The Nutritive Value and Organoleptic Properties of White Arabic Bread Supplemented With Soybean and Chickpea[1,2]

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ABSTRACT

The nutritive value and organoleptic properties were studied on white Arabic bread supplemented with 10, 20, 30, 40, and 50% chickpea flour and 4, 6, 8, and 10% soybean flour. Supplementation both with chickpea and soybean enhanced the nutritive value of the bread as shown by animal experiments. Amino acid analysis of supplemented bread revealed a net increase in lysine level. The organoleptic properties of the chickpea-supplemented bread compared favorably with the unsupplemented bread up to a level of 20% supplementation. Soybean-supplemented bread results showed a net increase in the available protein as compared to plain bread or L-lysine supplemented bread. Arabic bread supplemented with up to 10% soybean flour showed a high level of acceptability when compared to unsupplemented bread.

Nutritional studies conducted in various countries of the Middle East point to the prevalance of protein-calorie malnutrition (1). The Middle Eastern diet consists mainly of cereals and legumes (2,3); as much as 64% of the daily protein intake in the Middle East is derived from cereals (4).

Arabic bread is the main staple in the Middle Eastern diet. The bread is made from 60 to 65% extraction flour. It is a round and flat bread. The loaf measures 25 to 30 cm. in diameter and weighs between 150 and 200 g. per loaf. The dough is baked at a high temperature of 450° to 500°C. for 40 to 60 sec. The flat piece of dough puffs up in the oven and separates into two thin layers. The bread is consumed in large amounts, and its physical shape and structure make it an edible utensil by which food is carried to the mouth (2). Arabic bread, however, is considered to be a relatively poor protein source, being low in lysine (5); its lysine content varies between 130 and 140 mg. per g. nitrogen (5). This limitation causes the bread to be poorly utilized in the body (6).

Numerous attempts have been made to improve the protein quality of various types of European bread by supplementing them with different levels of protein sources and synthetic amino acids (7–11). However, studies on the supplementation of Arabic bread with protein sources and amino acid are few. Shakir et al. (12) reported the use of various cereals for Baladi bread (Egyptian bread) supplementation. No nutritional evaluation of the resulting bread was reported. Maleki and Djazayeri (13) supplemented Arabic bread with L-lysine at a level of 0.3%. They reported that the protein efficient ratio (PER) increased from 0.40 in the unsupplemented bread to 1.5 in the L-lysine-supplemented bread. Dalby (10) reported the use of cottonseed flour as a protein supplement in Baladi bread. He, however, did not report on the nutritional evaluation of such a bread. Maleki and Djazayeri (13) evaluated the nutritive value of Arabic bread.

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The objective of this study was to supplement local flour with different levels of chickpea flour (10, 20, 30, 40, and 50%), soybean flour (4, 6, 8, and 10%), and 0.25% L-lysine monohydrochloride. The nutritive value, amino acid content, and organoleptic properties of the resulting supplemented breads were studied and evaluated.

MATERIALS AND METHODS

Preparation of Samples

Wheat flour of 65% extraction was obtained from the local market in 5-kg. batches. The flour samples were sifted, mixed in a Hobart electric mixer (Model H-600T, Hobart Manufacturing Co., Ohio) for 30 min., and stored in polyethylene bags at 4°C. until used.

Chickpea flour was prepared by grinding raw chickpeas, bought from the local market in batches of 25 kg., in a Wiley Mill (Model No. 2, Arthur Thomas Co., Philadelphia) to pass 20-mesh. The sample was then ground in an Alpine Mill (Type 160 Z, Alpine, Augsburg, Germany) to pass 100-mesh. The flour was stored in polyethylene bags at 4°C. until used.

Soybean flour used in this study was obtained from Yoshihara Oil Mill, Ltd., Osaka, Japan. The flour was defatted, live-steam-heated, and fortified with 0.15% DL-methionine.

All the supplements were prepared by weighing the appropriate fractions of various flours to the second decimal place. The ingredients were then mixed for 30 min., and stored at 4°C. until used.

Arabic bread was prepared by a microbaking technique similar to that described by Maleki and Daghir (14) with a slight modification in the amounts of ingredients used for the preparation of the dough. The amounts used were: 1,000 g. flour; 450 to 600 ml. water; 15 g. salt; and 30 g. yeast (compressed). The exact amount of water for each kind of bread was determined with a Brabender Farinograph (OHG, Duisburg, Germany); a value of 800 Brabender Units (B.U.) was the reference value used for optimum consistency (15).

Arabic bread used in animal experiments was air-dried, ground, and stored according to the AOAC methods of analysis (16).

Nutritive Evaluation

The net protein utilization (NPU operative) experiment was performed as described by Miller (17) on chickpea- and soybean-supplemented bread, bread supplemented with 0.25% L-lysine monohydrochloride, and unsupplemented (or control) bread. Each diet was fed to a group of four 30-day-old rats of the Sprague-Dawley strain. The experiment was duplicated on different dates to ensure the reliability of the results. The net dietary protein as a percentage of total calories (NDP-Cal%) was determined as described by Miller (17). The protein quality score was calculated according to the FAO 1957 pattern (18).

Moisture and total nitrogen determinations were performed according to the AOAC methods of analysis (16).

Gross energy (GE) was determined with a ballistic bomb calorimeter (Gallenkamp, London) according to the procedure of Miller and Payne (19). Metabolizable energy (ME) was calculated with the equation of Miller and Payne (19).

TABLE I. PROXIMATE ANALYSIS OF WHEAT FLOUR, SOYBEAN FLOUR, CHICKPEA FLOUR, CONTROL AND SUPPLEMENTED BREADS

	Moisture[a] %	Dry-Weight Basis Protein %[a] N X 6.25	Fat[a] %	Fiber[a] %	Ash[a] %	NFE[a] %
Wheat flour	13.0	11.69	1.08	3.00	1.83	69.40
Soybean flour	6.77	51.38	1.02	4.12	6.84	36.64
Chickpea flour	10.50	22.09	6.05	3.80	2.85	65.21
Unsupplemented bread[b]	12.42	11.57	1.03	2.97	1.80	82.63
10% chickpea bread[b]	12.03	15.58	1.11	1.25	2.44	79.62
20% chickpea bread[b]	12.50	16.24	1.38	1.48	2.70	78.20
30% chickpea bread[b]	12.93	17.11	1.82	1.63	2.92	76.52
40% chickpea bread[b]	15.40	17.62	2.80	1.71	3.13	74.74
50% chickpea bread[b]	13.65	18.20	3.63	1.94	3.34	72.89
4% soybean bread[b]	12.76	13.24	1.02	3.11	2.07	80.57
6% soybean bread[b]	12.16	13.84	1.24	2.52	2.17	80.23
8% soybean bread[b]	12.04	14.62	1.49	3.11	2.33	78.44
10% soybean bread[b]	12.14	15.40	2.16	3.25	2.50	76.69

[a]Values are results of duplicate analyses.

[b]Air-dried bread samples.

TABLE II. THE NUTRITIVE VALUE OF ARABIC BREAD SUPPLEMENTED WITH CHICKPEA AND SOYBEAN

Type of Bread[a]	NPU (op)[b]	%N[b]	ME[b] Kcal./g.	NDP-Cal.%[b]
Unsupplemented bread	37	2.15	3.9	5.0
0.25% L-lysine bread	44	2.16	4.0	6.0
10% chickpea bread	41	2.19	3.9	5.7
20% chickpea bread	45	2.26	4.0	6.4
30% chickpea bread	52	2.38	3.9	7.9
40% chickpea bread	65	2.40	3.7	10.5
50% chickpea bread	66	2.51	3.8	10.8
4% soybean bread	50	2.02	3.7	6.9
6% soybean bread	50	2.11	3.7	7.1
8% soybean bread	54	2.25	3.9	7.8
10% soybean bread	55	2.36	3.9	8.3

[a]Air-dried bread samples.

[b]Values are results of duplicate analyses.

For amino acid analysis, the various bread samples were freeze-dried, hydrolyzed with 6N HCl at 110°C. for 22 to 24 hr., and the amino acids were determined with a Phoenix amino acid analyzer (Phoenix, Model K8000, Phoenix Precision Instruments Co., Philadelphia) according to the method of Spackman et al. (20).

Evaluation of Organoleptic Properties

Arabic bread supplemented with different levels of chickpea and 10% soybean was presented for evaluation to a trained taste panel of eight judges. The samples were tested according to a 10-point scale: 0–1, unacceptable; 2–3, poor; 4–6, fair; 7–8, good; 9–10, excellent. The characteristics evaluated were: color, taste, texture, and overall acceptability. Two samples of bread were presented at a time, a

TABLE III. THE ESSENTIAL AMINO ACIDS CONTENT OF WHEAT FLOUR, SOYBEAN FLOUR, CHICKPEA FLOUR, AND SUPPLEMENTED ARABIC BREADS

Essential Amino Acids EAA mg./ g. N	Wheat Flour	Chickpea Flour	Soybean Flour	Unsupplemented Bread	10% Chickpea Bread	20% Chickpea Bread	30% Chickpea Bread	8% Soybean Bread	10% Soybean Bread
Lysine	130	460	418	140	165	218	244	234	244
Threonine	152	247	253	174	170	189	193	249	229
Isoleucine	237	303	317	231	244	246	243	290	298
Leucine	467	520	542	463	472	479	486	509	545
Methionine	102	93	78	88	92	90	91	91	86
Cysteine	128	98	120	104	99	94	96	107	111
Total sulfur amino acids	230	191	198	192	191	184	187	198	197
Tyrosine	210	205	263	230	212	216	210	234	253
Valine	294	322	345	266	271	277	281	325	335
Phenylalanine	324	429	325	364	367	372	389	343	335
Protein quality score	48[a]	70[b]	73[c]	52[d]	61[e]	68[f]	69[g]	73[h]	73[i]

[a,d,e]Lysine-limiting.
[b,c,f–i]Sulfur amino acids-limiting.

control containing ordinary flour, and an experimental sample containing one of the different supplements. All samples were cooled to room temperature before evaluation. The average scores of eight judgments in the control and supplemented bread samples were compared statistically (21).

RESULTS AND DISCUSSION

Nutritive Value

The proximate analysis of ordinary flour and chickpea- and soybean-supplemented bread (Table I) showed the expected trend of increasing percent protein with increased levels of chickpea and soybean.

The nutritive value of Arabic bread was enhanced considerably by addition of chickpea flour and soybean flour (Table II). The NPU value increased from 37 to 65, an increase of 28 units, upon the addition of 40% chickpea flour. This increase indicates that the biological value of supplemented bread approached that of casein (NPU=70). The NPU at 50% chickpea supplementation level, however, did not differ significantly from that of the 40% level.

Soybean supplementation of Arabic bread also increased the quality of Arabic bread significantly (Table II). The NPU values increased from 37 to 50 and 54, an increase of 13 and 17 units, upon the addition of 4 and 8% soybean flour, respectively. No further increase was observed at the 10% level of supplementation. The leveling-off of NPU values in both chickpea- and soybean-supplementation experiments indicates that the amino acid balance of the bread did not improve beyond certain levels of supplementation. These results agree with the PER results obtained by Mizrahi et al. (22).

The NDP-Cal% value, an indicator of quality as well as quantity of protein present, increased significantly when Arabic bread was supplemented with soybean and chickpea flour at different levels. The results indicate that the addition of chickpea and soybean, in addition to improving the quality of the protein present in the bread, increased the level of balanced protein; whereas L-lysine tended to only slightly improve the quality of the protein present in the bread.

Amino Acid Content

The lysine content of Arabic bread (Table III) increased from 140 mg. per g. nitrogen (N) for the control bread to 244 mg. per g. N upon the addition of 30%

TABLE IV. THE EFFECT OF CHICKPEA SUPPLEMENTATION ON ORGANOLEPTIC PROPERTIES OF ARABIC BREAD (MEAN OF EIGHT JUDGMENTS)

Bread Characteristics Evaluated	Supplementation Level Used						LSD 5%
	0%	10%	20%	30%	40%	50%	
Color	7.9	7.6	7.8	6.4	6.4	6.5	0.0
Taste	7.6	7.0	7.0	5.1*	3.5*	4.3*	1.6
Texture	7.9	6.9	7.6	7.0	5.3	5.8	0.0
Overall acceptability	7.4	6.5	6.4	5.4*	3.9*	4.6*	1.5

TABLE V. THE EFFECT OF PARBOILING OF CHICKPEAS ON THE ORGANOLEPTIC QUALITIES OF ARABIC BREAD (MEAN OF SEVEN JUDGMENTS)

Bread Characteristics Evaluated	Treatments			
	None	Raw chickpeas	Parboiled chickpeas 30% level	Parboiled chickpeas 50% level
Color	7.0	6.3	6.3	6.0
Taste	8.1	4.4	7.0	6.6
Texture	7.8	6.6	6.6	6.2
Overall acceptability	7.8	5.1	6.4	6.5

TABLE VI. THE EFFECT OF SOYBEAN SUPPLEMENTATION ON ORGANOLEPTIC PROPERTIES OF ARABIC BREAD (MEAN OF EIGHT JUDGMENTS)

Bread Characteristics Evaluated	Unsupplemented Bread	10% Soybean Bread
Color	7.1	8.4
Taste	6.6	7.3
Texture	7.3	8.0
Overall acceptability	6.4	7.0

chickpea flour and to 234 and 244 mg. per g. N upon the addition of 8 and 10% soybean flour, respectively. The total sulfur amino acids showed no significant change upon addition of 30% chickpea flour (192 mg. to 187 mg. per g. N), and 10% soybean flour (192 mg. to 197 mg. per g. N). Lysine was the limiting amino acid in wheat flour, unsupplemented bread, and 10% chickpea bread. The total sulfur amino acids (cysteine and methionine) were the limiting amino acids in soybean flour, chickpea flour, 20 and 30% chickpea breads, and 8 and 10% soybean breads. The increase in protein quality score of Arabic bread (Table III) followed the same trend as the NPU operative values (Table II). Supplementation of bread with chickpea and soybean, therefore, corrected the lysine deficiency of Arabic bread as well as increased its quantity of protein.

Organoleptic Properties

Taste-panel tests indicated that acceptability of chickpea-supplemented bread compared favorably with the control bread up to a level of 20% (Table IV). Levels of 30% and above adversely affected the taste and overall acceptability of Arabic bread. Means of alleviating this effect were investigated. Parboiling the chickpeas for a period of 30 min. and drying at 70°C. before grinding alleviated this adverse acceptability of the supplemented bread (Table V). Supplementation of Arabic bread with the different levels of soybean failed to affect the color, texture, or overall acceptability. The results indicated that even with 10% soybean supplementation, the overall acceptability compared favorably with the control (Table VI).

These results suggest that supplementation of Arabic bread with soybean flour and chickpea flour is technically feasible and nutritionally advisable. Furthermore, the results indicate that considering soybeans and chickpeas, soybean flour is a better supplement for Arabic bread. Therefore, the authors recommend the adoption of 10% soybean supplementation in the bread supplied to orphanages and refugee camps throughout the Middle East in order to alleviate the protein-calorie malnutrition problem in these groups.

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