the food is not affected, while its nutritional value is enhanced (1).

The protein quantity and quality of soybean-containing foods have been studied. Tsen (2) showed that bread made with 12% defatted soy flour is acceptable by the consumer and contains more protein of higher nutritional quality than common wheat bread. Ranhotra et al. (3) studied the characteristics of breads fortified with fifteen commercial soy protein products. They found that most soy flours, especially full fat and high fat products, permitted fortification at the 15-20% level and produced breads of acceptable volume, flavor, and overall quality with resultant substantial increase in protein content and greatly improved amino acids balance. Tsen et al. (4) found that 12% soy-fortified buns contained 27.5% more protein and 29.2% more minerals than wheat buns. They noticed that soy-fortified buns were slightly larger and darker with grain similar to that of wheat buns and were rated acceptable by 85% of the children tested. Levinson and Lemancik (5) reported that the high protein snacks made from corn curl and 30% soy flour have a protein content of 20% as compared to a standard corn curl which only has 7% protein.

Levinson and Lemancik (5) recapitulate that soy proteins in baked products serve the following functions: (a) improve eating quality; (b) lessen moisture loss during baking; (c) make doughs more pliable and easier to handle; (d) increase rate of browning and provide a better crust color; (e) increase shelf life; (f) improve texture of baked products.

Very little work has been reported from Egypt on the desirability of using soy flour in food production. We became interested in the subject because of our enormous food grain deficits. For example, currently we import more than two million tons of wheat annually. The Egyptian diet consists mainly of cereals and legumes, and as much as 70% of the daily protein intake is derived from cereals.

This investigation describes the effect of blending full fat and defatted soy flour in Egyptian bread and some popular legume foods.

EXPERIMENTAL PROCEDURES

Grains of wheat (Giza 155, local variety), obtained from the Seed Production Department, Ministry of Agriculture, Cairo, Egypt, were conditioned to 14% moisture, milled on a Wiley mill, and sifted in an automatic plansifter. The flour sifted through an 8XX sieve was used.

Certified seed-grade soybeans (Clark variety, Ministry of Agriculture, Egypt) were dehulled, flaked, and defatted. The full fat and defatted flakes were autoclaved for 20 min, dried at 65 C for 24 hr, and ground to pass through an 8XX sieve.

Physical dough properties of wheat flour fortified with defatted soy flours were determined by the farinograph method according to AACC (6). Physical dough characteristics such as mixing time, stability, mixing tolerance index, and valorimeter values were computed from the curves obtained.

Fino bread was prepared by a straight dough method employing a lean formula. The basic formula consisted of 300 g flour, 2% yeast, 1.5% salt, and water based on the farinograph optimum absorption. The dough was fermented at 30 C for 3 hr, divided (100 g), molded, panned, and proved for 50 min at 30 C. The bread was baked for 25 min at 218 C. The loaf weight and volume were determined after cooling (2 hr).

The basic formula for Arabic bread was the same for fino bread, except that water was based on the farinograph at 800 Brabender Units (BU) water absorption. The dough was fermented at 30 C for 3 hr, divided (135 g), molded in a flat round shape (15-cm diameter), panned, and proofed for 50 min at 30 C. The bread was baked at high temperature of 450 C for 1 min. The flat piece of dough puffs up in the oven and separates into two thin layers.

Lentil soup is composed of raw lentil, onion, garlic, cumin powder, and salt. Full fat soy flour was added at 15, 25, and 40% levels. Defatted soy flour was used at 20, 40, and 60% levels. The mixed ingredients were cooked in a steam pressure cooker at 0.5 kg/cm^2 for 30 min.

Falafil is composed of steeped cotyledons of broad beans, mixed with green vegetables such as parsley, onion, garlic, spices, sodium bicarbonate, and salt, minced together

TABLE I

Effect of Substitutind Defatted Soy Flour for Wheat Flour on Water Absorption, Mixing Characteristics, and Quality of Fino Bread

	Substitution level (%)					
	0	3	6	9	12	15
Water absorption (%)	55.0	55.0	54.5	54.2	54.0	53.8
Farinograph values:						
Mixing time (min)	1.5	1.5	1.5	1.5	1.5	1.5
Stability (min)	1.0	1.5	2.0	2.5	3.0	4.0
Mixing tolerance (BU)[a]	120	100	80	70	60	50
Valorimeter value	32	32	40	41	42	43
Bread properties:						
Loaf weight (g)	124	125	127	130	132	134
Loaf volume (cc)	210	220	240	230	210	200
Appearance[b]	7	8	8	7	6	5
Crust color[b]	7	8	8	8	7	7
Crumb color[b]	9	9	8	8	6	4
Grain[b]	7	8	8	6	6	2
Texture[b]	8	7	7	6	5	2
Flavor[b]	8	8	8	7	5	3
Chemical constituent (db)[c]						
Moisture (%)	13.3	13.4	13.6	13.8	14.0	14.2
Protein (%)	11.0	13.1	14.1	15.2	16.4	17.2
Protein increase (%)	---	18.7	27.6	38.0	48.5	55.4
Fat (%)	1.0	1.1	1.2	1.3	1.3	1.4
Crude fiber (%)	1.0	1.2	1.3	1.4	1.5	1.7
Ash (%)	0.8	1.2	1.8	2.4	3.2	3.8
NFE[d] (%)	86.3	83.4	81.6	79.6	77.5	76.0

[a]Brabender Unit.
[b]Bread quality score out of 10.
[c]Dry basis.
[d]Total carbohydrate.

and fried in a deep fryer at 200 C as small cakes (5-cm diameter). Full fat and defatted soy flours were added to steeped cotyledon on dry weight basis.

Supplemented breads, lentil soup, and falafil were dried and ground. Moisture, fat, protein, ash, and crude fiber contents were determined according to AACC (6). Total carbohydrate (NFE) was obtained by difference.

Bread quality score was based on appearance, internal and external characteristics, and flavor, the latter assessed by a panel of testers. Lentil soup and falafil quality scores were based on appearance and flavor by a panel of testers.

RESULTS AND DISCUSSION

The effect of fortifying wheat flour with defatted soy flour on water absorption and dough rheology as measured by the farinograph is shown in Table I. Substitution of wheat flour at low levels had no effect on water absorption, but increasing levels up to 15% reduced the water absorption by 1.2% less than the control. Water absorption is generally related to the hydration capacity of protein. Gluten has the strongest imbibition power compared to protein from other sources. Substitution of wheat flour resulted in decreased water absorption despite the elevated protein content. Low moisture contents of soy flours may explain their water absorption results (damaged starch will absorb water and this will be diluted as the protein content is elevated). Mixing time was slightly affected by soybean flour substitution. The general appearance of the farinograms can be shown by the valorimeter. These values take into consideration mixing time and dough stability. The valorimeter value increased with supplementation of soy flours. According to Tsen and Hoover (7), the fortification with more than 12% full fat soy flour adversely affected both rheological properties and baking quality of wheat flour. Takubczyk and Haberowa (8) studied the physical properties of dough containing different levels of soy products as measured by means of the farinograph. They found that addition of soy flour improved dough rheological properties. On the other hand, they noticed a marked decrease in physical properties as measured by means of the extensograph during the fermentation process.

The effect of different levels of soy flour on the loaf weight, volume, and other properties of fino bread are presented in Table I. The loaf volume increased with substitution up to 6% defatted soy flour. The increase in volume is accompanied by a slight increase in loaf weight. Soy-fortified dough became soft and less elastic during fermentation and may not have been able to hold as much of the CO_2 produced, resulting in smaller volume. Both appearance and internal characteristics of the fortified breads compared favorably with the control loaves up to 9% soy flour. Beyond these levels, the total score decreased considerably. The crumb color became distinctly yellow, and the texture was dense at 15% level of soy flour. The results also indicated that up to 6% soy flour substitution, the flavor rating was the same as the control.

In case of Arabic bread (Table II), the flavor and acceptability reached maximum at a level of 3% full fat and 8% defatted soy flour, then decreased by increasing the percentage of soy flour. Arabic bread is flat, and its physical shape and structure make it an edible utensil by which food is carried to the mouth. Hallab et al. (9) reported that Arabic bread supplemented with up to 10% soybean flour showed a high level of acceptability when compared to the control. Similar findings have been reported by Shelef and Morton (1), Levinson and Lemancik (5), and Jakubezyk and Haberowa (8).

The flavor and acceptability of the supplemented lentil soup are presented in Table II. It showed that lentil soup compared favorably with the control soup when it contained up to 25% full fat soy and 40% defatted soy flour. Also, color, aroma, and textural properties were good at these levels. The soy flour in the mixes helped with emulsification of fats and other ingredients, so the soup was more uniform, more smooth, and pliable. Beyond these levels, the total score decreased considerably, where the color became distinctly pale yellow, the texture became

TABLE II

Chemical Constituent and Quality of Supplemented Arabic Bread, Lentil Soup, and Falafil

Amount of soy added (%)	Chemical consituent % (db)[a]					Protein increase (%)	Quality[c]	
	Protein	Fat	Crude fiber	Ash	NFE[b]		Flavor	Acceptability
Full fat soy flour	40.6	19.7	2.4	5.1	32.2			
Defatted soy flour	53.2	1.9	3.0	7.0	34.9			
Arabic bread:								
Unsupplemented bread	11.0	1.0	1.0	0.8	86.4			
Full fat soy bread:								
3	12.1	1.4	1.1	1.1	85.3	10.0	9	10
5	12.5	1.6	1.2	1.3	84.4	13.6	5	5
7	12.8	1.8	1.3	1.4	83.7	16.4	1	1
Defatted soy bread:								
6	14.2	1.2	1.3	1.8	81.5	29.1	10	10
8	15.0	1.3	1.4	2.2	80.1	42.7	9	10
10	15.7	1.4	1.5	2.5	78.9	42.7	7	8
Lentil soup:								
Lentil	20.8	1.6	1.2	2.1	74.3			
Unsupplemented Lentil soup	21.0	1.7	1.3	2.2	73.7			
Full fat soy lentil soup:								
15	24.1	5.5	1.5	3.0	65.9	14.8	10	10
25	26.3	6.4	1.7	3.2	62.4	25.3	9	9
40	29.1	8.0	2.0	3.5	57.4	38.6	6	6
Defatted soy lentil soup:								
20	28.0	1.8	1.9	3.9	64.4	33.4	10	10
40	33.0	1.8	2.1	4.2	58.9	57.2	9	9
60	38.1	1.8	2.3	4.7	53.1	81.4	5	5
Falafil:								
Braod bean cotyledon	30.5	1.8	2.4	3.3	62.0			
Unsupplemented falafil	31.0	12.9	2.5	3.5	50.1			
Full fat soy falafil:								
30	33.4	15.2	2.5	3.8	43.1	7.7	10	10
50	34.5	16.9	2.5	4.0	40.1	11.3	9	10
70	35.7	18.4	2.5	4.2	37.2	15.2	7	8
Defatted soy falafil:								
40	40.4	10.2	2.5	4.3	42.6	30.4	10	10
60	43.7	10.5	2.6	4.6	38.6	40.9	9	9
80	46.5	10.8	2.7	5.0	35.0	50.0	6	5

[a]Dry basis.
[b]Total carbohydrate.
[c]Quality score out of 10.

coarse, and the taste and general properties were adversely affected.

Addition of soy flour to falafil improved its flavor and acceptability with levels up to 80% full fat and 70% defatted soy flour as shown in Table II. It was noticed that addition of soy flour decreased the fat absorption during the frying operation. Also, the shelf life of the finished product increased by retention of high moisture in the finished product. Broad bean and soybeans are legume seeds and contain ca. 8% of low molecular weight carbohydrate with sucrose predominant; thus one might anticipate increased browning in baked products containing broad bean or soybean. Similar findings have been reported by Lineback and Ke (10).

The chemical compositions of substituted breads are shown in Tables I and II. The crude fat and fiber of the fortified breads increased by increasing the level of soy flour. The most favorable change of the chemical constituents of the bread is the increase in protein content. Breads made with different levels of soy flour contained more protein than the control, where it increased to 38% in fino bread fortified with 6% defatted soy flour. Moreover, Tsen (2) reported an increase of the protein efficiency ratio of soy-fortified bread which indicated high nutritional quality bread and improved amino acid balance. Similar findings have been reported by Tsen (4) and Shelef and Morton (1).

Chemical compositions of fortified lentil soup are shown in Table II. Protein increased by 25.3% and 57.2% with fortification of 25% full fat and 40% defatted soy flour. The ash content reached over 3.5% and 4.7% at high levels of full fat (25%) and defatted soy flour (40%), respectively. It is advantageous to use full fat soy since its fat will replace the addition of shortening for increasing the nutritional value and make lentil soup more palatable.

The chemical constituents of fortified falafil are shown in Table II. The most favorable change of the chemical composition of falafil is the increased protein content. Falafil made with different levels of full fat and defatted soy flour contained more protein than the control. Protein increased by 11.3% and 40.9% with fortification of 50% full fat and 60% defatted soy flour, respectively. While increasing the level of full fat soy flour has little effect on crude fiber, it caused a significant effect on crude fat. On the other hand, increasing the level of defatted soy flour increased ash content, but has a slight effect on crude fiber and fat contents.

In conclusion, substitution of wheat flour in fino bread with 6% defatted soy flour or Arabic bread with 3% full fat or 8% defatted soy flour produced breads of acceptable overall quality and containing more protein than common bread. The chemical constituents and the organoleptic properties of the enriched lentil soup and falafil were similar to those of the control at a level of 25% and 50% full fat and of 40% and 60% defatted soy flour, respectively. Appreciable deterioration of quality characteristics of bread, lentil soup, and fried falafil occured above these levels of fortification.

Soy-fortified food products appear to be the best vehicles for protein improvement in the diets of Egypt and many parts of the world. The net cost on a nutritional basis indicated that defatted flour is the least expensive protein source ($4.50/lb protein) (1). The future of soy-fortified popular foods seems bright.

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