J. Food and Dairy Sci., Mansoura Univ., Vol. 3 (7): 383 - 399, 2012

EFFECT OF ADDITION OF DIFFERENT TYPES OF SOYBEAN ON PROTEIN QUALITY OF PROCESSED KOFTA AND BURGER.

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ABSTRACT

The present work was carried out to study the effect of addition soybean products, namely Soy Protein Isolate (SPI) by substitution from meat at three levels (2, 3 and 4%), Textured Soy Protein (TSP) and Defatted Soy Flour (DSF) by substitution from meat at three levels (2.5, 3.75 and 5%) on protein quality of some meat products (kofta and burger). Processed meat products were evaluated chemically during frozen storage at -18˚C for 6 months. Results indicated that all processed kofta and burger formulas prepared with 2 and 3% SPI have the high amount of protein content being 20.05, 20.59 and 20.21, 20.71% respectively. Results of chemical analysis showed that total volatile nitrogen (TVN) of processed kofta and burger with different soy bean products was decreased in compare with control samples at zero time and during frozen storage periods. Also, TVN values were ascendingly increased as a result of freezing storage. TVN values of kofta were ranged from 11.96 mg/100g at zero time to 23.32 mg/100g for samples 6 months of frozen storage, while TVN values of burger were ranged from 11.61 to 21.75 mg/100g after 6 months of frozen storage respectively. Highest values of TSN were registered for kofta and burger samples substituted with 2 and 3% SPI which ranged from 0.86 to 0.38 and from 0.89 to 0.41 mg/100 gm sample, 0.80 to 0.35 and from 0.84 to 0.38 mg/100 gm sample at zero time and 6 months of frozen storage respectively in compare with control samples were 0.74 to 0.28 and from 0.69 to 0.24 mg/100 gm sample, Result of amino acids analysis indicated that the total amount amino acids in kofta samples ranged from 99.75 to 99.98(g/100g protein). Total essential amino acid (T.E.A.A.) were decreased in all processed kofta samples from 46.6 to 45.38 in compare with control sample, while the total amino acids in burger formulas ranged from 99.81 to 99.99 (g/100g protein). Total essential amino acid (T.E.A.A.) were decreased in all processed burger samples from 46.92 to 45.61 in compare with control sample, the predominate essential amino acids in both of kofta and burger formulas was lysine. Results indicated that restrict amino acid (RA) was tryptophan in kofta and burger formulas. Results of biological value (BV) indicated that samples of kofta processed with 2% SPI had (77.97) .While samples of burger processed with 2% SPI had (78.18). So, it could be recommended that substitution of meat by soy products SPI (2, 3%) and (2.5, 3.75%) of TSP and DSF could enhanced the protein quality of processed meat products.

Key word: Soy protein products (SPI – TSP – DSF) kofta – burger

INTRODUCTION

In recent years meat and meat products are important sources for protein, fat, essential amino acids, minerals and vitamins Non-meat proteins from a variety of plant sources including sunflower protein**,** corn germ flour and wild rice have been used as binders and extenders in comminuted meat products (Minerich *et al*., 1991). Plant and animal proteins are used in meat products to perform three basic functions: the first function is fat emulsification, the second is water retention, and the third is formation of

structure of meat products. (Minerich *et al*., 1991; Dzudie *et al*., 2002). Soybean is a highly nutritious food material that contains well balanced amino acids and desirable fatty acids and it plays an important role as a protein resource. Recently, many functions of soybeans have been in the spotlight, for example reducing the risk of heart disease, cancer, (FDA, 1999). In spite of many advantages of soybean, its use as a food material has been limited because of off – flavor such as beany flavor or green beany flavor generated during processing (king *et al* ., 2001 ; Mizutani and Hashimoto, 2004). Soybeans contain roughly 40% - 45% (w/w) of protein that is dependent upon the conditions under which they were grown (Lin, 1998), soy protein has been utilized by the food industry to serve as a replacement of animal protein (Lin *et al*., 2001). Soybeans contain all of the amino acids that are essential to human nutrition and contain less fat than animal foods (Henkel, 2004). Soy protein isolates (SPI) and texturized products are now used as a large variety of meat products. Soy proteins are added to meat products to enhance the emulsifying and water-binding capacity of meat proteins (Vránová, 2005). SPI is used in special meat nutrition products (sports nutrition and dairy products for hospital patients), snacks, weaning foods, and drinks (Kanyingi *et al*., 2006; Fadi *et al*., 2011).Consumer demands for nutritive, healthier meat and meat products with reduced level of fat, cholesterol, decreased contents of sodium chloride and nitrite, improved composition of fatty acid profile and incorporated health enhancing ingredients are rapidly increasing (Biesalski, 2005). So, this work was carried out to study the effect of processing different meat products by using high quality and low cost vegetable protein from soybean products, namely soy protein isolate (SPI), textured soy protein (TSP) and defatted soy flour (DSF) on protein quality of some meat products.

MATERIALS AND METHODS

Imported frozen beef meat from the shoulder cut was purchased from the local market of EL-Mansoura, Egypt. Soy protein products: Soy Protein Isolate (SPI 89.1% protein), Textured Soy Protein (TSP 52.96% protein) and Defatted Soy Flour (DSF 51.97%protein) were obtained from AL-Garas Company Alexandreia, Egypt.

Spices: namely celery, cubeb, cumin, nut mug, black pepper, cinnamon, cardamom and cloves were brought from local market of EL Mansoura-Egypt. Additives: salt, rusk, onion, burgole, whole fresh egg and tomato were obtained from the local market.

Chemicals: Trypolyphosphate, citric acid; mono sodium glutamate and sodium nitrate were obtained from El- Gomhuria for Trading in Medicines and Medical Supplies, EL-Mansoura, Egypt.

Preparation of different meat products:

The mixtures of meat and soybean products were prepared according to the ratio tabulated in Tables (1and 2).

Meat used in processing burger and kofta (control sample) were substituted with various types of soy bean products namely SPI, TSP and DSF at different ratios were 2, 3 and 4 SPI%, 2.5, 3.75 and 5% TSP and DSF

from different meat products according to (Ulu, 2004) and presented in Table (3)

Table (1): the formulas used for the kofta processing:

Formula	Meat	Hydrated SPI*	Hydrated TSP**	Hydrated DSF***
1	71.2%	---	---	---
2	61.2	10%	---	---
3	56.2	15%	---	---
4	51.2	20%	---	---
5	61.2	---	10%	---
6	56.2	---	15%	---
7	51.2	---	20%	---
8	61.2	---	---	10%
9	56.2	---	---	15%
10	51.2	---	---	20%

***SPI = Soy Protein Isolate **TSP = Textured Soy Protein ***DSF = Defatted Soy Flour**

Table (2): the formulas used for the burger processing:

Formula	Meat	Hydrated SPI	Hydrated TSP	Hydrated DSF
1	72.38%	---	---	---
2	62.38	10%	---	---
3	57.38	15%	---	---
4	52.38	20%	---	---
5	62.38	---	10%	---
6	57.38	---	15%	---
7	52.38	---	20%	---
8	62.38	---	---	10%
9	57.38	---	---	15%
10	52.38	---	---	20%

Table (3):burger and kofta formulas

Meat products	Burger	Kofta
Ingredient	**Weight %**	
Meat	65.38	64.2
Fat	7	7
Burgol	--	13.22
Tomato juice	7.55	--
Water	5.79	7.12
Whole fresh Egg	4.703	--
Onion	4.060	4.28
Rusk	2.64	--
Salt	2.00	1.9
*Spices	--	1.81
Black pepper	0.342	--
Trypolyphosphate	0.304	0.32
Monosodium glutamate	0.113	--
Citric acid	0.113	0.14
Sodium nitrate	0.005	0.01
Total	100	100

***Spices namely celery, cinnamon, cubeb, cumin, black pepper, cardamom, cloves and nut mug with the percentage of 56.06, 0.22, 22.44, 11.22, 5.62, 2.24, 2.2 and 0.22% respectively.**

Burger Processing

Lean beef meat and all ingredients were ground through Moulinex meat grinder model a15, soybean products rehydrated (1 part of SPI, TSP

and DSF hydrated in 4 and 3 parts of distilled water for 30 min) respectively. After mixing burger ingredients, each portion was needed for 30 min by hand to obtain homogeneous dough. The mixture was hand stuffed into a polyethylene film to form the beef burger and finally frozen at −18˚C for 6 months until further analysis. (Adisak 2010).

kofta Processing

Lean beef meat and all ingredients were ground through Moulinex meat grinder model a15, after mixing, the mixture was hand formulated and wrapped with polyethylene film according to the method described by Meltem(2005), then frozen at−18˚C for 6 months until further analysis.

Chemical analysis:

Protein was determined using microkeldahle method as described by A.O.A.C. (2000).

Total volatile nitrogen (TVN): was determined according to the method described by (Winton, 1958). While Total soluble nitrogen (TSN) was determined according to (Solviev, 1966).

Amino Acid Analysis: was carried out according to the method of (Smith, 2003; Ingos, 2007) by Amino Acid Analyzer model (AAA 400 INGOS Ltd) in Amino Acid Analyzer Lab at Chemistry laboratory, Faculty of Agriculture Cairo University, Egypt.

Tryptophan: was determined calorimetrically in the alkaline hydrolyses according to the method of Blauth *et al*., (1963), in Agriculture Research Center. Cairo. Egypt.

Protein efficiency ratio (PER) = - 0.684 + 0.456 Leucine – 0.047 Proline according to Alsmeyer *et al*., (1974) and Biological value (BV) = 49.9 + 10.53×PER (Michel and Block1946).

Amino acid score: was calculated using the scoring pattern suggested by Pellett and Young (1980) and expressed as mg amino acid per (g /protein).

Nutritional characteristics:

Total Energy (TE): calculated according to the following equation:

1 gram of protein = 4.0 k.cal.

1 gram of total carbohydrate = 4.0 k.cal.

1 gram of fat = 9.0 k.cal.

The total calories were expressed as kcal / gm sample.

Sensory evaluation: control, kofta and burger samples formulas substituted with 2, 3 and 4% of SPI, 2.5, 3.75 and 5% TSP and DSF were evaluated organolepticly according to Meilgard *et al*., (1991). 10 well trained panelists at Food industries Dept. Faculty of Agriculture, Mansoura University and Food Technology research center, El-Giza. Were requested to evaluate the taste, odor, color, texture and overall acceptability of the tested samples at zero time and during frozen storage at −18˚C for 6 months. They were asked to score all the organoleptic qualities in numerical system as follows: very good 9-8, 7-6, fair 5-4, poor 3-2 and very poor 1-0 respectively.

Statistical analysis:

Results of sensory evaluation were subjected to analysis of variance and least significant (LSD) at the 5% level of probability as reported by Snedecor and Cochran (1995)

RESULTS AND DISCUSSION

The gross chemical composition of raw materials:

Proximate chemical composition of raw materials used in meat products processing namely Beef meat and Soy bean products, Soy protein isolate (SPI), Textured soy protein and Defatted soy flour (DSF). The results in Table (4) revealed that moisture content in beef meat was

Table (4): Gross chemical composition of raw material used in meat products processing (on wet weight basis)

Raw material	Moisture	protein	Fat	Ash	Fiber	Carbohydrate	E.V (Cal / 100gm)
Beef Meat	67.53	20.08	10.37	1.52	—	0.5	175.65
SPI	6.06	89.1	0.7	3.26	0.6	0.28	363.82
TSP	7.05	52.96	1	6.5	3	29.49	338.8
DSF	8.08	51.97	1.03	6.42	3.5	29	333.15

***SPI = soy protein isolate **TSP = textured soy protein ***DSF = defatted soy flour**

Carbohydrates by difference.

67.53% while in other soy products were 6.06,7.05 and 8.08% in SPI, TSP and DSF respectively these results are in accordance with (Serrano *et al*., 2007) who found that of raw beef contained 63.72% moisture. While (Abbas and Ibrahiem 1998) found that DSF contained 6.58% moisture. Lowest value was 6.06% for SPI followed by TSP which recorded 7%. And (Fadi *et al*., 2011) reported that SPI contained 6.25% moisture and (Qammar *et al*., 2010) stated that TSP contained 7.1% moisture.

Results in the same Table also indicated that the crude protein ranged from 51.97 to 89.1% (on Wet Weight Basis), for DSF, TSP and SPI respectively, the lowest amount of protein content was detected in beef meat being 20.08% these results were confirmed with those given by (Kanyingi *et al*., 2006) who found that the protein content of (SPI) was 90 % and (Qammar *et al*., 2010) reported that protein content of (TSP) was 49.51 %. While Dikeman *et al*., (2006) found that Protein content of (DSF) was 50%. From obtained results in the same table the fat content was higher in meat beef 10.37% than other soy protein products these results are in agreement with (Weingartner, 1993) who mentioned that DSF contained 1% fat but (Qammar *et al*., 2010) found that TSP contained 1.1% fats. Also Fadi *et al*., (2011) stated that SPI contained 0.99 % fat. It could be also noticed that TSP had the highest content of ash being 6.5% followed by DSF and SPI which contained 6.42 % and3.26% while the lowest value of ash detected in beef meat (1.52%). These results are in agreement with those obtained by (Osheba *et al*., 2007) who reported that TSP contained 10% ash. While, DSF contained 6% ash. (Weingartner, 1993) reported that SPI contained 5.15% ash. Results in Table (4) also indicated that DSF contained the highest value of fiber (3.5%) followed by TSP which contained 3%, SPI contained lowest

value of fiber (0.6%). From the same results in Table (4) it revealed that TSP contained highest value of carbohydrates (29.49%) followed by DSF and beef meat which contained 29% and 0.5% respectively (on wet weight basis), SPI contained the lowest value of carbohydrates (0.28%). These results are in accordance with the results of (Osheba *et al*., 2007 and Aspinall, 1988) who mentioned that percentage of carbohydrate in TSP was 35.75%, and DSF 40 %. The obtained results in the same table also indicated that values of energy value content were ranged from (175.65 to 363.82Cal/100gm) (on Wet Weight basis). The highest value was found in SPI (363.82Cal/100gm), followed by TSP which contained (338.8 Cal/100gm). While, the lowest content was observed in beef meat (167.65 Cal/100gm).

Organoleptic evaluation of different meat formulas used in kofta and burger processing.

According to the results in Tables 5 and 6 of sensory properties for all processed kofta and burger formulas using soybean products, it could be noticed that the formulas contained meat substituted with 2 and 3% of SPI, 2.5 and 3.75 of TSP and DSF were more acceptable by the panelists in all sensorial properties (taste, odor, color, texture and overall acceptability), while the formulas processed by using the percentage of 4% from SPI, 5% from TSP and DSF were not accepted and have the low scores by the panelists. So, 2 and 3% of soy protein isolate (SPI), 2.5 and 3.75% textured soy protein (TSP) and defatted soy flour (DSF) were selected to use in processing kofta and burger and their products were evaluated for chemical and protein quality during prolonged frozen storage for 6 months at -18 ˚C

Table (5): Organoleptic evaluation of different meat formulas used in kofta processing

Comparison		Taste	Odor	Color	Texture	Overall acceptability
Control		7.9 ^{ab}	7.5 ^{a}	7.3 ^{a}	7.2 ^{cd}	7.4 ^{a}
*SPI	2%	8.3^{a}	8.0 ^{a}	7.2 ^{ab}	8.0 ^{a}	7.9^{a}
	3%	7.7^{abc}	7.4 ^{a}	6.6 ^{abc}	7.8 ^{ab}	7.0 ^{bcd}
	4%	7.1 ^{bcd}	7.1 ^{a}	6.4 ^{bc}	7.6 ^{abcd}	6.8 ^{bcd}
**TSP	2.5%	8.0 ^{ab}	7.7 ^{a}	7.0 ^{ab}	7.7 ^{abc}	7.6 ^{abc}
	3.75%	7.4 ^{abcd}	7.1 ^{a}	6.0 ^{c}	7.5 ^{abcd}	6.8 ^{bcd}
	5%	6.9 ^{cd}	6.7 ^{a}	5.8 ^{c}	7.1 ^{d}	6.5 ^{d}
***DSF	2.5%	8.2 ^{a}	7.8 a	7.1 ^{ab}	7.9 ^{a}	7.7 ^{ab}
	3.75%	7.3 ^{abcd}	7.2 ^{a}	6.4 ^{bc}	7.6 ^{abcd}	6.9 ^{bcd}
	5%	6.6 ^{d}	6.9 ^{a}	6.1 ^{c}	7.3 ^{bcd}	6.7 ^{cd}
LSD $_{at\ 5\%}$		0.65	N.S	0.57	0.38	0.62

a,b,c,d,e: Mean within the same raw with different superscription letters are significantly different (p≤0.05)

Table (6): Organoleptic evaluation of different meat formulas used in burger processing.

Comparison		Taste	Odor	Color	Texture	Overall acceptability
Control		7.6 ^{abc}	7.2 ^{a}	7.7 ^{a}	6.3 d	7.2 ^{abc}
SPI	2%	8.1 ^{a}	7.9 ^{a}	7.5 ^{ab}	7.6 a	7.6 ^{a}
	3%	7.5 ^{abc}	7.1 ^{a}	6.9 ^{abcd}	6.9 bcd	6.8 ^{abcd}
	4%	6.8 ^{cde}	6.8 ^{a}	6.7 ^{bcde}	6.8 bcd	6.4 ^{cd}
TSP	2.5%	7.7 ^{abc}	7.5 ^{a}	7.1 a^{bcd}	7.2 abc	7.3 ^{ab}
	3.75%	7.1 ^{bcde}	6.8 ^{a}	6.5 ^{cde}	6.5 cd	6.5 ^{bcd}

6.1 ^{d}	6.4 d	6.0 ^{e}	6.5 ^{a}	6.5 ^{de}	5%	
7.6 ^{a}	7.3 ab	7.3 ^{abc}	7.7 ^{a}	7.9 ^{ab}	2.5%	DSF
6.7 ^{bcd}	6.7 bcd	6.7 ^{bcde}	7.0 ^{a}	7.3 ^{abcd}	3.75%	
6.2 ^{d}	6.6 bcd	6.3 ^{de}	6.7 ^{a}	6.4 ^{e}	5%	
0.59	0.48	0.59	N.S	0.61	LSD at 5%	

a,b,c,d,e: Mean within the same raw with different superscription letters are significantly different (p≤0.05)

Changes in protein content of processed meat products using different types of soybean products during frozen storage at -18˚C for 6 months:

From Table (7), substitution of meat by 2 and 3% of SPI, 2.5 and 3.75% of TSP and DSF increased protein content in meat products, namely kofta and burger, this could be attributed to the high content in soybean products (90, 52 and 51% in SPI, TSP and DSF respectively) in compare with 20.94% in meat. All samples with 3 and 3.75% of different soy products had higher content of protein than those prepared with 2 and 3% of the same soy products. These results were in accordance with those given by Ulu (2004) and Adisak (2010). Also, data in Table (7) indicated that frozen storage slightly decreased gradually protein content of control and all different processed samples with soybean products. This may be due to the degradation of protein during frozen storage and the loss of some nitrogenous compounds caused by microorganism which resulted in breakdown of protein as reported by Abd El-salam (1978) and Ali (2001) and might be also due to the volatilization of some volatile nitrogenous compounds such as ammonia, in addition drip which separated during thawing which led to losses in water and protein (Ogino and Nanri, 1980 ; Hendriks *et al*., 2006)

Table (7): Protein content (%) of processed meat products using different types of soybean products during frozen storage at -18 ˚C for 6 months (on W.W.B).

Burger				Kofta				Comparison	
Storage Period per months									
6	4	2	Zero	6	4	2	Zero		
18.35	18.47	18.61	19.07	17.84	17.88	18.01	18.39	Control	
19.69	19.78	19.93	20.21	19.54	19.62	19.77	20.05	2%	SPI
20.27	20.37	20.46	20.71	20.1	20.23	20.3	20.59	3%	
18.87	18.94	19.13	19.41	18.28	18.44	18.52	18.81	2.5%	TSP
19.13	19.20	19.28	19.57	18.46	18.53	18.69	18.97	3.75%	
18.76	18.89	19.0	19.3	18.19	18.36	18.47	18.72	2.5%	DSF
18.98	19.08	19.22	19.48	18.35	18.45	18.61	18.88	3.75%	

***W.W.B: wet weight basis**

Changes in total volatile nitrogen (T.V.N):

Total volatile nitrogen (T.V.N) could be used as an indication of decomposition by bacteria and protein breakdown during the storage. (Moawad, 1995) Total volatile nitrogen is a mixture of many volatile nitrogenous compounds such as ammonia and other lower simple of mono-amines. From the results in Table (8), a decrease in TVN content in all prepared meat products formulas at zero time and during frozen storage was observed in compare with control samples and TVN values were pronouncedly increased as the time of frozen storage increased. The lowest TVN values were recorded at zero time for samples prepared with 3% SPI being 11.96 and 11.61 mg/100gm for kofta and burger respectively, while the highest values of TVN values were recorded after 6 months of frozen storage for samples, with 3.75% DSF being 23.32 and 21.75 mg/100gm for kofta and burger respectively. TVN values of processed kofta and burger formulas decreased by the increment of replacement ratio with soy protein products types from 2 to 3% SPI and from 2.5 to 3.75% TSP and DSF. During frozen storage TVN contents increased as the period of storage increased for all prepared formulas. These results are in agreement with those obtained by Abd-El-Aziz (2000), Osheba (2003) who reported that the increase in TVN during frozen storage of meat products could be due to the bacterial breakdown which associated with the formulation of some-alkaline substances such as ammonia, which confirmed by the rapid development in total nitrogen, these results are in accordance with Gill (2003) showed that total volatile base-nitrogen increased with the degree of spoilage due to several enzymatic processes, including deamination of amino acid, degradation of nucleotides and oxidation of amine

Table (8): Changes in total volatile nitrogen (mg/100gm sample) of processed kofta and burger using different types of soybean products during frozen storage at -18˚C for 6 months (on W.W.B).

Burger				Kofta				Comparison	
Storage Period per months									
6	4	2	Zero	6	4	2	Zero		
24.28	19.2	16.20	13.75	26.87	22.46	18.91	14.78	Control	
21.59	18.13	15.32	12.07	23.31	20.86	17.31	13.71	2%	SPI
20.23	17.72	14.34	11.61	22.61	20.23	16.5	11.96	3%	
21.46	18.56	1٥.63	1٣.56	23.49	21.02	17.58	13.91	2.5%	TSP
20.71	17.56	13.95	11.97	22.97	20.29	16.87	12.04	3.75%	
22	18.32	15.35	13.38	22.83	22.16	17.67	14.03	2.5%	DSF
21.75	18.09	15	13.18	23.32	20.71	17.23	13.77	3.75%	

Changes in total soluble nitrogen (T.S.N):

From data presented in Table (9), all kofta and burger samples substituted with 2 and 3% of SPI, 2.5 and 3.75% of TSP and DSF had higher values of TSN in compare with control samples at zero time and different periods of frozen storage up to 6 months.

Table (9): Changes in total soluble nitrogen (T.S.N.) (mg/100gm sample) of processed kofta and burger using different types of soybean products during frozen storage at -18˚C for 6 months

Burger				Kofta				Comparison	
Storage Period per months									
6	4	2	Zero	6	4	2	Zero		
0.24	0.38	0.53	0.69	0.28	0.42	0.59	0.74	Control	
0.35	0.48	0.61	0.80	0.38	0.53	0.68	0.86	2%	SPI
0.38	0.51	0.65	0.84	0.41	0.57	0.71	0.89	3%	
0.30	0.45	0.58	0.77	0.32	0.49	0.63	0.82	2.5%	TSP
0.34	0.48	0.62	0.79	0.36	0.51	0.67	0.85	3.75%	
0.28	0.42	0.55	0.74	0.30	0.46	0.61	0.79	2.5%	DSF
0.32	0.47	0.58	0.78	0.33	0.5	0.64	0.83	3.75%	

Moreover TSN values of both kofta and burger samples were descendingly decreased as a result of frozen storage possibly due to protein denaturation as well as to escape of soluble nitrogen with the separated drip as reported by Bayoumy (1986). From Table (9), TSN values ranged from 0.89 and 0.84 mg/100 gm for kofta and burger samples with 3% SPI at zero time respectively to 0.3 and 0.28 mg/100 gm for kofta and burger samples with 2.5% DSF after 6 months of frozen storage respectively. From the same Table, TSN values of all processed kofta and burger formulas increased by the increment of replacement ratio with soybean products from 2 to 3% SPI and from 2.5 to 3.75%TSP and DSF, this could be actually due to the high original crude soluble protein content of substituted meat products with soybean products as reported by Abd El-Aziz (1990).

Amino acids content of meat products as affected by frozen storage at -18 ˚C for 6 months:

The amino acids composition plays an important role in determine the nutritive value of protein. Changes in amino acid content in processed meat products namely kofta and burger stored at -18 ˚C for 6 months were presented in Tables 8 and 9. With regard to essential amino acids from Tables 7and 8 phenylalanine + tyrosine values increased in kofta and burger samples as a result of substitution of meat by soybean products while all other essential amino acids decreased in compare with control samples.

All essential amino acids were decreased in all kofta and burger as a result of frozen storage for 6 months in compare with control sample. On the other hand, non-essential amino acids decreased from its initial content at zero time and up to 6 months of frozen storage. From the same Tables (10 and 11), total essential amino acids was decreased from 47.1and 47.48 g/100g protein for kofta and burger control samples at zero time respectively to 44.96 and 45.21 g/100g protein for kofta and burger samples with 3.75% DSF. It could be also noticed that all essential amino acids in all processed kofta formulas were decreased in different ratios as result of frozen storage, the changes ranged from 46.99 to 44.77 g/100g protein for control sample and 3.75% substituted DSF samples after 6 months of frozen storage respectively.

The decrease of amino acids may be due to the loss of amino acids content in drip during thawing of samples, and also could be attributed to

chemical reaction between the free amino acids, and some other compounds such as, the reaction between formaldehyde and lipid oxidation products, also formation of sulphur compounds, there results were in agreement with those reported by Ogino and Nanri (1980) and Hendriks *et al*., (2006).

From data in Table (10) it is apparent that total amino acids content of kofta processed with SPI at level of 2 and 3% at zero time and after 6 months was 99.95, 99.98, 99.55 and 99.62 g/100g protein respectively distributed as 46.6, 46.35, 46.45 and 46.21 g/100g protein as essential amino acids and 53.35, 53.63, 53.1and 53.41 g/100g protein as non-essential amino acids respectively. Data showed that also the effect of frozen storage on the amino acids content in which the total essential amino acids was decreased considering to the initial content in kofta formulas processed with 2.5 and 3.75% DSF in compare with control sample. Data in Table (11) indicated that, total amino acids content of burger samples ranged from 99.99 g/100g protein for 3% SPI to 99.81 g/100g protein for 3.75% DSF at zero time respectively.

Also, at the same table, it is apparent that total amino acids content of burger processed with SPI at level of 2 and 3% at zero time and after 6 months was 99.96, 99.99, 99.59 and 99.63 g/100g protein respectively distributed as 46.92, 46.59, 46.81 and 46.48 g/100g protein as essential amino acids and 53.04, 53.4, 52.79 and 53.15 g/100g protein as non-essential amino acids respectively. The essential amino acids composition of kofta protein was presented in Table (10). Results showed that all essential amino acids were higher than those of the level in FAO/WHO protein pattern (2007) especially (lysine) except valine for kofta processed with 2.5% DSF, TSP and DSF at level of 3.75% was lower than those FAO/WHO protein pattern (2007). While (methionine and cystine) were lower than those FAO/WHO protein pattern (2007). Restrict amino acid (RA) was tryptophan being 1.02 to 1.19. From data presented in Table (11) for processed burger samples, it could be noticed that all essential amino acids of burger protein processed with soy products SPI, TSP and DSF showed high values compared with those of FAO/WHO protein references (2007) except valine for burger processed with 3.75% DSF was lower than those FAO/WHO protein pattern (2007).

Nutritional value and protein quality of processed kofta and burger formulas

The nutritive quality of protein is related to their content of amino acids, especially essential amino acids. Moreover, the nutritive value of any food protein was mainly depending upon its content of essential amino acid. As reported by Gertjan (2000). So, from data illustrated in Tables 12 and 13, it could be concluded that processed meat products namely kofta and burger are efficient in some essential amino acids and deficient in other essential amino acids namely, first limiting amino acid restrict amino acid (RA) was tryptophan. While second RAA was histidine. This deficiency in the aforementioned amino acids could be probably due to the added ingredients and the effect of frozen storage.

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Data in Tables 12 and 13indicated also that kofta and burger samples at zero time showed better protein as determined by biological value (BV) and Protein efficiency ratio (PER) especially formulas processed with both 2 and 3% SPI who showed somewhat better protein quality properties than those of other processed formulas. The present data also demonstrated that the protein of both of fresh kofta and burger samples is easily digested as indicated by the high protein efficiency (PER) ratio of 2.7 and 2.73 in control samples for kofta and burger, 2.67, 2.69, 2.63 and 2.66 in samples processed with 2 and 3% SPI respectively.

Table (12): Biological value of processed kofta using different types of soy bean products at zero time and 6 months of frozen storage at -18 ˚C.

Kofta															Comparison
DSF				TSP				SPI				Control			
3.75%		2.5%		3.75%		2.5%		3%		2%					
6 months	0 time	6 months	0 time	6 months	0 time	0 time	0 time	6 months	0 time	6 months	0 time	6 months	0 time		
1.01	1.02	1.05	1.08	1.09	1.11	1.13	1.15	1.12	1.14	1.13	1.16	1.17	1.19		Chemical score (CS)%
Trp 1.01	Trp 1.02	Trp 1.05	Trp 1.08	Trp 1.09	Trp 1.11	Trp 1.13	Trp 1.15	Trp 1.12	Trp 1.14	Trp 1.13	Trp 1.16	Trp 1.17	Trp 1.19		First limiting AA
Hist 2.75	Hist 2.77	Hist 2.8	Hist 2.81	Hist 2.78	Hist 2.80	Hist 2.88	Hist 2.89	Hist 2.86	Hist 2.88	Hist 2.94	Hist 2.95	Hist 3.15	Hist 3.16		Second limiting AA
2.54	2.56	2.57	2.58	2.53	2.54	2.55	2.57	2.63	2.63	2.65	2.67	2.69	2.7		PER*
76.6	76.68	76.92	77.06	76.5	76.64	76.71	76.96	77.55	77.55	77.76	77.97	78.22	78.29		BV**

PER* Protein efficiency ratio
BV Biological value**

Table (13): Biological value of processed burger using different types of soybean products at zero time and 6 months of frozen storage at -18 ˚C.

burger														Comparison
DSF				TSP				SPI				Control		
3.75%		2.5%		3.75%		2.5%		3%		2%				
6 months	0 time	6 months	0 time	6 months	0 time	0 time	0 time	6 months	0 time	6 months	0 time	6 months	0 time	
1.11	1.12	1.11	1.14	1.11	1.13	1.16	1.17	1.15	1.16	1.17	1.2	1.19	1.22	Chemical score (CS)%
Trp 1.10	Trp 1.12	Trp 1.11	Trp 1.14	Trp 1.11	Trp 1.13	Trp 1.16	Trp 1.17	Trp 1.15	Trp 1.16	Trp 1.17	Trp 1.12	Trp 1.19	Trp 1.22	First limiting AA
Hist 2.78	Hist 2.79	Hist 2.83	Hist 2.84	Hist 2. 80	Hist 2.82	Hist 2.86	Hist 2.87	Hist 2.95	Hist 2.96	Hist 3.04	Hist 3.05	Hist 3.17	Hist 3.19	Second limiting AA
2.57	2.58	2.59	2.6	2.56	2.57	2.57	2.59	2.66	2.66	2.68	2.69	2.72	2.73	PER
76.96	77.02	77.13	77.26	76.81	76.92	77.02	77.13	77.87	77.87	77.77	78.18	78.6	78.7	BV

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تأثيراضافة صور مختلفة من فول الصويا على جودة البروتين للكفتة صوالبرجصصر

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أجريت هذه الدراسة بغرض دراسة تاثير اضافة منتجات فول الصويا وهي معزول بروتين فول الصويا (SPI) بالاستبدال من اللحم بنسب 2، 3 4% ، مجروش فول الصويا (TSP) ودقيق فول الصويا (DSF) بالاستبدال من اللحم بنسب 2.5،3.75 و 5% على جودة البروتين لبعض منتجات اللحم مثل البرجر والكفتة.

تم التقييم الكيميائي لمنتجات اللحم المصنعة خلال التخزين المجمد على-١٨°م لمدة ٦ أشهر. وقد أظهرت نتائج تحليل البروتين أن استبدال اللحم بنسبة 2و 3% من معزول بروتين الصويا (SPI) أدى الى زيادة محتوى البروتين في عينات الكفتة والبرجرفكانت ٢٠,٠٥, ٢٠,٥٩, ٢٠,٢١ و ٢٠,٧١ % على التوالي. أظهرت نتائج التحليل الكيماوي أن قيم المركبات النيتروجينية الطيارة (TVN) في خلطات الكفتة والبرجر المصنعة من مختلف منتجات فول الصويا كانت أقل مقارنة بعينات الكنترول في بداية التصنيع وخلال فترات التخزين أيضا تزايدت تصاعديا قيم المركبات النيتروجينية الطيارة (TVN) نتيجة التخزين بالتجميد تراوحت قيم (TVN) لخلطات الكفتة المصنعة بالاستبدال من ١١,٩١ملجم /١٠٠جم بداية التصنيع الى ٢٣,٣٢ ملجم / ١٠٠جم للعينات بعد ٦ شهور من التخزين بالتجميد, بينما تراوحت قيم (TVN) للبرجر من ١١,٦١ملجم / ١٠٠جم للعينات المصنعة في بداية التصنيع الى ٢١,٧٥ ملجم / ١٠٠جم للعينات المصنعة بعد ٦ شهور من التخزين المجمد على التوالي.

أعلى قيم للنيتروجين الذائب الكلي (TSN) سجلتها منتجات الكفتة والبرجر المصنعة بالاستبدال بنسبة 2و 3% من معزول بروتين فول الصويا (SPI) وتراوحت ٠,٨٦ من ٠,٣٨ و ٠,٨٩ الى ٠,٤١ ملجم / ١٠٠جم , ٠,٨٠ الى ٠,٣٥ و ٠,٨٤ الى ٠,٣٨ ملجم/ ١٠٠جم مقارنة بعينة الكنترول والتي تراوحت من ٠,٧٤ الى ٠,٢٨ و ٠,٦٩ الى ٠,٢٤ ملجم / ١٠٠جم في بداية التصنيع وبعد ٦ شهور من التخزين بالتجميد على التوالي مقارنة بعينة الكنترول , التي تم فيها استبدال اللحم بنسبة 3% من معزول بروتين الصويا والتي تراوحت من ١١,٩٦ و١١,٦١ ملجم / ١٠٠جم . أوضحت نتائج تحليل الاحماض الامينية أن محتوى عينات الكفتة تراوحت من ٩٩,٧٥ الى ٩٩,٩٨ جم/ ١٠٠جم بروتين بينما انخفضت نسبة الاحماض الامينية الاساسية من 46.6 الى 45.38 جم/ ١٠٠جم بروتين, مقارنة بالعينة الكنترول. بينما الاحماض الامينية في عينات البرجر تراوحت من ٩٩,٨١ الى ٩٩,٩٩ جم/ ١٠٠جم بروتين بينما انخفضت نسبة الاحماض الامينية الاساسية من 46.92 الى 45.61 جم/ ١٠٠جم بروتين, مقارنة بالعينة الكنترول وكان أعلى حمض اميني أساسي في كلا من خلطات الكفتة و البرجر المصنعة هو الليسين وأوضحت النتائج أن الحامض الأميني المحدد هو التربتوفان في كلا من خلطات الكفتة والبرجر المصنعة وأن قيمة الاستفادة الحيوية لعينات الكفتة المصنعة بالاستبدال بنسبة 2% من معزول فول الصويا (SPI) كانت (77.97) بينما كانت لعينات البرجر المصنعة بالاستبدال بنسبة 2% من (SPI) كانت(78.18) لذا توصي الدراسة باستخدام معزول فول الصويا (SPI) واضافتها لمنتجات اللحوم بنسبة 2 و 3% بالاستبدال من اللحم ومجروش فول الصويا(TSP) ودقيق فول الصويا (DSF) بالاستبدال من اللحم بنسب 2.5،3.75% لتحسين جودة بروتين منتجات اللحوم المصنعة.

قام بتحكيم البحث

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Table (10): Amino acids composition (g/100g protein) of processed kofta using different types of soybean products at zero time and 6 months of frozen storage at -18 ˚C.

Essential Amino acid	Control		SPI				TSP				DSF				/FAO WHO/UNU 2007
			2%		3%		2.5%		3.75%		2.5%		3.75%		
	0 time	6 months	0 time	6 months	0 time	6 months	0 time	6 months	0 time	6 months	0 time	6 months	0 time	6 months	
Lysine	9.02	9	8.67	8.65	8.56	8.55	58٨,	55٨,	8.52	8.5	8.64	8.62	8.6	8.58	5.5
Leucine	7.93	7.91	7.87	7.84	7.8	7.78	7.64	7.62	7.58	7.56	7.67	7.65	7.61	7.58	7.0
Isoleucine	5.03	5.02	4.88	4.87	4.79	4.78	4.69	4.66	4.61	4.6	4.75	4.72	4.67	4.65	4.0
Valine	5.21	5.19	5.11	5.09	5.09	5.06	5.06	5.02	4.99	4.95	5.01	4.98	4.95	4.92	5.0
Phenylalanine + Tyrosine	7.96	7.92	8.65	8.59	8.87	8.83	8.4	8.37	8.46	8.42	8.34	8.3	8.3	8.24	6.0
Threonine	4.17	4.12	3.95	3.9	3.86	3.81	3.88	3.87	3.78	3.72	3.79	3.72	3.72	3.67	4.0
Histidine	3.16	3.15	2.95	2.94	2.88	2.86	2.89	2.88	2.8	2.78	2.81	2.8	2.77	2.75	-
Methionine + Cystine	3.43	3.51	3.36	3.44	3.36	3.42	3.35	3.42	3.37	3.43	3.29	3.34	3.32	3.37	3.5
Tryptophan	1.19	1.17	1.16	1.13	1.14	1.12	1.15	1.13	1.11	1.09	1.08	1.05	1.02	1.01	1.0
Total E.A.A.	47.1	46.99	46.6	46.45	46.35	46.21	45.64	45.52	45.22	45.05	45.38	45.18	44.96	44.77	
Glutamic	17.05	17.02	17.8	17.77	18.11	18.08	18.36	18.34	18.53	18.5	18.48	18.44	18.56	18.53	
Aspartic	9.31	9.25	9.49	9.44	9.63	9.58	9.57	9.52	9.69	9.64	9.62	9.59	9.77	9.71	
Argnine	6.33	6.3	6.61	6.59	6.85	6.82	6.69	6.65	6.87	6.83	6.76	6.73	6.88	6.85	
Proline	5.07	5.05	5.16	5.14	2.5	18.5	5.15	5.13	5.18	5.15	5.11	5.08	5.17	5.14	
Alanine	5.76	5.74	4.94	4.91	4.61	4.59	4.85	4.82	4.69	4.66	4.93	4.9	4.78	4.76	
Serine	4.22	4.15	5.08	5.01	5.21	5.16	1٥,	03٥,	5.27	5.2	5.13	5.07	5.3	5.26	
Glycine	5.06	5.02	4.27	4.24	4.02	4.0	4.48	4.45	4.37	4.34	4.42	4.4	4.33	4.3	
Total N. E.A.A.	52.8	52.53	53.35	53.1	53.63	53.41	54.2	53.94	54.6	54.32	54.45	54.21	54.79	54.55	
Total Amino acid	99.9	99.52	99.95	99.55	99.98	99.62	4٩٩,٨	46٩٩,	99.82	99.37	99.83	99.39	99.75	99.32	

Table (11): Amino acids composition (g/100g protein) of processed burger using different types of soybean products at zero time and 6 months of frozen storage at -18 ˚C.

Essential Amino acid	Control		SPI*				TSP**				DSF***				/FAO WHO/ UNU 2007
			2%		3%		2.5%		3.75%		2.5%		3.75%		
	0 time	6 months	0 time	6 months	0 time	6 months	0 time	6 months	0 time	6 months	0 time	6 months	0 time	6 months	
Lysine	9.15	9.14	8.86	8.85	8.69	8.68	71ᴧ,	69ᴧ,	8.58	8.57	69ᴧ,	68ᴧ,	8.54	8.53	5.5
Leucine	8.03	8.02	7.94	7.93	7.88	7.87	7.7	7.68	7.67	7.66	7.72	7.7	7.7	7.67	7.0
Isoleucine	5.07	5.05	4.94	4.93	4.83	4.82	4.74	4.73	4.63	4.62	4.76	4.74	4.64	4.65	4.0
Valine	5.29	5.27	5.17	5.16	5.11	5.1	5.15	5.13	5.05	5.01	5.1	5.08	5.00	4.96	5.0
Phenylalanine + Tyrosine	7.81	7.75	8.39	8.32	8.74	8.69	8.22	8.18	8.35	8.3	8.2	8.16	8.32	8.29	6.0
Therionine	4.12	4.08	3.89	3.85	3.78	3.72	3.84	3.79	3.8	3.75	3.78	3.72	3.73	3.67	4.0
Histidine	3.19	3.17	3.05	3.04	2.96	2.95	2.87	2.86	2.82	2.8	2.84	2.83	2.79	2.78	--
Methionine + Cystine	3.6	3.66	3.48	3.56	3.44	3.5	3.43	3.5	3.41	3.47	3.38	3.45	3.35	3.43	3.5
Tryptophan	1.22	1.19	1.2	1.17	1.16	1.15	1.17	1.16	1.13	1.11	1.14	1.11	1.12	1.10	1.0
Total E.A.A.	47.48	47.33	46.92	46.81	46.59	46.48	45.83	45.72	45.44	45.29	45.61	45.47	45.21	45.08	
Glutamic	17.13	17.1	17.71	17.68	17.86	17.83	18.33	18.31	18.46	18.44	18.36	18.33	18.5	18.48	
Aspartic	9.18	9.13	9.33	9.26	9.65	9.6	9.54	9.48	9.74	9.68	9.6	9.55	9.75	9.68	
Argnine	6.21	6.18	6.57	6.55	6.74	6.72	6.65	6.62	6.73	6.71	6.71	6.68	6.8	6.78	
Proline	5.09	5.07	5.17	5.15	33.5	31.5	5.16	5.14	5.22	5.2	5.13	5.12	5.19	5.18	
Alanine	5.62	5.6	4.89	4.87	4.54	4.52	4.83	4.81	4.66	4.64	4.88	4.85	4.69	4.67	
Serine	4.13	4.07	5.03	4.97	5.19	5.11	1ᵒ,	02ᵒ,	5.21	5.17	06ᵒ,	01ᵒ,	5.16	5.1	
Glycine	5.1	5.07	4.34	4.31	4.09	4.06	4.47	4.44	4.4	4.37	4.49	4.46	4.51	4.49	
Total N. E.A.A.	52.46	52.22	53.04	52.79	53.4	53.15	54.08	53.82	54.42	54.21	54.23	54	54.6	54.38	
Total Amino acid	99.94	99.55	99.96	99.59	99.99	99.63	91⁹⁹,	54⁹⁹,	99.86	99.5	99.84	99.47	99.81	99.46	