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QUALITY ATTRIBUTES OF SOME SAUSAGE LIKE- PRODUCTS

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ABSTRACT

This research addresses the consumer driven need for the development of a healthy substitute to the traditional popular sausage which contains very high levels of saturated fat. Organoleptic evaluation of twelve formulas of like-sausages produced from oyster mushroom as main ingredient where six of them had different levels of texture soy protein (TSP) and other six had different levels of peas. Then, the quality attributes such as, chemical composition, physicochemical properties, physical properties, texture profile analysis and nutritional characteristics were evaluated. Obtained results showed that most values of organoleptic evaluation of the mushroom-pea formulas were higher than the corresponding values recorded for TSP. Using both TSP and peas conduce increased protein content in like-sausage formulas. The TVN and TBA for all like-sausage formulas were within the Egyptian standard requirements. By increasing the levels of TSP or peas the water holding capacity and cooking yield significantly increased. Texture properties of like-sausage are affected by levels of TSP and peas. Data proved that increasing the levels of TSP or peas in like-sausage led to increase the total energy and decrement GDR of protein and GDR of energy. The results indicated that mushroom, TSP and peas can be utilized in production sausage alternative of the traditional sausage.
Keywords: Like-sausages, oyster mushroom, TSP, peas, alternative.

INTRODUCTION

Resently, consumers are very concern about their diet and the food they eat. With the demand for nutritious and healthy food products, the researchers have to focus their creation towards utilization of plant sources such as soybean, chick pea, and mushroom in preparing meat like products with high nutritional value and quality and at the same time with low price (Kumar and Sharma, 2004).

It is well known that, the food industry does not only use the meat muscle but also other sections of the animal such as fat (Pearson and Gillett 1996). From a health point of view, an excessive intake of meat products such as sausage and burger cannot be recommended, especially for certain population groups sausage and burger because of their significant fat content, cholesterol and a higher proportion of saturated fatty acids than poly unsaturated fatty acids (Muguerza *et al.,* 2004; Cengiz and Gokoglu 2005).

Therefore, the meat alternatives market is a fast-growing food market sector. Over the last 20 years, novel purified protein isolates or concentrated protein fractions from non-traditional sources, e.g. wheat, soybeans, peas and mycoprotein have been developed. These are used for the development of new products that resemble meat products in their texture, color, flavor, taste and even shape.

Vegetable proteins have a lower price than meat proteins and therefore, it can be led to reduce the cost of the meat product (Singh *et al.,* 2008).

Mycoprotein can be used as a high-protein, low-fat, health-promoting food ingredient and has a good taste and texture. Mushrooms are considered as the most famous mycoprotien and could be called "Poor man's Protein" due to their high content of proteins, vitamins and minerals (Pandey 2004). Moreover, many medicinal properties have been attributed to mushrooms, such as reduction of blood cholestrol levels, prevention or alleviation of heart diseases and reduction of blood glucose levels and affect liver enzymes positively (Bobek *et al.,* 2001; Jayakumar *et al.,* 2006 and El-Refai *et al.,* 2011).

Edible mushrooms can be used as an alternative protein source to meat products (Asgar *et al.,* 2010). The addition of oyster mushroom at 25% can be recommended for incorporation in beef patties and permit a reduction of the formulation cost without affecting sensory characteristics of the product to which the consumer is familiarized (Wan Rosli and Solihah, 2012).

Pulses (soybean, peas, chick- peas and lentil) contain high amounts of lysine, leucine, aspartic acid, glutamic acid, and arginine and provide well-balanced essential amino acid profiles when consumed with cereals and other foods rich in sulfur-containing amino acids (Boye *et al.,* 2010).

Pulses are highly nutritious seeds of pod-bearing leguminous plants, specifically dry peas, lentils, and chickpeas. Moreover, it provide tremendous opportunities to be utilized in the processed foods such as bakery products, bread, pasta, snack foods, soups, cereal bar filing, tortillas, meat, etc. (Asif *et al.*, 2013). In addition, soy proteins can provide functional properties to a formulation such as gelling/textural capabilities, fat emulsification, and water binding. Studies show that peas proteins may be a good substitute for soybean proteins as a functional additive in food products intended for human consumption (Aluko *et al.*, 2009 and Barac *et al.*, 2010).

The aim of this investigation is to study the possibility of producing new blends of sausage supplemented with different levels of vegetarian sources, then evaluation their chemical , physical and sensory properties were achieved to get the best alternative to traditional sausage products.

MATERIALS AND METHODS

Materials

Fresh oyster mushroom (*Pleurotus ostreatus*) was obtained from Mas Mushroom Farm, Mansoura city, Dakahlia governorate, Egypt. Textured Soy Protien (TSP) was obtained from Food Technology Research Institute, Agricultural Research Center, Giza governorate, Egypt. Peas (*Pisum sativum* L.), sunflower oil, other ingredients such as spices mixture (black pepper, cummin, cardamon, cloves, nutmeg, red peppers, ginger and mustard), salt, starch, onion powder and garlic powder were obtained from local market, Mansoura, Dakahlia governorate, Egypt.

Emulsifier agent contains mono-diglyceride of fatty acids E471, cellulose gum E466, locust bean gum E410, guar gum E412 and carrageenan E407. The emulsifier was obtained from Al-Amreety Co. for Importing Edible Materials, Mansoura city, Dakahlia governorate, Egypt.

Import cellulose casing was obtained from EL-Qasaby Factory of Meat Products, Talkha, Dakahlia governorate, Egypt.

Methods

Preparation of oyster mushroom:

Oyster mushrooms were washed by tap water, chopped coarsely and steamed at 100°C for 20 min to eliminate bitter taste. Excess water in the mushrooms was removed by centrifugation at 700 rpm for 5 min according to **Chockchaisawasdee *et al.* (2010).**

Preparation of peas:

Peas seeds were cleaned and ground twice using an experimental mill. The powder was put into autoclave for 30 min then was partially dried into dry oven at 80°C for 2 hours after that was put in polyethylene bags and kept in refrigeration at 4°C.

Preparation of pre-emulsified oil:

Sunflower oil was pre-emulsified on the day of use. In this process, ten parts of hot oil were mixed for 2 min with one part of emulsifier type Palsgaard. Then the mixture was emulsified with eight parts of water for 3 min. This procedure was achieved as a modification for the method described by HoogenKamp (1989 a,b) and Hammer (1992).

Preparation of like sausage products:

The mixtures of oyster mushroom with Textured Soy Protein and mushroom with peas' products were prepared according to the ratios tabulated in Table (1).

Table (1): Oyster mushroom / textured soy protein (TSP) or peas ratios of formulas used for like sausage product.

Oyster mushroom : TSP or peas	75:25	65:35	55:45	45:55	35:65	25:75
Oyster mushroom % in formulas	48	41.6	35.2	28.8	22.4	16
TSP or peas % in formulas	16	22.4	28.8	35.2	41.6	48

Table (2): Formulas used for like-sausage processing

Formula	Mushr-oom	TSP	Peas	Emulsi-fied oil	Starch	Spices	Salt	Water	Onion powder	Garlic powder
MS1	48	16	_	18	3	1.5	2	10	1	0.5
MS2	41.6	22.4	_	18	3	1.5	2	10	1	0.5
MS3	35.2	28.8	_	18	3	1.5	2	10	1	0.5
MS4	28.8	35.2	_	18	3	1.5	2	10	1	0.5
MS5	22.4	41.6	_	18	3	1.5	2	10	1	0.5
MS6	16	48	_	18	3	1.5	2	10	1	0.5
MP1	48	_	16	18	3	1.5	2	10	1	0.5
MP2	41.6	_	22.4	18	3	1.5	2	10	1	0.5
MP3	35.2	_	28.8	18	3	1.5	2	10	1	0.5
MP4	28.8	_	35.2	18	3	1.5	2	10	1	0.5
MP5	22.4	_	41.6	18	3	1.5	2	10	1	0.5
MP6	16	_	48	18	3	1.5	2	10	1	0.5

MS1: 75% mushroom+25% Texture Soy Protein (TSP). MS2: 65% mushroom+35%TSP. MS3: 55% mushroom+45% TSP. MS4: 45% mushroom+55% TSP. MS5: 35% mushroom+65% TSP. MS6: 25% mushroom+75%TSP. MP1: 75% mushroom+25% Peas. MP2: 65% mushroom+35% Peas. MP3: 55% mushroom+45% Peas. MP4: 45% mushroom+55% Peas. MP5: 35% mushroom+65% Peas. MP6: 25% mushroom+75% Peas.

Oyster mushroom was ground through Moliniex grinder, then the other ingredients were added to it as shown in Table (2), then the whole mix was ground again. The mixtures were stuffed into cellulose casing, linked and tied (8-9 cm length, 1.5-1.8 diameter and 30-33 g weight).

Cooking method:

Sausage was cooked in water at 100°C for 10 min to determine the texture properties and cooking properties then, sausage samples were fried in sunflower oil at 160°C for 5 min.

Organoleptic evaluation:

Fifteen panelists at Food Industries Dept., Fac. of Agric., Mansoura Univ. evaluated 12 samples of the prepared cooked like-sausage products. The panelists were asked to evaluate the taste, odor, color, texture and overall acceptability. The test panel used a nine point as follows: very good 8-9, good 6-7, fair 4-5, poor 2-3 and very poor 0-1 according to **Meilgaard *et al.* (1991).** Then, the quality attributes of the chosen formulas were evaluated.

Analytical methods:

Gross chemical composition:

Moisture, crude protein, fat, ash and sodium chloride% contents were determined according to A.O.A.C. (2005). Total carbohydrates content was calculated by difference.

Chemical properties:

Total volatile nitrogen (TVN) was determined as the method of Pearson (1968). Total soluble nitrogen (TSN) was determined according to the method described by Soloviev (1966). All obtained results were expressed as mg per 100g sample.

Thiobarbituric acid (TBA) was colorimeterically determined as described by Krik and Sawyer (1991)

Physicochemical properties:

pH values were measured by using pH meter type CG 710 as described by Fernandez *et al.* (2008).

The water activity (a_w) was calculated by using the following described equation by Demeyer (1979).

$a_w = 1.0014 - 0.6039\ x.$, when If $x < 0.1755$.

$a_w = 1.0288 - 0.7614\ x.$, when If $x > 0.1755$.

where: $x = \%NaCl / \%H_2O$.

Physical properties:

Water holding capacity (WHC) and plasticity were measured by pressing method of Volovinskaja and Merkoolova (1958).

Cooking loss of prepared samples was determined and calculated according to the following equation described by A.M.S.A. (1995).

$$\%\ \text{Cooking loss} = \frac{\textit{Raw sample weight} - \textit{Cooked sample weight}}{\textit{Raw sample weight}} \times 100$$

Cooking yield was calculated according to El-Magoli *et al.* (1996) as follows:

$$\% \text{ Cooking yield} = \frac{(\text{cooked weight} \times 100)}{\text{Raw weight}}$$

Protein-water coefficient (PWC) and protein-water-fat coefficient (PWFC) were calculated according to Tsuladze (1972).

$$\text{PWC} = \frac{\% \text{ protein}}{\% \text{ moisture}} \quad \& \quad \text{PWFC} = \frac{\% \text{ protein}}{\% \text{ moisture} + \% \text{ fat}}$$

Feder value was calculated according to **Peasrson (1970),** using the following equation:

$$\text{Feder value} = \frac{\% \text{ moisture}}{\% \text{ organic non fat}}$$

where:

% organic non-fat = 100 – (% Moisture + % Fat + % Ash).

Texture profile analysis:

Texture was determined by a universal testing machine (Cometech, B type, Taiwan) provided with software. An Aluminum 25 mm diameter cylindrical probe was used in a "Texture profile analysis" (TPA) double compression test to penetrate to 50% depth, at 1 mm/s speed test. Firmness (N), chewiness (N), cohesiveness, springiness and resilience were calculated from the TPA graphic (Bourne, 2003) at Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.

Nutritional characteristics:

Total Energy (TE) was calculated according to A.O.A.C (2005) using the following equation:

Total Energy = (% protein x 4.1) + (% carbohydrate x 4.1) + (% fat x 9.1).

The total calories were expressed as Kcal / 100 gm sample.

The amount of different formulas in grams consumed to cover the daily requirements (GDR) for adult man (19 to 30 years) of protein (56 gm) or energy (2900 Kcal) were calculated according to Recommended Dietary Allowances (R.D.A., 2012) by the following equation:

$$GDR \text{ of protein} = \frac{RDA \text{ of protein}}{\% \text{ protein}} \times 100$$

$$GDR \text{ of energy} = \frac{RDA \text{ of energy}}{\% \text{ energy}} \times 100$$

Statistical Analysis:

Data obtained were analyzed using one way analysis of variance. All statistical analysis were performed according to SAS (2006).

RESULTS AND DISCUSSION

Chemical composition of raw materials used in like-sausage products processing:

The chemical composition of tested raw materials is shown in Table (3). The obtained results showed that, steaming mushroom had lower contents of protein, fat, and ash, but had higher value of carbohydrates, comparing to fresh mushroom (on dry weight basis). The low protein content of steaming mushroom could be attributed to Millard reaction. Also, the low fat content might be due to the reaction between fat and reducing sugars. Furthermore, the high in carbohydrates content could be attributed to the increase in fiber. Similar trends have been reported by Medany (2004) and Abd Rabo (2011) on dried mushroom.

As shown in Table (3), the chemical composition of fresh mushroom is in harmony with those of Abd Rabo (2011). The moisture content of steaming mushroom is more close to the value given by Chockchaisawasdee *et al.* (2010) being 76.96% .

The chemical composition of TSP is on line with those obtained by Ziena (2000). While, Hassan (2010) found that defatted soy flour contained 8.31% moisture, 51.51 % crude protein, 6.19 % crude fat, 7.55 % total ash and 34.75% total carbohydrates (on dry weight basis).

Table (3): Chemical composition of raw materials used in like-sausage products processing

Property		Fresh mushroom	Steaming mushroom	TSP	Peas
Moisture		88.30	77.15	6.02	15.25
Protein	W.W	2.85	5.48	50.71	24.7
	D.W	24.36	23.98	53.96	29.14
Fat	W.W	1.28	2.35	10.21	2.42
	D.W	10.94	10.28	10.86	2.86
Ash	W.W	1.13	2.11	6.35	2.67
	D.W	9.66	9.23	6.76	3.15
Carbohydrate	W.W	6.44	12.91	26.71	54.96
	D.W	55.04	56.51	28.42	64.85

TSP: Texture Soy Protein. W.W: Wet weight. D.W: Dry weight.

The values of chemical composition of peas are more close to those of Boye *et al.* (2010) who reported that the chemical composition of peas was 14.19% moisture, 24.58 % crud protein, 2.34 % ash, 2.82 % crud fat, and 70.26 % carbohydrate (on dry weight basis).

Organoleptic evaluation of different processed like-sausage products:

Organoleptic attributes of processed like-sausage products are given in Table (4). Generally, the obtained values of taste and odor of formulas which prepared with peas were higher than the corresponding values recorded for TSP. This phenomenon could be related to the concentration of glutamic acid in peas which had beneficial effect on palatability. Zhang *et al.* (2013) reported that peas protein rich in leucine, lysine, glutamic acid, valine, or proline. Glutamic acid and other amino acids are flavor enhancers and increase the palatability of foods (Halpern, 2000 and Prescott, 2001).

Table (4): Organoleptic evaluation of like-sausage formulas made from mushroom substituted by different levels of TSP or peas different processed like:

Products	Taste	Odor	Color	Texture	OA	T.S
MS1	6.33^{c} ±1.80	6.47^{abc} ±2.07	5.40^{ab} ± 1.88	5.53^{c} ±1.60	6.20^{b} ±1.26	29.93^{e} ±3.81
MS2	6.60^{bc} ±1.40	5.93^{abc} ±1.67	5.53^{ab} ± 1.41	6.20^{c} ±1.26	6.53^{ab} ±0.92	30.80^{de} ±2.76
MS3	6.20^{c} ±1.47	5.67^{bc} ±1.63	5.93^{ab} ± 1.28	7.27^{a} ±1.49	6.67^{ab} ±0.90	31.73^{de} ±3.35
MS4	5.67^{cde} ±1.80	5.53^{cd} ±2.20	6.47^{a} ± 2.00	7.78^{a} ±1.01	6.80^{ab} ±1.15	32.27^{cde} ±4.30
MS5	4.73^{ef} ±1.83	5.40^{cd} ±2.41	6.47^{a} ± 1.19	3.93^{d} ±1.28	4.53^{d} ±0.92	25.07^{fg} ±3.67
MS6	4.07^{f} ±1.83	4.40^{d} ±1.84	6.20^{ab} ± 1.52	3.53^{d} ±1.06	4.20^{d} ±1.01	22.40^{g} ±4.36
MP1	7.53^{ab} ±1.13	6.60^{abc} ±1.35	6.00^{ab} ±2.00	5.93^{c} ±1.03	6.87^{ab} ±1.19	32.93^{bcd} ±3.92
MP2	7.87^{a} ±1.06	6.80^{ab} ±1.01	6.40^{a} ±1.40	6.33^{bc} ±0.98	7.27^{a} ±1.03	34.67^{abc} ±2.61
MP3	8.07^{a} ±0.96	7.13^{a} ±1.13	6.40^{a} ±1.76	7.20^{ab} ±1.32	7.27^{a} ±1.33	36.07^{a} ±4.27
MP4	7.87^{a} ±1.06	6.53^{abc} ±1.55	5.93^{ab} ±1.91	7.80^{a} ±1.08	7.27^{a} ±1.22	35.40^{ab} ±3.97
MP5	5.80^{cd} ±1.21	6.00^{abc} ±1.20	5.60^{ab} ±1.84	4.27^{d} ±1.33	5.33^{c} ±0.98	27.00^{f} ±3.32
MP6	4.80^{def} ±1.01	5.47^{cd} ±1.92	5.13^{b} ±1.73	3.73^{d} ±1.49	4.87^{cd} ±1.13	24.00^{g} ±4.58

OA: overall acceptability. T.S: total score. MS1: 75% mushroom+25% Texture Soy Protein (TSP). MS2: 65% mushroom+35%TSP. MS3: 55% mushroom+45% TSP. MS4: 45% mushroom+55% TSP. MS5: 35% mushroom+65% TSP. MS6: 25% mushroom+75%TSP. MP1: 75% mushroom+25% Peas. MP2: 65% mushroom+35% Peas. MP3: 55% mushroom+45% Peas. MP4: 45% mushroom+55% Peas. MP5: 35% mushroom+65% Peas. MP6: 25% mushroom+75% Peas. Each value is a mean value of fifteen replicates and is followed by the stander deviation. (A, B, C, D, E, F and G): means in the same column with different superscript differ significantly at p< 0.05.

The highest taste score was given by the panelists for formula MP3 (very good) which was not significantly differed ($p< 0.05$) with MP2, MP4 and MP1 followed by formula MS2 (good), MS1 and MS3 with non-significant differences ($p<0.05$) among them. As could be seen in Table (4), the increasing the level of TSP resulted in decreasing the taste of formulas. This result is in accordance with those obtained by Thomas *et al.* (2008).

It could be noticed that, odor scores of different like-sausage formulas which prepared by using TSP were slightly decreased with increasing replacement ratio from 25 to 75%. These results are in agreement with those obtained by Brewer *et al.* (1992). On the other hand, like-sausage formulas which prepared by using peas were slightly increased in odor scores with increasing replacement ratio up to 45% then, odor values decreased with ratio 65 and75%. The highest values of odor were given for formula MP3

followed by MP2, MP1, MP4, MS1, MP5 and MS2 in descending order without significant different ($p<0.05$) among them.

There were small differences in visible color among the formulas containing TSP and those of containing peas. The highest color score was found in MS4 and MS5 (good) with non-significant different ($p< 0.05$) with MP1 and MP2 was observed.

Increase the levels of TSP and peas from 25 to 55 % led to improve texture of like-sausage formulas. On the other hand, especially TSP increment up to 65, 75 % led to deterioration of texture like hard texture. The highest texture score was recorded for formula MP4 followed by MS4, MS3 and MP3 with non-significant differences ($p<0.05$) among them.

The highest overall acceptability (good) was recorded for MP2, MP3 and MP4 without significant differences ($p<0.05$) between them.

Generally, increment TSP and peas up to 65 and 75 % led to deterioration sensory properties such as hard texture, poor taste and beany odor, consequently formulas MS5, MS6, MP5 and MP6 were refused and neglected of further measurements.

Chemical composition of like-sausage formulas made from mushroom substituted by different levels of TSP or peas:

The chemical composition of like-sausage formulas is shown in Table (5). Results indicated that there was gradually decrease in moisture content as affected by increasing levels with either texture soy protein or peas. These results are in accordance with those obtained by Shams El-Din (1998) who reported that, the addition of peas fiber and defatted peas or soy flour caused a reduce in moisture content but increase the fiber and ash levels. Similar trends have been reported by Hassan (2010). From the same table, it was elicited that, like-sausage formulas which were substituted by different levels of peas had significantly higher moisture content than the corresponding formula with TSP. This could be due to the high moisture content of peas when compared to TSP.

While, the protein content was significantly increased by the increment of TSP and peas ratio from 25 to 55%. But, protein content was significantly higher in formulas prepared with TSP than that prepared with peas. This may be due to high content of protein in TSP comparing to peas. These results go in line with those found by Hassan (2010). Fatty matter content of the like-sausage formulas was slightly increased by increasing TSP and decreased by increasing peas. The increment and decrement of fatty matter may be due to the high fat in TSP and the low fat in peas respectively. Ash contents of the like-sausage formulas slightly decreased by increasing TSP and peas. This may be due to the lower content of ash in TSP and peas than mushroom. In this respect, Abd-Rabo (2011) observed that oyster mushroom contained 8.72% ash on dry weight.

Generally, peas had low content of ash comparing to TSP (Table, 3). Therefore, like-sausage formulas which prepared with TSP had high ash content when were compared to those which prepared with peas.

Table (5): Chemical composition of like-sausage formulas made from mushroom substituted by different levels of TSP or peas (on dry weight basis).

Products	Moisture	Protein	Fatty matter	Ash	Carboh -ydrate
MS1	53.23^{B} ±0.051	25.38^{D} ±0.076	25.08^{A} ±0.093	12.31^{A} ±0.055	37.23^{B} ±0.051
MS2	49.93^{D} ±0.078	28.04^{C} ±0.170	25.14^{A} ±0.147	11.98^{B} ±0.109	34.83^{C} ±0.185
MS3	45.82^{F} ±0.030	30.12^{B} ±0.073	25.29^{A} ±0.032	11.71^{C} ±0.048	32.88^{D} ±0.123
MS4	42.37^{H} ±0.145	32.58^{A} ±0.008	25.31^{A} ±0.090	11.16^{D} ±0.056	30.95^{E} ±0.147
MP1	55.39^{A} ±0.406	17.17^{H} ±0.086	21.07^{B} ±0.076	6.23^{E} ±0.094	55.53^{A} ±0.198
MP2	51.91^{C} ±0.240	18.60^{G} ±0.264	19.71^{C} ±0.085	6.11^{E} ±0.124	55.58^{A} ±0.217
MP3	48.64^{E} ±0.061	19.59^{F} 0.197	18.98^{D} ±0.147	5.83^{F} ±0.106	55.60^{A} ±0.241
MP4	45.42^{G} ±0.061	20.39^{E} ±0.164	18.39^{E} ±0.282	5.59^{G} ±0.139	55.63^{A} ±0.418

MS1: 75% mushroom+25% Texture Soy Protein (TSP). MS2: 65% mushroom+35%TSP. MS3: 55% mushroom+45% TSP. MS4: 45% mushroom+55% TSP. MP1: 75% mushroom+25% Peas. MP2: 65% mushroom+35% Peas. MP3: 55% mushroom+45% Peas. MP4: 45% mushroom+55% Peas. Each value is a mean value of three replicates and is followed by the stander deviation. (A, B, C, D, E, F, G and H): Mean values in the same column with different superscript differ significantly at $p< 0.05$

Also, it could be observed that, carbohydrate contents were significantly higher in like-sausage formulas which prepared by using peas than that in formulas which prepared with TSP. These results may be due to the highest carbohydrate contents of peas. Karaca *et al.* (2011) reported that carbohydrate content of peas was 70.85%. The carbohydrate content was significantly decreased by increasing TSP levels. This may be due to the lower content of carbohydrate in TSP than mushroom. These results in agree with those obtained by Abd Rabo (2011).

Chemical and physicochemical properties of like-sausage formulas made from mushroom substituted by different levels of TSP or peas:

Chemical and physicochemical properties of like-sausage formulas are presented in Table (6). There were significant differences ($P<0.05$) in total volatile nitrogen (TVN) among all prepared formulas. It could be observed that, TVN values were increased by increasing the levels of TSP or peas. Like-sausage formulas which prepared by peas had significantly lower TVN as compared to the other formulas which prepared with TSP. The differences in TVN between all like-sausage formulas may be due to the differences in protein contents of these formulas (Hassan, 2010).

The total soluble nitrogen TSN values showed the same trend as that in TVN. The TSN values of all processed like-sausage formulas increased by the increment of ratio either TSP or peas. This result is in line

with Abd El-Aziz (2000). Formulas which prepared with TSP had higher values of TSN than corresponding values recorded for peas. The highest value was recorded for formula MS4 followed by MS3 with non-significant differences ($p<0.05$) between them.

Table (6): Chemical and physicochemical properties of like-sausage formulas made from mushroom substituted by different levels of TSP or peas. (on wet weight)

Products	TVN	TSN	TBA	PH	a_w
MS1	6.750^{F} ±0.040	0.849^{E} ±0.015	0.107^{C} ±0.007	5.907^{D} ±0.015	0.981^{B} ±0.000
MS2	7.033^{E} ±0.147	0.887^{D} ±0.006	0.114^{BC} ±0.003	6.037^{C} ±0.012	0.979^{D} ±0.000
MS3	7.297^{C} ±0.075	0.917^{B} ±0.005	0.119^{AB} ±0.004	6.143^{B} ±0.032	0.977^{F} ±0.000
MS4	7.787^{A} ±0.055	0.943^{A} ±0.009	0.126^{A} ±0.004	6.307^{A} ±0.025	0.975^{H} ±0.000
MP1	6.550^{G} ±0.046	0.817^{F} ±0.008	0.087^{E} ±0.006	5.723^{E} ±0.012	0.982^{A} ±0.000
MP2	6.920^{E} ±0.062	0.859^{E} ±0.004	0.096^{D} ±0.002	5.667^{F} ±0.015	0.980^{C} ±0.000
MP3	7.120^{D} ±0.026	0.901^{C} ±0.003	0.099^{D} ±0.003	5.570^{G} ±0.020	0.979^{E} ±0.000
MP4	7.503^{B} ±0.060	0.929^{AB} ±0.004	0.110^{C} ±0.004	5.520^{H} ±0.036	0.977^{G} ±0.000

MS1: 75% mushroom+25% Texture Soy Protein (TSP). MS2: 65% mushroom+35%TSP. MS3: 55% mushroom+45% TSP. MS4: 45% mushroom+55% TSP. MP1: 75% mushroom+25% Peas. MP2: 65% mushroom+35% Peas. MP3: 55% mushroom+45% Peas. MP4: 45% mushroom+55% Peas. Each value is a mean value of three replicates and is followed by the stander deviation. (A, B, C, D, E, F, G and H): Mean values in the same column with different superscript differ significantly at $p< 0.05$.

Thiobarbituric acid (TBA) values of the like-sausage formulas were slightly increased by increasing levels of TSP or peas. It could be observed that, the TBA values in the formulas which prepared by using TSP were the highest as compared to the other like-sausage formulas which prepared by using peas. These results may be due to the high fatty matter content of like-sausage formulas. These results are agreement with those obtained by Liu *et al.* (1991). From the same Table, pH values of formulas which prepared with TSP were slightly increased by increasing TSP levels. These results may be due to the high pH values of soy products as mentioned by Abu-Shaishai (2012). On the other hand, pH values of formulas which prepared with peas were slightly decreased by increasing peas' level. It could be observed that, water activity (a_w) significantly decreased by increasing the levels of TSP and peas. This result is in accordance with Thomas *et al.* (2008) who found that the reduction in water activity might be due to the addition of TSP in the dehydrated powder form.

Generally, the values of water activity of formulas which prepared with peas were slightly higher than the corresponding values recorded for TSP. This might be related to the higher moisture content in formulas contain peas when compared with TSP.

Physical properties of like-sausage formulas made from mushroom substituted by different levels of TSP or peas:

Physical properties of like-sausage formulas are presented in Table (7). The water holding capacity (WHC) of like-sausage formulas significantly was increased by increasing the ratios of TSP or peas from 25 to 55%. This might be due to increase in protein content which has higher absorption capacity (Abd Rabo, 2011). In this field, Pelgrom (2013) showed that using peas in food productions improved the water holding capacity. Plasticity values significantly decreased by increasing the addition of TSP or peas. These results go in line with findings of El-Mesalate (2008). It could be concluded that, formulas which prepared with peas had higher plasticity values than the corresponding values recorded for TSP. This is probably due to the ability of peas protein to bind more water. Cooking loss values of different formulas were gradually decreased, so cooking yield had gradually increased by increasing the levels of TSP or peas. This may be due to the addition of TSP and peas which are able to bind water and fat, consequently improved the cooking loss and cooking yield. These results in agree with those findings by Kassama *et al.* (2003) and Abu-Shaishai (2012) who reported that, cooking loss was decreased with adding soy products.

Texture indices (PWC and PWFC) of like-sausage formulas were significantly increased by increasing levels of TSP or peas. This may be due to the increase in protein content and decrease in moisture content (Abd Rabo, 2011). Generally, PWC and PWFC values of formulas which prepared with TSP were higher than corresponding values recorded for peas. This may be due to the higher protein content of TSP than peas.

Table (7): Physical properties of like-sausage formulas made from mushroom substituted by different levels of TSP or peas.

Products	WHC	Plasti-city	Cooking Loss	Cooking Yield	PWC	PWFC	FV
MS1	2.08^{A} ±0.044	4.19^{B} ±0.055	1.84^{A} ±0.333	98.16^{F} ±0.616	0.223^{E} ±0.000	0.183^{E} ±0.000	1.818^{A} ±0.002
MS2	1.64^{B} ±0.047	3.52^{C} ±0.060	-0.38^{D} ±0.022	100.38^{C} ±0.022	0.281^{C} ±0.002	0.225^{C} ±0.001	1.586^{C} ±0.006
MS3	1.06^{C} ±0.045	2.88^{D} ±0.050	-0.63^{E} ±0.062	100.63^{C} ±0.062	0.356^{B} ±0.001	0.274^{B} ±0.001	1.342^{E} ±0.001
MS4	0.81^{D} ±0.060	2.61^{E} ±0.062	-2.34^{G} ±0.071	102.34^{A} ±0.071	0.443^{A} ±0.003	0.330^{A} ±0.002	1.157^{G} ±0.009
MP1	1.98^{A} ±0.135	4.53^{A} ±0.085	0.96^{B} ±0.137	99.04^{E} ±0.137	0.138^{H} ±0.002	0.118^{H} ±0.001	1.708^{B} ±0.029
MP2	1.51^{B} ±0.090	4.37^{A} ±0.110	0.37^{C} ±0.019	99.63^{D} ±0.019	0.172^{G} ±0.001	0.146^{G} ±0.001	1.455^{D} ±0.013
MP3	0.98^{C} ±0.126	3.65^{C} ±0.095	-1.12^{F} ±0.009	101.12^{B} ±0.009	0.207^{F} ±0.002	0.172^{F} ±0.001	1.259^{F} ±0.004
MP4	0.68^{E} ±0.067	2.97^{D} ±0.185	-2.26^{G} ±0.018	102.26^{A} ±0.018	0.245^{D} ±0.002	0.201^{D} ±0.001	1.095^{H} ±0.007

MS1: 75% mushroom+25% Texture Soy Protein (TSP). MS2: 65% mushroom+35%TSP. MS3: 55% mushroom+45% TSP. MS4: 45% mushroom+55% TSP. MP1: 75% mushroom+25% Peas. MP2: 65% mushroom+35% Peas. MP3: 55% mushroom+45% Peas. MP4: 45% mushroom+55% Peas. Each value is a mean value of three replicates and is followed by the stander deviation. (A, B, C, D, E, F, G and H): Mean values in the same column with different superscript differ significantly at $p< 0.05$.

Also, feder values of like-sausage formulas were significantly decreased with increasing levels of TSP or peas. These results are in accordance with those obtained by Hassan (2010). This result might be due to loss in moisture content as a result to increase TSP or peas. Generally, feder values of these products were less than 4. So, all sausage formulas had good quality products according to Pearson (1970).

Texture profile analysis of like-sausage formulas made from mushroom substituted by different levels of TSP or peas:

The textural profiles were assessed and given in Table (8).Generally, it could be noticed that, the formulas which prepared by using mushroom and peas had higher values of all textural profiles than the corresponding values record with TSP. This may be due to the high carbohydrate content of peas. Also, addition of peas which contained starch produced the firmest, chewiest texture of the bologna sausages (Pietrasik and Janz, 2010).

Table (8): Texture profile analysis of like-sausage formulas made from mushroom substituted by different levels of TSP or peas.

Products	Hardness	Cohesiveness	Gumminess	Chewiness	Springiness	Resilience
MS1	2.970^{G} ±0.154	0.310^{D} ±0.027	0.916^{F} ±0.143	0.227^{E} ±0.046	0.352^{D} ±0.045	0.143^{E} ±0.012
MS2	4.500^{F} ±0.671	0.364^{C} ±0.022	1.627^{EF} ±0.319	0.554^{DE} ±0.048	0.338^{D} ±0.017	0.194^{D} ±0.055
MS3	5.272^{F} ±0.210	0.338^{CD} ±0.033	1.755^{E} ±0.079	0.576^{DE} ±0.178	0.318^{D} ±0.017	0.185^{DE} ±0.031
MS4	7.780^{E} ±0.122	0.335^{CD} ±0.009	2.602^{D} ±0.231	0.870^{D} ±0.114	0.249^{E} ±0.010	0.159^{DE} ±0.026
MP1	6.449^{D} ±0.190	0.527^{A} ±0.037	3.400^{C} ±0.147	1.742^{C} ±0.062	0.555^{A} ±0.009	0.340^{A} ±0.001
MP2	9.996^{C} ±1.066	0.527^{A} ±0.006	4.943^{B} ±0.201	2.696^{B} ±0.125	0.531^{AB} ±0.026	0.318^{AB} ±0.007
MP3	15.50^{B} ±0.535	0.504^{A} ±0.032	9.649^{A} ± 1.049	4.722^{A} ±0.184	0.513^{B} ±0.006	0.288^{BC} ±0.011
MP4	19.98^{A} ±0.733	0.439^{B} ±0.016	10.01^{A} ±0.105	5.099^{A} ±0.869	0.473^{C} ±0.011	0.249^{C} ±0.017

MS1: 75% mushroom+25% Texture Soy Protein (TSP). MS2: 65% mushroom+35%TSP. MS3: 55% mushroom+45% TSP. MS4: 45% mushroom+55% TSP. MP1: 75% mushroom+25% Peas. MP2: 65% mushroom+35% Peas. MP3: 55% mushroom+45% Peas. MP4: 45% mushroom+55% Peas. Each value is a mean value of three replicates and is followed by the stander deviation. (A, B, C, D, E, F, G and H): Mean values in the same column with different superscript differ significantly at $p< 0.05$.

The hardness of like-sausage formulas increased proportionally with increasing the levels of TSP or peas. This might be due to the better binding ability resulted from increased protein content (Thomas *et al.,* 2008).

Similarly, the gumminess and chewiness values of all like-sausage formulas were increased by increasing the levels of TSP or peas. Vice versa, cohesiveness was increased at level 35% TSP and decreased by increasing TSP or peas levels 45, 55%. Moreover, springiness values were decreased by increasing the levels of TSP or peas. These results are in line with Thomas *et al.* (2008) who reported that hardness, gumminess and chewiness values were significantly increased by adding TSP could be due

to the formation of better quality as a result of increase in protein content of the formulation. Moreover, Cofrades *et al.* (2000) reported that hardness and chewiness increased and cohesiveness decreased when soy content increased from 0% to 5% in bologna sausages. In this aspect, sausages became harder with peas protein incorporation (Carlos *et al.*, 2009).

Resilience value ($p<0.05$) significantly increased at TSP level 35% then, decreased by increasing the level of TSP. Otherwise, resilience was significantly decreased ($p<0.05$) with increased the levels of peas.

Nutritional characteristics of like-sausage formulas made from mushroom substituted by different levels of TSP or peas:

As the TSP or peas content increased in like-sausage formulas, total energy significantly increased. These results in accordance with those obtained with Hassan (2010). It could be observed that the obtained values of total energy of TSP were higher than the corresponding values recorded for peas. This phenomenon may be due to high fat content of TSP. GDR of protein was significantly decreased with increasing the level of TSP or peas. This may be due to the higher content protein of TSP or peas when compared with mushroom. However, GDR of protein for formulas which prepared with peas were higher than the corresponding values recorded for TSP. This may be due to high protein content in TSP when compared with peas. The same trend was obtained with GDR of energy. This may be due to the higher fat content of TSP and the high carbohydrate content of peas comparing to mushroom.

Table (9): Nutritional characteristics of like-sausage formulas made from mushroom substituted by different levels of TSP or peas.

Products	T.E	GDR of protein	GDR of energy
MS1	226.79^{G} ±0.333	471.78^{E} ±1.053	1278.71^{B} ±1.878
MS2	243.61^{E} ±0.273	398.87^{F} ±2.226	1190.44^{D} ±1.335
MS3	264.62^{B} ±0.076	343.14^{G} ±0.759	1095.92^{G} ±0.313
MS4	282.87^{A} ±0.613	298.24^{H} ±0.716	1025.22^{H} ±2.220
MP1	218.52^{H} ±1.798	731.08^{A} ±3.435	1327.19^{A} ±10.871
MP2	232.52^{F} ±0.774	626.20^{B} ±5.854	1247.24^{C} ±4.151
MP3	247.05^{D} ±0.540	556.51^{C} ±5.041	1173.85^{E} ±2.570
MP4	261.43^{C} ±0.817	503.31^{D} ±3.625	1109.30^{F} ±3.475

MS1: 75% mushroom+25% Texture Soy Protein (TSP). MS2: 65% mushroom+35%TSP. MS3: 55% mushroom+45% TSP. MS4: 45% mushroom+55% TSP. MP1: 75% mushroom+25% Peas. MP2: 65% mushroom+35% Peas. MP3: 55% mushroom+45% Peas. MP4: 45% mushroom+55% Peas. Each value is a mean value of three replicates and is followed by the stander deviation. (A, B, C, D, E, F, G and H): Mean values in the same column with different superscript differ significantly at $p< 0.05$.

CONCLUSION

From the foregoing results it could be concluding that production of a healthier, vegetarian alternative to the traditional meat sausage is feasible and economical. The formulas which prepared with oyster mushroom and TSP had the highest values of protein, fat and ash. Otherwise, sensory evaluation revealed that the formulas which prepared with oyster mushroom and peas were the most favorable amongst panelists.

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خصائص الجودة لبعض شبيهات السجق

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يتناول هذا البحث ضرورة تطوير منتجات صحية بديلة للسجق التقليدى الذى يحتوى على كميات عالية جداً من الدهون المشبعة . تم إجراء تقييم للصفات الحسية لإثنى عشر خلطة من شبيهات السجق المنتجة من فطر عيش الغراب كمكون رئيسى مع ستة مستويات مختلفة من الصويا وستة أخرى من البازلاء، بعد ذلك تم دراسة التركيب الكيميائى ، الخصائص الكيميائية والفيزيائية و خواص القوام للعينات المختارة. وأظهرت النتائج أن معظم قيم الصفات الحسية للعينات التي تحتوى على الماشروم والبازلاء كانت أعلى من القيم المناظرة لها التى تحتوى على الفطر والصويا، كذلك استخدام الصويا والبازلاء أدى إلى زيادة محتوى البروتين. أيضاً أظهرت النتائج أن قيم كلاً من TVN وTBA لجميع العينات ضمن متطلبات المواصفة القياسية المصرية. زيادة مستويات إضافة الصويا والبازلاء أدى إلى زيادة معنوية في القدرة على الاحتفاظ بالماء وكذلك عائد الطهي. كذلك استخدام مستويات مختلفة من الصويا والبازلاء أثر على خصائص القوام. زيادة النسبة المضافة من الصويا وكذلك البسلة أدى إلى زيادة الطاقة فى العينات بينما انخفض كلاً من الاحتياجات اليومية للبروتين والطاقة. بصفة عامة أشارت النتائج إلى أنه يمكن استخدام الفطر و الصويا أوالبازلاء في إنتاج سجق بديل للسجق التقليدى.