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SOYBEAN—EFFECT OF SOAKING AND DIFFERENT HEAT TREATMENTS ON CHEMICAL COMPOSITION, FUNCTIONAL PROPERTIES AND UTILIZATION IN FOOD PRODUCTS

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Key words: soybean, functional properties roasted soybean

The effect of soaking and thermal treatments of soybeans on chemical composition as well as functional properties were investigated. Soaked and/or roasted soybeans were incorporated in the manufacture of patti beans which were organolepticaly evaluated.

INTRODUCTION

Soybean has been introduced recently, however, it could be considered one of the main seed crops in Egypt. It is rich in both oil and protein and has a potential in some food products. Effect of germination on both chemical and nutritional aspect in soybean was raported by Mostafa et al. [9]. Also effect of different hat treatments and soaking on the properties of soybean oil and nutritional quality of soybean flour was studied by Mostafa et al. [10] and Rady et. al. [12].

However, this work was carried out to study the effect of either soaking of soybean in water as well as 2% NaOH, or heating at 85°C, 100°C and 120°C and autoclaving for 5 and 10 minutes on the chemical composition and functional properties of the produced flour. Also soybean was used in preparing taameia a common deep fried food in Egypt which was evaluated organoleptically.

MATERIALS AND METHODS

MATERIALS

Soybean seeds (*Glycine max L.*) variety Calland and broad beans (*Vicia faba*) var. Giza 3, grown in Minufiya Governorate during 1984 were supplied by the seed section. Agricultural Department, Shebin El-Kom, Egypt.

PREPARATION OF THE TREATMENTS

1. Soaking. About 500 g of sound and clean soybeans were soaked at room temperature (~28°C) in tap water and 2% NaOH solution for 12 and 24 hr in each solution respectively. The ratio of soybeans to soaking medium was 1:5 (w/v). After the particular time of soaking the beans were washed, drained, dried at 45-50°C overnight, ground and defatted by several washing with hexane. After desolventizing the meal was finely ground to pass through 60 mesh sieve and used for analysis.

2. Dry and moist heat treatments. About 500 gm of good quality soybeans were exposed at 85, 100 and 120°C for 1 hr. Thereafter, beans were cooled to room temperature, defatted and processed as that of soaked samples. The same amount of soybeans were autoclaved at 121°C 15 lb/sq. in for 5 and 10 minutes. After removal of the condensed water droplets, beans were defatted and prepared similar to the other tratments.

Patti beans were prepared from roasted soybean at 100°C for one hour and raw sample. Both dehulled broad beans and soybeans were separately soaked overnight in tap water, then mixed together according to percentages stated in Table 1.

Table 1. The composition percentages of different patti beans blends

Components	Blends												
	A	B	C	D	E	F	G	H	I	J	K	L	M
Broad bean seeds	100	90	80	70	60	50	90	80	70	60	50	—	—
Roasted soybean	—	10	20	30	40	50	—	—	—	—	—	100	—
Raw soybean	—	—	—	—	—	—	10	20	30	40	50	—	100

Each blend was mixed with 20% cleaned green herbs (on fresh weight basis) consisted of parcley, coriander, Egyptian leek, onion and garlic which were finely ground. Other spices as cumin, dried coriander in minute quantities and 3% ordinary salt were also added. Each mixture was packed in polyethylene bags of $\frac{1}{2}$ k. capacity and were deep fried cirectly. The fried patti beans were tested organoleptically.

METHODS

1. Analytical methods. Total protein and ash contents were determined according to the method of AOAC [1]. The non protein nitrogen was estimated as described by Bahtty [2]. The method of Dubois et al. [4] was followed to estimated total reducing sugars in the ethanol extracts using glucose as standard. The total carbohydrates were calculated by difference.

2. Functional properties. Water and fat absorption capacity were determined according to the method of Sosulski et al. [15]. The method of Lawhon et al. [7] was followed to estimate foaming properties. Emulsification capacity was conducted using the procedure discribed by Beuchat et al. [3]. Soluble protein and protein solubility index were determined according to AOAC [1] in water, 5% NaCl and 0.02 M NaOH.

3. Organoleptic analysis. Taste and texture of various patti bean blends were evaluated organoleptically by a pannel of 10 staff members of food science, Fac. of Agric., Minufiya Univ. The scores for both texture and flavour were as follows: Excellent 5, V. Good 4, Good 3, and Fair 2 (poor/unsatisfactory or rejected).

The results were subjected to analysis of variance and least significant differences (LSD) according to Snedecor and Cochran [14].

RESULTS AND DISCUSSION

Steeping or soaking of soybeans in water at room temperature for 12 and 24 hr showed a marked decrease in total protein, non-protein nitrogen, total ash and reducing sugars (Table 2). The decreasing rate of these components increased with the increasing soaking time. The same trend was observed pertaining soybeans soaked in 2% NaOH solution. Meanwhile, ash content of alkaline soaked beans increased due to sodium ion penetration through the soaked beans. Ash content increased by 2.5% and 23.02% after alkaline soaking (2% NaOH) for 12 and 24 hr respectively. The substantial increase in ash content after 24 hr of soaking could be attributed to the increasing rate of sodium ion penetration.

Concerning the effect of both dry and moist heat on the chemical composition of soybean flours, results in the same Table 2 reveal that non-protein nitrogen slightly increased due to heat treatment. However, at higher temperatures and longer time of autoclaving a marked increase in non-protein nitrogen was noticed. This could be ascribed to dissociation of the protein molecules. On the other hand, ash content did not show any changes due to the above mentioned treatments. Results in Table 3 show that longer times of soaking reduced the protein solubility index in both treatments. However, soaking in alkaline solution showed a drastic decrease in the protein solubility which could be attributed to leaching out of some soluble protein compounds. Rahma [13] has reported the same observation pertaining sunflower seed soaked in alkaline solution.

Three solvents were used to study the effect of soaking on solubility of the protein; distilled water, 5% NaCl and 0.02 M NaOH. Among these extractants sodium chloride solution was the most effective solvent in solubilizing the proteins. The protein solubility index in 0.02 M NaOH solution was 53.04%, 59.39% and 81.24% for unsoaked and after 12 and 24 hr. of soaking in water respectively. The 24 hr soaked sample gave the highest protein solubility index in the three solvents since it was 54.97%, 86.53, and 81.24% in water, 5% NaCl and 0.02 M NaOH solutions respectively.

Table 2. Effect of both soaking as well as thermal treatments of soybean on the proximate chemical composition of soybean flour*

Component	Control	Soaking in water for		Soaking in 2% NaOH for		Dry heating for 1 hr at			Autoclaving at 121°C for	
		12 hr	24 hr	12 hr	24 hr	85°C	100°C	120°C	5 min.	10 min.
Total protein % (N × 6.25)	50.53	49.65	46.52	48.50	45.30	48.04	46.39	44.05	48.91	47.77
Non protein nitrogen %	3.41	1.14	0.92	1.13	1.02	3.42	3.78	4.0	3.60	4.24
Total ash %	7.60	6.59	6.53	7.79	9.35	7.60	7.53	7.62	7.50	7.52
Reducing sugars (as glucose) %	10.35	9.65	7.88	6.87	3.58	8.02	7.78	7.10	7.50	7.20
Total carbohydrate %+	28.11	32.97	38.15	35.71	40.75	32.94	34.52	37.23	32.49	33.27

* Average of three determinations on dry weight basis
+ By difference after excluding glucose

[28]

Table 3. Effect of both soaking as well as thermal treatments of soybean on the solubility and protein solubility index of soybean flour proteins*

Component	Control	Soaking in water for		Soaking in 2% NaOH for		Dry heating for 1 hr at			Autoclaving at 121°C for	
		12 hr	24 hr	12 hr	24 hr	85°C	100°C	120°C	5 min.	10 min.
Soluble protein (%)										
H_2O	27.45	30.33	25.55	8.25	6.19	13.79	8.89	27.60	9.20	19.33
5% NaCl	31.57	29.41	40.22	4.25	3.61	11.85	7.99	30.92	7.60	16.24
0.02 M NaOH	26.80	31.96	37.76	9.02	7.22	16.88	14.43	29.38	12.37	26.29
Protein solubility Index (%)										
H_2O	54.32	56.36	54.97	20.10	12.74	29.75	21.84	61.43	18.44	40.46
5% NaCl	62.48	54.65	86.53	10.35	7.43	25.45	19.30	70.19	15.54	34.00
0.02 M NaOH	53.04	59.39	81.24	21.97	14.86	36.66	34.84	66.70	25.29	55.03

* Average of two determinations.

The data in the same table reveal that the solubility of the protein depended on both the type and time of heat treatment, as well as the solvent used to extract the protein. The dry beans gave the highest protein solubility in 5% NaCl solution (31.57%) compared to 27.45% and 26.80% in water and sodium hydroxide respectively. The dry heat treatment showed a variable effect on both protein solubility and protein solubility index of soybeans. Heating at 85 and 100°C for 1 hr decreased both solubility properties. However, heating at 120°C for the same period increased it. The same effect was noticed pertaining the protein solubility since it decreased after being autoclaved at 121°C, 15 lb per sq. in for 5 min but increased when autoclaved for 10 min. McWatters and Holmes [8] have reported that heat has a variable effect on the solubility of the protein according to both size and type of protein being heated. These results agree well with our results for heated soybeans.

Results in Table 4 reveal that water absorption capacity increased markedly due to soaking in 2% NaOH solution over the control sample but decreased after being soaked in water. These results could be attributed to penetration of sodium ions which usually retain more water molecules. This improved the water absorption of the flour. The same observation was reported El-Aadawy [5] for alkaline soaked faba bean. On the contrary, the leaching out of some compounds which may have a potential in absorbing water could be ascribed to the observed decrease in the water absorption of water soaked samples.

Oil or fat absorption of water and 2% NaOH soaked samples showed almost the same trend as that of water absorption capacity. Soaking in both solutions improved the oil absorption capacity over the unsoaked sample. However, the increase was not much as that observed for water absorption.

Emulsification capacity (EC) of soybean was affected by both time and type of the soaking solution. There was a marked increase in EC of the flour after 12 hr of soaking in both solutions. As the time of soaking increased to 24 hr. the EC decreased however a marked decrease was observed due to soaking in NaOH solution. Generally the EC depends upon the amounts of soluble protein in the solution [6].

Foam properties (foam capacity and stability) were markedly affected after being soaked either in water or alkaline solutions (Table 4). The control showed the highest foam capacity and stability than both soaked samples. Also a marked decrease was observed for the 24 hr. than for the 12 hr. soaked samples. Soaking in sodium hydroxide also decreased the foam properties more than soaking in water. The reduction in foam properties could be either due to denaturation of the protein by the alkaline solution or removal of some soluble protein compounds which may have foaming action.

Data in the same table show that oil absorption capacity increased after both thermal treatments when compared to unheated samples. Such increase was markedly either at higher heating temperatures or longer time of autoclaving. Water absorption capacity showed the same trend as oil absorption capacity. The heated samples were higher in water absorption than the control sample. The

Table 4. Effect of both soaking as well as thermal treatments of soybean on some functional properties of the flour*

Property	Control	Soaking in H_2O for		Soaking in 2% NaOH for		Dry heating for 1 hr at			Autoclaving at 121°C for		Standard error
		12 hr	24 hr	12 hr	24 hr	85°C	100°C	120°C	5 min.	10 min.	
Fat absorption ml oil/100 g flour	117.5	180.0	165.0	160.0	160.0	132.5	140.0	152.5	120.0	140.0	±0.0—2.5 ±0.75—2.5
Water absorption g H_2O/100 g flour	233.5	202.25	185.0	491.0	495.0	253.5	273.75	284.75	256.25	296.25	±1.0—3.0 ±0.0—2.0
Emulsification capacity ml oil/g flour	64.0	68.67	64.0	72.5	62.5	60.5	55.67	51.35	62.92	52.50	±0.0—2.0
Foam capacity (% increase)	65.0	48.0	41.0	30.0	24.0	56.0	36.0	26.0	40.0	27.0	
Foam stability (ml)	30.0	25.5	19.5	12.0	6.0	27.0	18.0	15.0	20.0	15.0	

* Average of there determinations.

water absorption increased by 21.95% and 26.87% after heating soybean at 120°C for one hr and autoclaving for 10 min. respectively. The corresponding values for the increase in fat absorption were 29.78% and 19.15% respectively. The reports of Wu and Inglett [16] for heat processed soybean flour and that of Narayana and Narasinga Rao [11] for heat treated winged bean agree well with our findings.

Emulsification capacity and foaming properties showed an opposite trend compared to both water and oil absorption properties. All the heat treated samples were lower in these properties than the unheated soybean. This was expected because the heat denatured the protein and became less soluble. Also these properties are mainly due to soluble protein. The EC reduced by 19.76% and 17.97% after being heated at 120°C for 1 hr and autoclaved for 10 min. respectively. However, the corresponding values for foam capacity decreased by 60% and 58.46% at the same level of heat treatments.

In general, both heat types improved water and fat absorption properties and reduced emulsification and foaming properties of soybean flour compared to unheated soybean. Therefore, the final use of soybean flour will determine if the heat treatment is necessary or not.

Results in Table 5 represent the scores of consumer preference pertaining sensory evaluation of different blends of patti beans. From these results it could

Table 5. Sensory scores for patti beans made from a mixture of broad beans and soybeans in different rations

Blend	Average score		Total score
	texture	taste	
A	2.5	2.3	4.8
B	3	2.4	5.4
C	2.4	2.4	4.8
D	2.7	2.7	5.4
E	3.1	2.6	5.7
F	4.8	4.8	9.6
G	2.7	2.5	5.2
H	3.2	2.9	6.1
I	3.6	3.6	7.2
J	3.9	3.6	7.5
K	3.5	3.6	7.1
L	1.0	1.6	2.6
M	1.0	1.7	2.7
$L.S.D_{0.05}$	0.687	0.83	
$L.S.D_{0.01}$	0.909	1.10	

be observed that blend F scored best either for texture or taste. It seems that the addition of soybean obviously improved the flavour as it was distinctive in blends F, J, I and K when compared to control. It is interesting to noticed that as

percentage of adding soybean increased the total acceptability socres (taste + texture) increased to reach its maximum at 40 and 50% level for raw and roasted soybean.

Therefore, roasting treatment of soybean before soaking help to increase the incorported amount of soybean which cause a distinctive improvement pertaining flavour. However, soybean seeds alone proved to be unsatisfactory for the manufacture of patti bean as it affected the texture negatively. The least significant differences (LSD) between different treatments revealed that almost all treatments were significant at both 5% and 1% level (Table 5).

Conclusively, soybean seeds could replace broad beans in a range of 20 to 50%. However, the higher percentage seemed to have the top quality especially when roasted before being added.

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SOJA — WPŁYW MOCZENIA I ZRÓŻNICOWANEJ OBRÓBKI TERMICZNEJ NA SKŁAD CHEMICZNY, WŁAŚCIWOŚCI FUNKCJONALNE I WYKORZYSTANIE W PRODUKTACH SPOŻYWCZYCH

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Streszczenie

Ziarno soi było moczone w wodzie i 2% roztworze NaOH przez 12 i 24 h w temp. ok. 20°C lub poddane zróżnicowanej obróbce termicznej. Moczenie powodowało spadek zawartości białka

ogółem, azotu niebiałkowego i cukrów redukujących oraz rozpuszczalności białek, przy czym moczenie w roztworze NaCl powodowało także wzrost zawartości popiołu. Obróbka termiczna spowodowała natomiast wzrost azotu niebiałkowego, spadek zawartości białka ogółem i cukrów redukujących, przy braku wpływu na zawartość popiołu. Rozpuszczalność białek początkowo spadała, a następnie rosła w miarę podnoszenia temperatury lub przedłużania czasu ogrzewania. Absorpcja tłuszczu otrzymanej mąki sojowej uległa podwyższeniu w wyniku moczenia zarówno w wodzie, jak i w roztworze NaOH, osiągając maksymalną wartość po 12 h moczenia. Podobną tendencję wykazywała wodochłonność, przy czym wyraźniejszy jej wzrost stwierdzono w przypadku moczenia alkalicznego.

Zdolność emulgująca polepszyła się w wyniku moczenia przez 12 h, natomiast uległa pogorszeniu podczas moczenia przez 24 h. Moczenie powodowało spadek zdolności do tworzenia piany. Obydwa warianty obróbki termicznej polepszyły zdolność absorpcji tłuszczu i wodochłonność badanych mąk, natomiast pogorszyły zdolność emulgującą i zdolność tworzenia piany. Wykazano możliwość zastąpienia 20-50% bobu przez soję podczas wyrobu paszteciков. Wyższy dodatek był korzystniejszy, szczególnie gdy ziarno soi przed mieleniem było poddane obróbce termicznej na sucho.