PREPARING SOME MEAT PRODUCTS USING SOYBEAN SEEDS AFTER REMOVING THE ANTINUTRITIONAL MATTERS
By

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ABSTRACT

This study was carried out to remove the antinutritional matters from soybean seeds to be used in beef sausage and beef burger products. Crude protein content in raw soybean seeds was 44.82%, while, the antinutritional factors: trypsin inhibitor, chymotrypsin inhibitor, hemagglutinating, total phenolic compounds and phytic acid were: 31.6 mg/g, 3.40 mg/g, 713 U/g, 0.75% and 1.21%, respectively.

Autoclaving was effective in removing all antinutritional matters except phytic acid, however, roasting was most effective for its reduction.

In order to reduce the cost of meat products and to improve their physico-chemical properties, meat was replaced by rehydrated soybean flour at the levels of 0, 10, 15, 20, 25 and 30%.

So, it could be recommended to apply replacement level to 20% soybean, treated with autoclaved, from meat used in prepared sausage and beef burger.

INTRODUCTION

The growing third world population and its domestic animals need protein. The cheapest protein are those derived from plant material.

Beef burger is versatile, easy to prepare and relatively inexpensive. Thus, it is one of the most popular meat products and is a multi-billion dollar commodity in the United States (Cross *et al.*, 1980).

Legume seeds are important source of energy and protein in many part of the world. However, their nutritional value may be limited in part by the presence of undesirable components known as antinutritional factors (ANFs), such as proteinase inhibitors, lectins (hemagglutinnis), amylase inhibitors, tannins, phytic acid and vicine.

Lectins (hemagglutinin, phytohemagglutinin) are proteins or glycoproteins that are capable of agglutinating red blood cells and can bind to specific carbohydrate residues in cell membranes (Lis and Sharon, 1972, Sharon and Lis, 1990). They are widely distributed in nature and have been isolated from plants, animals and microorganisms.

Lectins have been identified in numerous seeds such as soybean, pinto bean, castor bean, jack bean, mungbean, lima bean, kidney bean, navybean, pea, lentil and faba bean (Chen *et al.*, 1977; Staron, 1977 and Bau *et al.*, 1997).

The lectin and trypsin inhibitor can both affect pancreas function. Their combined action, either additively or synergistically, may have considerable implications and consequences for the use of legume meal or proteins in human and animal nutrition (Grant *et al.*, 1987).

Proteinase inhibitors (PI) are antinutritional factors which occur in the seeds of many plants belonging to the legume family. These inhibitors and other antinutrional factors (ANFs) are the subject of a recent review written by El-Morsi (1996). Trypsin inhibitors in legumes were shown to have an adverse effect on animal nutrition due to these inhibitory properties on major pancreatic proteinases (Sato and Herman, 1990 and Arentoft *et al.*, 1991) as well as reduced animal weight gain (Herkelman *et al.*, 1992 and Saikia *et al.*, 1999).

Polyphenolic compounds, tannins, phytic acid and vicine are among the antinutritive factors detected in many legume seed, (El-Morsi, 1996 and Vijayakumari *et al.*, 1998). Tannins are known to decrease protein digestibility either by binding with digestive enzyme as trypsin and chymotrypsin or binding directly to dietary proteins (Jambunathan and Singh, 1981). The levels of these compounds were determined in soybean seed by some investigators (Friedman *et al.*, 1991 and Foda and Abd El-Aleem, 1998).

Soaking slightly reduces the levels of trypsin in legume seeds (Zaki *et al.*, 1996) while, different heat treatment destroy most of them (Umoren *et al.*, 1997; Aarti *et al.*, 1999; Zaki *et al.*, 1999 and Seda *et al.*, 2002).

Fermentation of soybean seeds decreased fat, available carbohydrates, phytic acid, trypsin inhibitor activity and total vicine content and increased crude protein, non protein nitrogen, true protein, fiber content, pH value, total volatile nitrogen and ammonia (Paredes-Lopez and Harry, 1989).

There are three types of soy protein products that can be used as extenders and binders in meat products: soy flour, soy concentrate and isolated soy protein (Richert, 1991).

Several studies have been carried out to retain sensory and textural attributes through fat reduction by replacing fat with water, water and phosphate (Miller *et al.*, 1993 and Frederick *et al.*, 1994), carbohydrate and protein based on fat substitutes (Dexter *et al.*, 1993 and Carballo *et al.*, 1995) and vegetable gums (Osburn and Keton, 1994 and Trius *et al.*, 1994)

The purpose of the present study was to test the effect of autoclaving or roasting on antinutritive matters, protein digestibility and amino acid composition in soybean seeds. After that defatted soybean seeds were used to prepare beef sausage and burger meat.

MATERIALS AND METHODS

Materials:

Soybean seeds (Giza 21 variety) were obtained from Agricultural Research Center, Giza, Egypt.

Raw beef meat and mutton fat purchased from supermarkets of Kalyobia governorate. Spices ingredients (black pepper, cloves, cubeb, cumin, garlic, nutmeg, fennel, coriander, laurel and cardamom) were purchased from local market.

Treatments:

Autoclaving treatment: Soybean seeds were autoclaved at 121°C for 10, 20, 30, and 40 min.

Roasting treatment: Soybean seeds were roasted by heat at 140°C for 10, 20, 30 and 40 min.

The seeds were cleaned and finely ground. Hexane (b.p. 40-60°C) was used for the extraction of oil from the ground seeds.

Preparation of beef sausage and burger samples:

Visible fat tissues were trimmed from lean meat, then minced by electric chopper. Mutton fat tissues also, were minced. Soybean flour was rehydrated by mixing with distilled water at ratio 1 : 2 (w:w) and added by levels, 0 (control), 10, 15, 20, 25, 30 and 35% from beef meat to prepare sausage and burger. The formula of beef sausage and burger are shown in table (A):

Table (A): The formula of beef sausage and beef burger prepared in laboratory*.

Component		Sausage	Burger	Spices mixture
Beef meat	(%)	70.60	62.00	For sausage:
Mutton fat	(%)	14.00	-	Fennel 59.76%, coriander
Water (as ice flakes)	(%)	7.00	10.00	27.09%, cubeb 3.19%,
Starch	(%)	4.65	-	black pepper 3.19%, clove
Sodium pyrophosphate	(%)	0.30	-	3.19%, laurel 1.99% and
Salt (NaCl)	(%)	2.00	1.50	cardamom 1.59%.
Garlic	(%)	0.24	-	
Skimmilk powder	(%)	0.40	-	
Glucose	(%)	0.10	-	
Ascorbic acid	(%)	0.04	-	For burger:
Sodium nitrite	(%)	0.01	-	Black pepper 5.61%,
Ground onion	(%)	-	7.00	cardamom 2.24%, cloves
Egg	(%)	-	7.00	2.24%, cubeb 22.42%,
Semolina	(%)	-	12.00	cumin 11.21%, garlic
Spices mixture	(%)	0.66	0.50	56.05%, and nutmeg 0.22%.

*Source [Moghazy and El-Shaarawy (2001) and Moghazy *et al.* (2004)]

Methods:

Chemical analysis: Moisture, crude protein, ether extract and ash contents were determined according to A.O.A.C. (1995). Carbohydrates content was calculated by difference.

Assay of trypsin inhibitors (TI): The trypsin inhibitors was measured according to Stauffer (1993).

Assay of chymotrypsin inhibitors (CI) was measured as described by Samirnoff *et al.* (1976).

Determination of Hemagglutinating activity (HA): Lectin activity was determined by measuring its hemagglutinating action according to the method described by Thompson *et al.* (1983).

Determination of total phenols (TPC): The polyphenolic compounds were determined as described by Swain and Hills (1959).

Determination of phytic acid (PA): Phytic acid was estimated colorimmetrically using Wade reagent (Latta and Eskin, 1980).

In vitro **protein digestibility:** The digestibility of protein *in vitro* was carried out as described by Santosh and Chauhan (1986).

Determination of amino acids: Amino acid analyzer (Model 121) was used to determine amino acid in soybean seeds as described by Moore *et al.* (1958). Cystine was microbiologically determined as described by Barton (1952). Tryptophan was colorimetrically determined in the alkaline hydrolysate of samples according to the method of Blouth *et al.* (1963).

Freshness tests: Total volatile nitrogen (TVN) was determined according to the methods mentioned by Winton and Winton (1958). Thiobarbituric acid (TBA) value, as a measure of oxidative rancidity was determined according to Harold *et al.* (1981). pH value of meat product samples was measured using digital pH-meter model SA 210 according to the method of Woye Woda *et al.* (1986).

Water holding capacity (WHC) and plasticity were measured according to the method described by Soloviev (1966).

Cooking loss and shrinkage were determined according to Darweash and Moghazy (1998).

Sensory evaluation were evaluated according to Watts *et al.* (1989).

Statistical analysis was applied on the results of organoleptic evaluation of different samples of beef sausage and beef burger which were treated as data for complete randomization design. Least significant difference (L.S.D.) was calculated at 0.05 level of significance according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Chemical composition of soybean seeds:

Data in Table (1) show that crude protein content of soybean seeds was 44.82%, followed by ether extract (25.30%), total carbohydrate (24.28%) and ash

content were 5.60%, (dry weight basis), while moisture content was 8.30%. These results confirms the view that soybean seeds are considered to be an excellent source of protein. Results are in agreement with Foda and Abd El-Aleem (1998).

Table (1): Chemical composition of raw dry soybean seeds.

Components		
Moisture	(%)	8.30
Ash*	(%)	5.60
Ether extract*	(%)	25.30
Crude protein*	(%)	44.82
Total carbohydrate*	(%)	24.28
Trypsin inhibitor *	(mg/g)	31.60
Chymotrypsin inhibitor*	(mg/g)	3.40
Hemagglutinating *	(U/g)	713
Total phenolic compounds*	(%)	0.75
Phytic acid*	(%)	1.21

*: On dry weight basis.

Antinutritional matters in soybean seeds:

Data in the same Table showed that the levels of antinutritional matters were determined in soybean seeds and found to be 31.6 mg/g, 3.4 mg/g, 713 U/g, 0.75% and 1.21% for trypsin inhibitor (TI), chymotrypsin inhibitor (CI), hemagglutinating (HA), total phenolic compounds (TPC) and phytic acid (PA), respectively.

The presence of antinutritional matters in soybean seeds was in agreement with many other workers (Friedman *et al.*, 1991 and Foda and Abd El-Aleem, 1998).

Effect of autoclaving and roasting on antinutritional matters of soybean seeds:

The effect of various heating methods of soybean seeds on TI, CI, HA, TPC and PA contents were examined and the results are presented in Fig (1) which indicated that autoclaving and roasting of soybean seed reduced the levels of antinutritional matters.

Results show that autoclaving and roasting soybean seeds for 40 min inactivated trypsin inhibitor to 87.6% and 77.7%, respectively. Under the same conditions chymotrypsin inhibitor was more resistant to heat treatment compared to trypsin inhibitor.

The hemagglutinine was totally destroyed after 30 min. autoclaved and 40 min roasted soybean seeds. As shown in Fig. (1) all treatments resulted in decrease of TPC and PA.

Autoclaving seems more effect on destruction of TPC compared with roasting, but less effect on destruction of phytic acid compared with roasting. Similar observation was reported by Umoren *et al.* (1997), Aarti *et al.* (1999) and Zaki *et al.* (1999), they found that cooking and autoclaving on the levels of total free phenols and phytic acid in seed, autoclaving seemed to be the most efficient
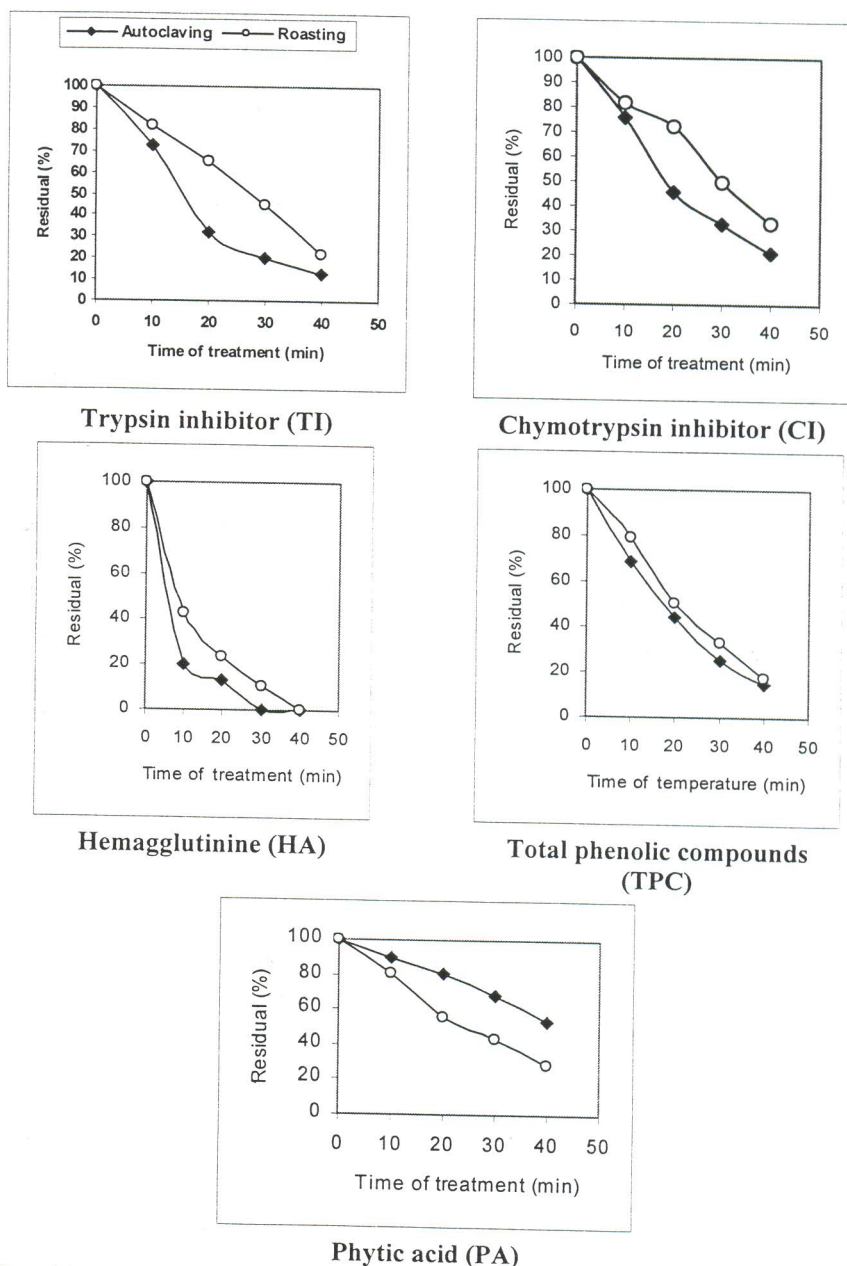
Trypsin inhibitor (TI)

Chymotrypsin inhibitor (CI)

Hemagglutinine (HA)

Total phenolic compounds (TPC)

Phytic acid (PA)

Fig. (1): Effect of autoclaving and roasting on the antinutritional matters of soybean seeds

for reduction in content of the antiutrients except phytic acid and improving protein digestibility index.

Effect of heating in an autoclave and roaster on the amino acids composition of soybean seeds:

The results of amino acid analysis of soybean dry seeds as well as seed heated in autoclave for 40 min and seeds roasted for 40 min. are presented in Table (2).

The provisional amino acid scoring pattern proposed by FAO (1973) qualified an ideal protein as one in which 36% of the total essential amino acids.

The data shown in Table (2) indicated that soybean seed proteins had higher E/T ratio than proposed 36% for an ideal protein. Little changes were observed in some essential amino acids as a result of autoclaving and roasting which are in agreement with results of Friedman *et al.* (1991) who reported no changes in amino acid composition of soybean seed after 30 min autoclave heated.

Table (2): Effect of heating in an autoclaving and roasting on amino acids composition of soybean seeds (g/100 g protein).

Amino acids	Dry seeds	Autoclaving (40 min)	Roasting (40 min)
Essential amino acids (EAA):			
Lysine	5.94	5.82	5.10
Leucine	7.83	7.84	7.68
Isoleucine	4.39	4.39	4.35
Cysteine	1.40	1.38	1.32
Methionine	1.50	1.47	1.43
Phenylalanine	4.90	4.75	4.75
Tyrosine	3.77	3.80	3.74
Therionine	3.89	3.91	3.88
Valine	4.52	4.52	4.46
Trptophan	0.85	0.78	0.69
Total EAA	38.99	38.66	37.40
Non essential amino acids (NEAA):			
Hestidine	2.54	2.60	2.54
Arginine	6.16	6.12	5.89
Asparatic	11.31	11.35	11.36
Glutamic	16.87	16.90	16.85
Serine	4.58	4.58	4.54
Proline	5.63	5.44	5.39
Glycine	4.13	4.23	4.17
Alanine	4.28	4.21	4.18
Total NEAA	55.50	55.43	54.92
Total amino acids	94.49	94.09	92.32
E/T (%)	41.26	41.10	40.51

Effect of heating in an autoclave and roaster on the protein digestibility index of soybean seeds:

Data in Table (3) show the effect of heating in an autoclave and roaster on the protein digestibility index of soybean seeds. Results show that increasing heating time improved protein digestibility for both autoclaved and roasted soybean seeds. The optimum conditions for maximum digestibility was heating for 40 min by autoclaved.

The increase in protein digestibility after heat treatment could be partially attributed to protein denaturation which improve protein susceptibility to enzyme attack. Furthermore inactivation of trypsine inhibitor would certainly improve *in vitro* protein digestibility (Zaki *et al.*, 1996).

Vijayakumari *et al.* (1998) found that autoclaving seemed to be best method for eliminating the contents of antinutrients. It also improved the protein digestibility index.

Table (3): Effect of heating in an autoclave and roaster on the protein digestibility index of soybean seeds

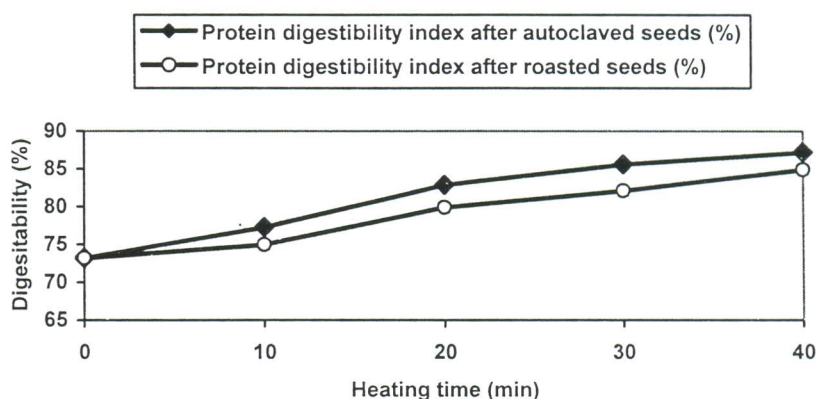| Heating time	Protein digestibility index after autoclaved seeds (%)	Protein digestibility index after roasted seeds (%)
Without heating	73.20	73.20
Heating 10 min	77.30	74.98
Heating 20 min	82.90	79.92
Heating 30 min	85.60	82.10
Heating 40 min	87.20	84.90

Fig. (2): Effect of heating in an autoclave and roaster on the protein digestibility index of soybean seeds

Evaluation of products prepared (beef sausage and beef burger) with replacement part of used meat by treated soybean:

a) Beef sausage:

Data in Table (4) show moisture, crude protein, ether extract, ash and total carbohydrates content in beef sausage prepared in laboratory with replacement part of meat used by levels of soybean treated with autoclaved or roasted (0, 10, 15, 20, 25 and 30%). Moisture content of fresh sausage treatments ranged from 57.17-60.50%, but, after frying all sausage treatments ranged from 48.63-52.63%. Crude protein and ether extract content were decreased with increasing the level of replacement levels with rehydrated soybean flour (autoclaved or roasted) compared with control sample, while, ash and total carbohydrate content were opposite direction. This is mainly due to the lower content of protein and fat content in the replace ingredients. On the contrary, ash and total carbohydrates increased by increasing the replacement levels. These results are in agreement with those reported by Faheid *et al.* (1998).

Also, results in the same table indicated that moisture content and ether extract decreased after frying compared with fresh sausage treatments, while crude protein, ash and total carbohydrates increased. Crude protein content decreased in all treatments with increasing the levels of replacement levels for part meat by rehydrated soybean flour. The percentage of decreased for crude protein reached to 7.41 and 4.90% by replacement with soybean treated (autoclaved and roasted), respectively, at level 30% compared to control sample. But, increasing of crude protein after frying may be due to decrease in ether extract content (data calculated on dry weight basis) due to escape of some fats in cooking process and/or lowering of meat with increasing the level of replacement as mentioned by Nuzhat *et al.* (2002).

Data in Table (5) indicate the physico-chemical properties of beef sausage with series levels of rehydrated souybean flour replacement besides changes in TVN, TBA, pH value WHC, plasticity and cooking loss in prepared beef sausage. TVN amounted to 9.71 mg/100 g in fresh beef sausage (control) and increased after frying to 9.92 mg/100 g. Adding rehydrated soybean flour (treated with autoclaving) at levels from 10 to 30% in fresh or fried beef sausage decreased TVN to 6.65 and 6.90 mg/100 g. While reached to 6.94 and 7.10 mg/100 g in case using rehydrated soybean flour (treated with roasted). Also, TBA took the same trend and revealed 0.65 and 0.68 mg malonaldhyde/kg in fresh and fried beef sausage (control) and decreased to 0.45 to 0.49 mg/kg, respectively for autoclaved rehydrated soybean flour, while reached to 0.44 and 0.49 mg/kg for roasted rehydrated soybean flour. On the contrary pH value was 5.80 and 5.85 in fresh and fried beef sausage (control) and increased gradually to 6.07 and 6.09, respectively for autoclaved rehydrated soybean flour, while reached to 6.08 and 6.09 for roasted rehydrated soybean.

Concerning WHC it was 1.45 cm^2/0.3 g in fresh beef sausage (control) and decreased gradually to 0.65 and 0.55 cm^2/0.3 g sample preparing for autoclaved and roasted rehydrated soybean flour, respectively. Also, plasticity decreased from 3.15 to 1.95 and 1.80 cm^2/0.3 g for autoclaved and roasted rehydrated soybean flour, respectively. Cooking loss percentage was 14.49 in

Table (4): Chemical composition of beef sausage prepared with rehydrated soybean flour.

Replacement with soybean (%)		Moisture		Crude protein*		Ether extract*		Ash*		Carbohydrate*	
		Fresh	After frying	Fresh	After frying	Fresh	After frying	Fresh	After frying	Fresh	After frying
Control (0)		60.50	52.63	36.66	37.67	44.09	40.48	7.45	8.30	11.81	13.57
Autoclaving	10	59.80	51.76	35.05	36.85	43.89	38.15	7.51	8.65	13.56	16.36
	15	59.12	50.15	34.15	36.75	42.94	37.04	7.52	8.70	15.39	18.19
	20	58.87	49.84	32.65	35.47	42.39	36.43	7.54	8.81	17.43	19.30
	25	57.71	48.93	31.05	35.63	42.15	35.56	7.55	8.94	19.26	19.88
	30	57.41	48.63	29.25	34.27	41.90	34.45	7.60	9.00	21.25	22.28
Roasting	10	60.22	52.06	35.15	36.38	43.86	39.94	7.50	8.30	13.50	15.40
	15	59.74	52.25	34.32	35.99	42.65	38.35	7.53	8.72	15.50	16.95
	20	58.23	51.85	33.16	35.15	42.17	37.53	7.60	8.81	17.08	18.52
	25	57.78	51.21	32.04	34.13	41.64	36.39	7.63	8.82	18.69	20.67
	30	57.17	50.48	30.25	33.89	40.61	34.31	7.67	9.05	21.47	22.76

* (on dry weight basis)

Table (5): Physico-chemical of beef sausage prepared with rehydrated soybean flour.

Replacement with soybean (%)	TVN (mg/100 g)		TBA (mg/kg)		pH value		WHC (cm²/0.3 g)		Plasticity (cm²/0.3 g)		Frying loss (%)	
	Fresh	After frying	Fresh	After frying	Fresh	After frying	Fresh	After frying	Fresh	After frying	Fresh	After frying
Control (0)	9.71	9.92	0.65	0.68	5.80	5.85	1.55	-	3.15	-	14.49	-
Autoclaving 10	9.10	9.31	0.60	0.63	5.90	5.96	1.45	-	2.90	-	13.56	-
Autoclaving 15	8.45	8.70	0.58	0.62	6.00	6.03	1.40	-	2.70	-	10.28	-
Autoclaving 20	7.68	8.10	0.56	0.58	6.02	6.05	1.15	-	2.55	-	6.46	-
Autoclaving 25	7.20	7.60	0.50	0.55	6.04	6.07	0.85	-	2.20	-	5.46	-
Autoclaving 30	6.65	6.90	0.45	0.49	6.07	6.09	0.65	-	1.95	-	4.53	-
Roasting 10	9.23	9.60	0.58	0.64	6.01	6.04	1.50	-	2.95	-	14.59	-
Roasting 15	8.30	8.80	0.55	0.58	6.03	6.05	1.40	-	2.68	-	9.63	-
Roasting 20	7.80	8.24	0.50	0.56	6.04	6.06	1.30	-	2.45	-	6.24	-
Roasting 25	7.15	7.48	0.46	0.52	6.05	6.07	0.90	-	2.15	-	5.23	-
Roasting 30	6.94	7.10	0.44	0.49	6.08	6.09	0.55	-	1.80	-	4.49	-

TVN: Total volatile nitrogen   TBA: Thiobarbituric acid   WHC: Water holding capacity

fresh beef sausage (control) and decreased gradually to 4.53 and 4.49 for autoclaved and roasted rehydrated soybean flour, respectively. These results are in agreement with Moghazy *et al.* (2004).

Total volatile nitrogen (TVN), TBA, WHC, plasticity and cooking loss were decreased with increasing of replacement levels (0 to 30% soybean from meat used). Also, TBA was increasing after frying compared with fresh samples may be due to the decreased of moisture content because the results calculated on wet weight basis. The decrease of WHC and cooking loss were suitable characterization.

Data in Table (6) indicate that sensory evaluation (color, aroma, taste, texture, palatability and total scores) in beef sausage prepared in laboratory with replacement by soybean (0 to 30%). Results show that there are significant differences (P<0.05) for color, taste and total score between control sample and other treatments, except there is no significant differences (P>0.05) in aroma between control sample (0%) and treatments with replacement level 10% of soybean treated with autoclaved or roasted.

Anyhow, the soybean flour added to sausage samples could be separated into two groups, hence there is no significant differences (P>0.05) between any two samples with the same group. The first group includes sausage treatments replacement levels 10, 15 and 20% of soybean treated with autoclaved, while, at levels 10 and 15% of soybean treated with roasted.

The second group include sausage treatments replacement with 25 and 30% of soybean treated with autoclaved, while, 20, 25 and 30% for soybean roasted. In the same time there is significant difference (P<0.05) between the two groups.

Table (6): Sensory evaluation of beef sausage prepared with rehydrated soybean flour.

Treatment		Color	Aroma	Taste	Texture	Palatability	Total score
Control		9.7 ± 0.15^a	9.7 ± 0.15^a	9.7 ± 0.15^a	9.7 ± 0.48^a	9.7 ± 0.48^a	48.5 ± 2.22^a
Soyabean autoclaving	10	9.1 ± 0.10^b	9.1 ± 0.10^{ab}	9.1 ± 0.10^b	9.2 ± 0.42^{ab}	9.3 ± 0.48^{ab}	45.8 ± 1.32^b
	15	8.8 ± 0.13^{bc}	8.7 ± 0.15^{bc}	8.8 ± 0.13^b	9.1 ± 0.57^{ab}	8.9 ± 0.32^b	44.3 ± 1.49^b
	20	8.7 ± 0.21^{bc}	8.6 ± 0.15^{bc}	8.7 ± 0.15^{bc}	8.9 ± 0.71^b	8.7 ± 0.71^b	43.6 ± 2.50^b
	25	7.6 ± 0.31^d	7.6 ± 0.31^{de}	7.4 ± 0.31^d	7.3 ± 1.34^{de}	7.5 ± 1.08^d	37.4 ± 3.98^{cd}
	30	6.7 ± 0.21^e	7.1 ± 0.50^e	6.7 ± 0.26^e	6.9 ± 1.20^e	6.8 ± 0.92^{ef}	34.2 ± 4.16^e
Soyabean Roasting	10	9.0 ± 0.15^b	9.1 ± 0.10^{ab}	8.8 ± 0.13^b	8.8 ± 0.42^b	8.7 ± 0.67^{bc}	44.4 ± 1.35^b
	15	8.9 ± 0.18^b	8.6 ± 0.16^{bc}	8.7 ± 0.15^{bc}	8.6 ± 0.52^{bc}	8.7 ± 0.48^{bc}	43.5 ± 1.58^b
	20	8.4 ± 0.22^c	8.3 ± 0.30^{cd}	8.2 ± 0.20^c	8.0 ± 0.67^{cd}	8.1 ± 0.57^{cd}	41.0 ± 2.00^c
	25	7.3 ± 0.15^d	6.9 ± 0.31^e	7.3 ± 0.15^d	7.1 ± 0.88^d	7.2 ± 0.79^e	35.8 ± 2.86^{de}
	30	6.0 ± 0.30^f	6.1 ± 0.31^f	5.90 ± 0.23^f	6.40 ± 1.26^e	6.40 ± 0.97^f	30.80 ± 3.68^f
LSD		0.57	0.73	0.53	0.74	0.63	2.36

a, b, c, d, e & f: There is no significant difference between any two means, with the same attribute, have the same letter (P > 0.05).

So, it could be recommended to apply replacement level with 20% soybean treated with autoclaved from meat used in prepared sausage, 15% for used soybean roasted.

b) Beef burger:

Data in Table (7) show moisture, crude protein, ether extract, ash and total carbohydrate content in beef burger prepared in laboratory with replacement levels of rehydrated soybean flour treated with autoclaved or roasted (0, 10, 15, 20, 25 and 30%). Moisture content of fresh beef burger (control) was 66.79%, while it was ranged from 65.58 to 66.79% in all treatments. Moisture content decreased after frying in all treatments, where it ranged from 52.99 to 54.81%.

Crude protein and ether extract contents decreased with increasing the level of replacement by rehydrated soybean compared to control sample, while ash and total carbohydrates content were increased with increasing replacement levels (0 to 35%) for autoclaved or roasted treated.

Also, results in the same table indicate that moisture, crude protein, ash and total carbohydrate contents decreased after frying compared with fresh beef burger treatments, wherever, ether extract content increased.

Crude protein content decreased in all treatments with increasing the level of replacement for part meat used by rehydrated soybean flower (autoclaved or roasted). The percentage of decreasing reached to 6.31 and 7.64% for crude protein at level 30% for rehydrated soybean flower (autoclaved and roasted) compared to fresh control sample, while were 5.14 and 3.73% after frying, respectively. But, the decreasing of crude protein after frying may be due to increasing in ether extract content (data calculated on dry weight basis). These results are in agreement with Abd El-Salam and Hassanin (1987) and El-Mansy *et al.* (2002).

Data in Table (8) indicate the physicochemical properties of beef burger with series levels of rehydrated soybean replacement besides changes in TVN, TBA, pH value, WHC, plasticity, cooking loss and shrinkage in prepared beef burger.

Total volatile nitrogen (TVN) amounted to 9.75 mg/100 g in fresh beef burger and increased after frying to 10.80 mg/100 g. Adding rehydrated soybean treated with autoclaved at levels from 10 to 30% in fresh or fried beef burger decreased TVN to 5.60 and 6.50 mg/100 g, respectively, while reached to 6.40 and 7.15 mg/100 g, respectively for roasted rehydrated soybean. TBA took the same trend and revealed 0.50 and 52 mg malonaldhyde/kg in fresh and fried beef burger (control) and decreased to 0.37 and 0.39; 0.38 and 0.41 mg/kg, for autoclaved and roasted rehydrated soybean, respectively. On the contrary pH value was 5.42 and 5.65 in fresh and fried beef burger (control) and increased gradually to 5.55 and 5.85, respectively for autoclaved rehydrated soybean, while reached to 5.60 and 5.88, respectively for roasted rehydrated soybean. Concerning WHC it was 4.75 cm^2/0.3 g in fresh beef burger and decreased gradually to 2.60 and 4.20 cm^2/0.3 g sample preparing for autoclaved and roasted rehydrated soybean, respectively, While plasticity increased from 1.65 cm^2/0.3 g in control to 1.85 and 1.90 cm^2/0.3 g for autoclaved and roasted rehydrated soybean, respectively. Cooking loss percentage and shrinkage after frying were

Table (7): Chemical composition of beef burger prepared with rehydrated soybean flour.

Replacement with soybean (%)		Moisture		Crude protein*		Ether extract*		Ash*		Carbohydrate*	
		Fresh	After frying	Fresh	After frying	Fresh	After frying	Fresh	After frying	Fresh	After frying
Control (0)		66.79	54.81	54.09	48.76	17.81	21.41	7.31	7.10	20.79	22.73
Autoclaving	10	66.51	54.03	51.67	47.32	16.77	20.615	7.36	7.18	24.21	24.89
	15	66.49	53.29	50.13	46.97	15.66	19.86	7.38	7.24	26.83	25.94
	20	66.43	53.16	49.76	46.30	14.37	19.22	7.41	7.27	28.47	27.23
	25	66.15	53.14	48.34	46.42	13.72	18.20	7.42	7.31	30.53	28.08
	30	65.66	52.99	47.78	43.62	12.70	17.47	7.40	7.34	32.12	31.58
Roasting	10	66.73	53.91	51.06	49.20	16.47	19.08	7.38	7.03	25.11	24.71
	15	66.66	53.61	49.62	48.78	15.72	18.14	7.40	7.15	27.27	25.94
	20	66.26	53.42	48.97	47.41	14.54	17.52	7.42	7.18	29.08	27.90
	25	66.16	53.24	47.34	46.96	13.68	16.68	7.40	7.23	31.59	29.14
	30	65.58	53.20	46.45	45.03	12.96	16.16	7.42	7.29	33.18	31.53

* (on dry weight basis)

Table (8): Physico-chemical of beefburger prepared with rehydrated soybean flour

Replacement with soybean (%)		TVN (mg/100 g)		TBA (mg/kg)		pH value		WHC (cm²/0.3 g)		Plasticity (cm²/0.3 g)		Cooking loss (%)		Shrinkage after frying (%)
		Fresh	After frying	Fresh	After frying	Fresh	After frying	Fresh	After frying	Fresh	After frying	Fresh	After frying	
0		9.75	10.80	0.50	0.52	5.42	5.65	4.75	-	1.65	-	16.11	-	12.98
Autoclaving	10	9.50	10.30	0.48	0.49	5.44	5.69	4.50	-	1.65	-	14.25	-	11.98
	15	9.00	9.80	0.45	0.47	5.48	5.71	4.10	-	1.70	-	12.93	-	10.76
	20	8.10	8.20	0.42	0.45	5.50	5.76	3.40	-	1.75	-	12.56	-	9.27
	25	6.90	7.60	0.40	0.43	5.53	5.80	3.10	-	1.80	-	10.19	-	8.71
	30	5.60	6.50	0.37	0.39	5.55	5.85	2.60	-	1.85	-	9.62	-	7.76
Roasting	10	9.60	10.40	0.49	0.51	5.46	5.70	7.85	-	1.70		14.83	-	11.45
	15	9.25	10.00	0.45	0.48	5.51	5.75	8.05	-	1.75		13.2	-	10.41
	20	8.15	9.10	0.43	0.46	5.55	5.78	5.40	-	1.80	-	11.37	-	9.97
	25	7.10	8.00	0.41	0.43	5.58	5.82	4.70	-	1.85	-	10.88	-	7.79
	30	6.40	7.15	0.38	0.41	5.60	5.88	4.20	-	1.90	-	9.26	-	6.95

TVN: Total volatile nitrogen   TBA: Thiobarbituric acid   WHC: Water holding capacity

16.11 and 12.98 in fresh beef burger and decreased gradually to 9.62 and 7.76; 9.26 and 6.95 for autoclaved and roasted rehydrated soybean, respectively. These results are in agreement with El-Mansy *et al.* (2002) and Modi *et al.* (2003).

Data in Table (9) indicate that sensory evaluation (color, aroma, taste, texture, palatability and total scores) in prepared beef burger treatments in laboratory with replacement by soybean treated with autoclave or roaster (0 to 30%). Results indicated that there were no significant differences (P>0.05) for all properties tested except cut between control sample and all treatments at 15% replacement levels.

Table (9): Sensory evaluation of beef burger with rehydrated soybean flour.

Treatment		Color	Aroma	Taste	Texture	Palatability	Total score
Control		9.4±0.27[a]	9.1±0.20[a]	9.4±0.67[a]	9.4±0.52[a]	9.3±0.27[a]	46.6±2.26[a]
Soyabean autoclaving	10	9.2±0.21[a]	8.9±0.16[ab]	9.3±0.45[ab]	9.1±0.35[ab]	8.8±0.27[b]	45.3±1.65[ab]
	15	8.9±0.28[ab]	8.6±0.28[ab]	9.2±0.42[abc]	8.9±0.38[abc]	8.7±0.32[b]	44.3±2.48[abc]
	20	8.7±0.16[ab]	8.5±0.23[ab]	9.0±0.46[abc]	8.7±0.35[bcd]	8.6±0.25[b]	43.5±2.01[bc]
	25	8.5±0.21[b]	8.3±0.13[bc]	8.8±0.49[bcde]	8.2±0.46[def]	8.4±0.31[bc]	42.2±1.32[cd]
	30	8.3±0.36[b]	7.8±0.19[cd]	8.1±0.53[f]	7.6±0.62[ef]	8.1±0.35[cd]	39.9±2.14[de]
Soyabean roasting	10	9.3±0.19[a]	9.0±0.25[a]	9.3±0.53[ab]	9.3±0.42[ab]	8.7±0.35[b]	45.6±2.06[a]
	15	8.9±0.23[ab]	8.8±0.23[ab]	8.9±0.73[abc]	8.9±0.55[abc]	8.6±0.41[b]	44.1±2.47[abc]
	20	8.6±0.16[ab]	8.4±0.17[bc]	8.7±0.67[cde]	8.7±0.42[bcd]	8.5±0.19[bc]	42.9±1.74[bc]
	25	8.5±0.17[b]	8.3±0.19[bcd]	8.5±0.50[def]	8.3±0.46[cde]	8.2±0.13[bc]	41.8±1.46[cde]
	30	8.0±0.23[c]	7.7±0.27[d]	8.3±0.70[ef]	7.5±0.78[f]	7.7±0.42[d]	39.2±2.43[e]
LSD		0.81	0.60	0.53	0.70	0.44	2.86

a, b, c, d, e & f: There is no significant difference between any two means, with the same attribute, have the same letter (P > 0.05).

Anyhow, the treatment of beef burger samples could be separated into two groups, hence there is no significant differences (P>0.05) between any two samples with the same group. The first group includes beef burger treatments replacement levels 10, 15 and 20% of soybean treated with autoclave, while 10 and 15% of soybean treated with roaster.

The second group includes beef burger treatments replacement with 25 and 30% soybean treated with autoclaved, while 20, 25 and 30% soybean roasted. In the same time there is significant difference (P<0.05) between the two groups.

So, it could be recommended to apply replacement level with 20% soybean treated with autoclaved from meat used in prepared sausage and beef burger.

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إعداد بعض منتجات اللحوم باستخدام بذور فول الصويا
بعد إزالة المواد الضارة غذائيا منها

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أجريت هذه الدراسة بهدف إزالة المواد الضارة غذائيا من بذور فول الصويا
واستخدامه فى إنتاج السجق والبرجر البقرى. وجد أن محتوى البروتين لبـذور فـول
الصويا كانت ٤٤,٨٢%، بينما المواد الضارة: مثبط التربسين، مثـبط الكيموتربـسـن،
اللكتين، والمركبات الفينولية، وحمض الفيتيك كانت ٣١,٦ مجم/جم، ٣,٤٠ مجم/جم،
٧١٣ وحدة/جم، ٠,٧٥%، و ١,٢١% على التوالى.

وجد أن المعاملة بالأتوكلاف أزالت معظم المواد الضارة فيما عـدا حمـض
الفيتيك ولكن التحميص كان أكثر تأثيرا فى التخفيض.

تم استخدام دقيق بذور فول الصويا النـاتج بعـد المعاملـة بـالأتوكلاف أو
التحميص فى تصنيع السجق والبرجر البقرى وذلك بعد اسـترجاعها بالمـاء بنـسبة
(١ : ٢) (وزن : وزن) وتم الاستبدال بنسب صفر، ١٠، ١٥، ٢٠، ٢٥، و٣٠% من
كمية اللحم المستخدم فى التصنيع.

وأظهرت نتائج التحليل الكيماوى والتقييم الحسى للمنتجات المصنعة أنه يمكن
استخدام دقيق فول الصويا المعامل بالأتوكلاف حتى ٢٠% من اللحم المـستخدم فـى
إعداد السجق والبرجر البقرى لآنتاج منتج جيد الصفات الحسية.