PHYSICAL, CHEMICAL, MICROBIOLOGICAL AND SENSORY QUALITY ATTRIBUTES OF LIQUID-SMOKED POULTRY BURGER PATTIES AS AFFECTED BY ADDING LIQUID SMOKE AND FROZEN STORAGE (-18 °C) FOR 6 MONTHS

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Abstract

Due to the desired color and flavor of smoked food especially smoked muscle food, the demand on these products is increased. Nevertheless, there are some negative aspects associated with traditional smoking of these products that affect the consumer health. On the other hand, there is a difficulty in smoking of minced muscle foods with traditional smoking. Therefore, some attention to apply properly the modern and safe technology systems (liquid smoke) in smoking of foods is needed. Moreover, with increasing of poultry meat production in Egypt, the market should be provided with liquid-smoked products.

Therefore, in this work, chicken and turkey burger patties prepared with liquid smoke were processed (chicken and turkey burger patties prepared without liquid smoke were control samples) and stored at −18 °C for 6 months.

Chemical composition and physical, chemical and microbiological quality attributes of liquid smoked and control burger patties were analyzed and evaluated immediately after processing and during frozen storage at −18 °C for 6 months. Moreover, the smoked chicken and turkey burger patties were sensory evaluated immediately after processing and by the end of frozen storage, meanwhile control samples (non smoked) were objected for sensory evaluation only after manufacturing because of its higher total volatile nitrogen, thiobarbituric acid and total bacterial count than the permissible limits recorded according to Egyptian standards at the end of storage, and the results of sensory evaluation were statistically analyzed.

Generally, the physical, chemical and microbiological results indicated that chicken and turkey burger patties prepared with liquid smoke (direct mix method of liquid smoke at level of 0.5 %) were fit for human consumption after 6 months of frozen storage. Moreover, the sensory evaluation revealed that all the liquid smoked burger patties (chicken and turkey) were accepted by the end of frozen storage period, provided that the chicken burger patties were better than the turkey ones. Finally, these products are suggested for production on commercial scale.

INTRODUCTION

Poultry are birds that have been selected and domesticated by man. Domestic fowl (chickens), ducks and turkeys are the three common species of domesticated

poultry in the world, domestic fowl account 90% of the total. Over the world, the poultry numbers in the developed countries represent 94, 5 and 1% of chickens, turkeys and ducks corresponding 92.5, 0.5 and 7% in the third countries, respectively (FAO, 1992). The world production of chicken was increased over the last decade, in Egypt, production increased from 38 million birds in 1991 to 88 million birds in 2001 (FAO, 2001), after that the production of birds in Egypt and some countries was decreased referred to birds flu (influenza) infection followed by slight increment in numbers according to the infection retarded.

Guillen and Manzanose (1998) found that smoking caused desirable development of sensory properties of smoked meat products including, aroma and flavor while changes in texture were observed. Nevertheless, there are some negative aspects associated with traditional smoking (using whole smoke) of these products that may affect the consumer health. Moreover, Brandt (2001) reported that using liquid smoke as GRAS (Generally Recognize As Safe) ingredients in smoking of food product is required because liquid smoke has many advantages including: Removing the potentially harmful compounds before it is blended with food, applying to a wide variety of foods that traditionally are not smoked, using it on the consumer and commercial processing scale, reducing the cost and production time of smoked food, less environmental pollution, controlling of flavor and color of smoked product and it can be applied in various ways (versatility) such as spraying, dipping, injection and actual mixing with food. Any way, smoking with liquid smoke of various poultry products has been suggested as a mean of expanding the market with new, safe and desired products.

The aim of the present investigation was to manufacture liquid-smoked poultry (chicken and turkey) burger patties as well as study the chemical composition, physical, chemical and microbiological quality attributes of liquid-smoked poultry burger patties as affected by adding liquid smoke and frozen storage at -18 °C for 6 months. Moreover, sensory evaluation and statistical analysis immediately after processing and by the end of frozen storage were carried out.

MATERIALS AND METHODS

Materials

Fresh samples of turkey and chicken were obtained as thighs and breast from the Experimental Station of the Faculty of Agric., Cairo Univ., at Giza Governorate. The poultry samples either chicken or turkey were obtained from carcasses of birds slaughtered at 6 - 8 weeks of age.

Other ingredients such as salt, white pepper, onion, soy protein concentrate and egg were collected from the local market. The wood sawdust used as a source for generating and preparing smoke condensate was the beech wood sawdust (Zan wood sawdust resulted from the furniture industry as a by-product).

Methods

Technological methods

Liquid smoke preparation

Liquid smoke was prepared as follows: The wood sawdust (zan flakes) was moistened to contain about 18 % moisture. Smoke was obtained by a small laboratory smoke generator, combusting or generating temperature was about 350 °C, combustion rate of wood sawdust was 150 g /hr, and the smoke generated via the destructive distillation of sawdust was condensed through a small condenser to collection flask so as to obtain the whole smoke condensate. Thereafter, the tarry substances were removed from the obtained whole smoke condensate by settling about 7 days at 4 °C, centrifuging at 2500 rpm for 10 min., filtering through Whatman No.1 papers (three times) then titration by saturated solution of sodium carbonate to obtain prepared smoke concentrate stock with pH of 4.5. Finally, the stock diluted with distilled water in a ratio of 1:2 (smoke concentrate: distilled water) to obtain the liquid smoke.

Preparation of liquid-smoked chicken burger patties

Liquid smoked chicken burger patties were prepared according to the recipe presented in Table (1). The burger patties of chicken meat were prepared by the common method where the meat was minced one time through 4.0 mm plate and mixed with all the other ingredients. The mixture was then shaped using hand-burger machine to obtain burger patties with 10 cm of thickness and about 50 g weight per unit (patty). The control of samples was prepared using the same recipe and method but without adding liquid smoke. All the samples were arranged in fibrous plates before packaging in polyethylene bags, and then stored by freezing at - 18°C for 6 months.

Table 1. Recipe used in preparation of liquid-smoked chicken burger patties.

Ingredients	%
Minced chicken meat (thigh and breast)	73.0
Rehydrated soy protein concentrate	10.0
Egg	5.0
Minced onion	3.5
Salt	2.0
Iced water	5.0
White pepper	0.5
Sodium pyrophosphate	0.5
Liquid smoke	0.5

Liquid- smoked turkey burger patties

The same recipe used for preparing the chicken burger patties was applied to prepare the burger patties of turkey by replacing the chicken meat with turkey meat (thighs and breasts meat). Also, the processing, packaging and storage conditions of turkey burger patties were similar to those used for chicken burger patties.

Analytical methods

Chemical analysis

Moisture, crude fat, protein (TN x 6.25) and ash contents were determined according to A.O.A.C. (1995). Carbohydrates content was calculated by difference. Total energy value was calculated as this equation:

Total energy= (Carbohydrate + protein contents) x 4 + (fat contents) x 9.

The total phenols content was determined according to the method of Chan *et al.* (1975). Total volatile basis nitrogen (T.V.B.N.) was measured according to the method mentioned by Winton and Winton (1958). Thiobarbituric acid (T.B.A.) value was determined as described by Pearson (1991). The pH value was determined according the method of Fernández-López *et al.* (2006).

Physical properties

Water holding capacity (W.H.C.) and plasticity were measured by filter press method of Soloviev (1966). Cooking loss % of samples was calculated as percentage of weight change from the raw to cooked state. Shrinking was calculated for poultry burger patties as a percentage of the diameter length change from the raw to cooked state.

Microbiological evaluation

The samples were subjected to the following microbiological examination procedure: Total plate count, lipolytic bacteria, proteolytic bacteria, halophilic bacteria, psychrophilic bacteria, coliform bacteria and *Staphylococcus aureus* counts were enumerated according to the method described by Difco Manual (1984). The presence or absence of salmonella was based on the methods described by FAO (1979) using buffered peptone as a pre-enrichment, while tetrathionate broth was used as a selective enrichment broth, and S-S agar used as a selective plating media.

Sensory evaluation

Sensory evaluation was carried out on smoked samples after manufacturing and by the end of frozen storage, meanwhile control samples (non smoked) were objected for sensory evaluation only after manufacturing (at a zero time). Samples were fried in sunflower oil and subjected to a 10 member trained sensory panel to evaluate color, taste, aroma, texture and overall acceptability of these products. A 9-point hedonic scale was used for the sensory evaluation according to Teeny and Mjyauchi (1979) in which 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much and 1 = dislike extremely.

Statistical analysis

Data of sensory evaluation were subjected to analysis of variance (ANOVA). Means comparison was performed using Duncan's test at the 5% level of probability as reported by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Chemical composition

Data presented in Table (2) indicate the gross chemical composition of chicken and turkey burger patties as affected by direct mix of liquid smoke (at level of 0.5%) and storage at -18 °C for 6 months.

From the results obtained, it could be noticed that the moisture contents recorded for the treatment and control samples of both chicken and turkey burger slightly decreased during frozen storage to be 68.32, 67.78 and 68.83, 67.80 % by the end of frozen storage (6 months).

Concerning the protein content (calculated on W.W.), it was slightly increased in all the stored samples (with exception of the turkey burger control that recorded slight decrease after the fourth month of frozen storage) with increase of frozen storage time. This may be attributed to the decrease in moisture content in all samples throughout the frozen storage. The reverse was observed on D.W basis as the protein content decreased in all of the stored samples with increasing of frozen storage time. The mentioned decrease in protein (calculated on D.W) during frozen storage may be due to the loss of nitrogen as a result of slight protein breakdown. However, the loss of protein was lower for both chicken and turkey burger which were prepared with liquid smoke (treatments) than controls (may be due to the antimicrobial properties of liquid smoke that lead to reduce the protein decomposition via reducing the microbial activity).

With respect of fat, ash, total carbohydrates and total energy, the results indicated that the fat content recorded the same trend of protein regardless the fat content of burger patties was higher for chicken than turkey burger. The loss of fat was lower in treatments than controls (possible due to the antioxidant properties of liquid smoke, as reported by Lesimple *et al.* 1995). On the other hand, ash content of all stored samples slightly increased with increasing of storage time at -18 °C for 6 months (either on W.W or on D.W). The total carbohydrates % of stored burger was nearly increased on W.W and slightly decreased on D.W with increasing of storage time at -18 °C for 6 months. The total energy of all burger samples as expected decreased (on D.W) with increasing of storage time at -18 °C for 6 months.

Chemical quality attributes

The results of the chemical quality attributes including total volatile nitrogen (T.V.N), thiobarbituric acid (T.B.A), phenols and pH value of chicken and turkey burger patties as affected by adding liquid smoke (direct mix of liquid smoke at level of 0.5 %) and frozen storage at -18 °C for 6 months are presented in Table (3).

From the results of Table (3), it could be observed that the T.V.N., T.B.A and pH values of all samples either liquid smoked or controls, gradually increased (on W.W as well as D.W) with increasing of frozen storage at -18 °C for 6 months, nevertheless the increasing rates of both T.V.N. and T.B.A. were pronouncedly higher for burger patties prepared without liquid smoke (controls) than that observed for burger patties prepared with liquid smoke (treatments) either chicken or turkey burger patties. On the other hand, the reverse was observed for the phenols content as, the phenols content of experimental decreased with increasing of storage at -18 °C for 6 months. Such results of T.V.N and T.B.A indicated the effect of liquid smoke as antimicrobial

and antioxidant, respectively. In addition, the decrease of phenols during storage may refer to consume it when act as antioxidant.

According to the Egyptian Standard (1996), which reported that the T.V.N. and T.B.A. of frozen poultry meat should not exceed 20 mg / 100 g and 0.9 mg malonaldehyde / kg, respectively, the chicken and turkey burger patties prepared with liquid smoke still accepted for 6 months at -18 °C versus only 4 months for controls (chicken and turkey burger patties prepared without liquid smoke).

Physical quality attributes

Data presented in Table (4) represent some physical properties such as water holding capacity (W.H.C), plasticity, shrinkage % and cooking loss % of chicken and turkey burger patties as affected by adding liquid smoke (direct mix of liquid smoke at level of 0.5 % during manufacturing) and frozen storage at -18 °C for 6 months.

The results of Table (4) indicated that the W.H.C. and plasticity decreased with increasing of frozen storage period for all the burger patties but the decreasing rate was lower in liquid smoked samples than in controls (either chicken or turkey burger). By the end of frozen storage, the chicken burgers recorded better W.H.C. and plasticity than turkey one. On the other hand, there was an inverse relationship between the W.H.C. and both shrinkage and cooking loss %, therefore shrinkage and cooking loss % increased with increasing of storage period. Nevertheless the shrinkage and cooking loss percentages during and by the end of frozen storage were lower for liquid smoked than controls provided that changes were lower for chicken burger than turkey one. These results were supported with the findings of Chung and Chun (1996).

Microbiological quality attributes

Data presented in Tables (5 and 6) show the microbiological evaluation of chicken and turkey burger patties as affected by adding liquid smoke (direct mix of liquid smoke at level of 0.5 % during manufacturing) and frozen storage at -18 °C for 6 months.

From the results of Table (5), it could be summarized that the microbial load, i.e., total plate count (T.P.C), proteolytic bacteria (P.B), lipolytic bacteria (L.B), psychrophilic bacteria (Ps.B) and halophilic bacteria (H.B) increased by increasing of frozen storage period for all the stored samples however, the liquid smoked samples (either chicken or turkey burger patties) recorded lower microbial load than that recorded for controls (burger without liquid smoke). Again, this may be ascribed to the antimicrobial effect of liquid smoke. By the end of frozen storage, the turkey burgers

(smoked and control) recorded higher microbial load than that of chicken (with exception of L.B that recorded the reverse).

On the other hand, results of Table (6) indicated that the pathogenic bacteria (*Staphylococcus aureus, E. coli* and *Salmonella spp*) was not detected being completely absent in all the samples either immediately after processing (at a zero time) or during frozen storage period. This reflects good manufacturing practice besides the sanitary conditions prevailing during preparation, packing and storage.

In general, these results were confirmed by the findings of Anand *et al.* (1991), Jeffrey *et al.* (1997) and Lucielle *et al.* (2001).

Sensory evaluation

To find out the best product (palatability) of poultry burger patties prepared with or without liquid smoke, data presented in Table (7) show the sensory evaluation scores of chicken and turkey burger prepared with or without liquid smoke immediately after manufacturing (zero time storage).

Considering statistical analysis (Table, 7), it could be noticed that, there were no significant differences in color and texture between all treatments. On the other hand, the addition of liquid smoke to burger patties, either chicken or turkey, had significantly improved taste and aroma. Also, from the same table, it could be observed that, immediately after manufacturing (zero time storage), the chicken burger patties either prepared with or without liquid smoke recorded higher scores of color, taste, texture, aroma and overall acceptability when compared with turkey samples. Moreover, although there were low significant differences between all treatments in overall acceptability, but it could be noticed that, the addition of liquid smoke to burger either chicken or turkey had pronounced desirable effect on overall acceptability.

On the other hand, from the results of Table (8), it could be concluded that all the samples of chicken and turkey burger patties which were prepared with liquid smoke were sensory accepted by the end of frozen storage, provided that chicken burger patties were better than turkey ones, and the overall acceptability scored 6.65 and 6.57 (almost like slightly) for chicken and turkey burger patties, respectively. On the other hand, the samples of chicken and turkey burger patties without addition of liquid smoke were not evaluated at the end of storage because of its higher total volatile nitrogen, thiobarbituric acid and total bacterial count than the permissible limits recorded according to Egyptian standards (1996).

Table 2. Chemical composition of chicken and turkey burger patties as affected by adding liquid Smoke and stored at -18ºC for 6 months.

Parameters	Samples		Liquid-smoked and control samples stored at -18 °C (in months)							
			Zero time*		2		4		6	
			W.W.	D.W.	W.W.	D.W.	W.W.	D.W.	W.W.	D.W.
Moisture %	A	Treatment	70.30	-	69.80	-	69.12	-	68.32	-
		Control	70.25	-	69.55	-	68.73	-	67.78	-
	B	Treatment	71.00	-	70.40	-	69.70	-	68.83	-
		Control	70.90	-	70.10	-	68.90	-	67.80	-
Protein %	A	Treatment	23.90	80.47	24.00	79.47	24.09	78.01	24.18	76.33
		Control	23.75	79.83	23.79	78.13	23.82	76.18	23.88	74.11
	B	Treatment	24.40	84.14	24.50	82.77	24.59	81.16	24.68	79.18
		Control	24.35	83.68	24.44	81.73	24.42	78.52	24.40	75.78
Fat %	A	Treatment	3.80	12.79	3.82	12.65	3.90	12.63	3.96	12.50
		Control	3.45	11.60	3.46	11.36	3.42	10.94	3.41	10.58
	B	Treatment	2.65	9.14	2.70	9.12	2.74	9.04	2.70	8.66
		Control	2.29	7.87	2.26	7.56	2.19	7.04	2.21	6.86
Ash %	A	Treatment	1.25	4.21	1.62	5.36	2.12	6.87	2.76	8.71
		Control	1.45	4.87	2.09	6.86	2.91	7.00	3.82	11.86
	B	Treatment	1.20	4.14	1.63	5.51	2.19	7.23	3.00	9.63
		Control	1.39	4.78	2.13	7.12	3.41	10.97	4.53	14.07
Total carbohydrates %	A	Treatment	0.75	2.53	0.76	2.52	0.77	2.49	0.78	2.46
		Control	1.10	3.70	1.11	3.66	1.12	3.58	1.11	3.45
	B	Treatment	0.75	2.59	0.77	2.60	0.78	2.57	0.79	2.53
		Control	1.07	3.68	1.07	3.59	1.08	3.47	1.06	3.29
Total energy K cal./100 g	A	Treatment	132.79	447.11	133.42	441.79	134.54	435.69	135.48	427.65
		Control	130.46	438.51	130.74	429.37	130.54	417.46	130.65	405.49
	B	Treatment	124.46	429.16	125.38	423.58	126.14	416.31	126.18	404.81
		Control	122.30	420.27	122.38	409.31	121.71	391.35	121.73	378.05

* Immediately after processing. W.W. = Wet weight D.W. = Dry weight

A = Chicken burger patties. B = Turkey burger patties. Treatment = Burger patties with liquid smoke that was added by direct mix at level of 0.5 %.

Table 3. Chemical quality attributes of chicken and turkey burger patties as affected by adding liquid smoke and stored at -18°C for 6 months.

Parameters	Samples		Liquid-smoked and control samples stored at -18 °C (in months)							
			Zero time*		2		4		6	
			W.W.	D.W.	W.W.	D.W.	W.W.	D.W.	W.W.	D.W.
T.V.N.	A	Treatment	8.15	27.44	11.30	37.41	14.30	46.31	18.00	56.81
		Control	8.33	28.00	13.40	44.00	17.60	56.28	22.70	70.45
	B	Treatment	8.01	27.62	11.90	40.20	15.50	51.16	19.70	63.20
		Control	8.25	28.35	13.90	64.49	18.40	59.16	23.90	74.22
T.B.A.	A	Treatment	0.310	1.045	0.412	1.370	0.651	2.110	0.982	3.100
		Control	0.358	1.204	0.579	1.870	0.717	2.290	1.668	4.246
	B	Treatment	0.301	1.037	0.394	1.330	0.545	1.800	0.936	3.003
		Control	0.340	1.17	0.531	1.780	0.704	2.260	1.293	4.010
Phenols	A	Treatment	4.19	14.12	3.78	12.53	3.30	10.67	2.80	8.83
		Control	-	-	-	-	-	-	-	-
	B	Treatment	4.28	14.74	3.80	12.83	3.39	11.18	2.86	8.88
		Control	-	-	-	-	-	-	-	-
pH value	A	Treatment	5.60	-	5.90	-	6.00	-	6.20	-
		Control	6.10	-	6.20	-	6.40	-	6.50	-
	B	Treatment	5.80	-	6.00	-	6.20	-	6.30	-
		Control	6.20	-	6.40	-	6.50	-	6.60	-

* Immediately after processing. W.W. = Wet weight. D.W. = Dry weight.
A = Chicken burger patties.
B = Turkey burger patties.
Treatment = Burger patties with liquid smoke that was added by direct mix at level of 0.5 %.
T.V.N = Total volatile nitrogen (mg / 100 g).
T.B.A = Thiobarbituric acid (mg malonaldehyde / kg).
Phenols = Total phenols (mg / 100 g).

Table 4. Physical properties of chicken and turkey burger patties as affected by adding liquid Smoke and storage at -18ºC for 6 months.

Parameters	Samples		Liquid–smoked and control samples stored at –18°C (in months)			
			Zero time*	2	4	6
W.H.C. (cm^2/ 0.3 g)	A	Treatment	0.29	0.33	0.66	1.00
		Control	0.28	0.61	0.93	1.11
	B	Treatment	0.34	0.54	0.75	1.03
		Control	0.33	0.72	0.98	1.14
Plasticity**	A	Treatment	3.20	3.12	3.05	2.86
		Control	3.35	3.08	2.87	2.69
	B	Treatment	2.95	2.90	2.85	2.75
		Control	3.22	2.88	2.65	2.45
Shrinkage %	A	Treatment	22.50	23.00	23.50	24.22
		Control	21.00	22.70	24.30	25.70
	B	Treatment	23.50	24.10	24.70	25.51
		Control	23.00	24.80	26.60	28.60
Cooking loss %	A	Treatment	21.70	22.92	23.81	24.93
		Control	20.85	23.71	24.78	26.67
	B	Treatment	22.19	23.11	24.34	25.81
		Control	21.68	23.89	24.96	27.32

* Immediately after processing.

A = Chicken burger patties.

B = Turkey burger patties.

Treatment = Burger patties with liquid smoke that was added by direct mix at level of 0.5 %.

W.H.C = Water holding capacity (cm^2 / 0.3 g sample).

** Plasticity calculated as cm^2 / 0.3 g sample.

Table 5. Microbiological evaluation (*cfu /g*) of chicken and turkey burger patties as affected by adding liquid Smoke and stored at -18°C for 6 months.

Microorganisms	Samples		Liquid-smoked and control samples stored at −18°C (in months)			
			Zero time*	2	4	6
T.P.C.	A	Treatment	7.0×10^{3}	2.3×10^{4}	6.0×10^{4}	6.0×10^{5}
		Control	5.0×10^{4}	3.7×10^{5}	9.0×10^{5}	2.0×10^{7}
	B	Treatment	8.0×10^{3}	4.6×10^{4}	7.4×10^{4}	7.3×10^{5}
		Control	6.0×10^{4}	5.0×10^{5}	9.7×10^{5}	3.2×10^{7}
P.B.	A	Treatment	1.3×10^{3}	4.3×10^{3}	7.6×10^{3}	3.0×10^{4}
		Control	3.8×10^{3}	4.2×10^{4}	1.6×10^{5}	5.0×10^{5}
	B	Treatment	1.9×10^{3}	5.5×10^{3}	8.3×10^{3}	4.6×10^{4}
		Control	5.3×10^{3}	3.8×10^{4}	2.0×10^{5}	6.0×10^{5}
L.B.	A	Treatment	2.0×10^{3}	3.0×10^{3}	6.0×10^{3}	2.3×10^{4}
		Control	4.7×10^{3}	4.8×10^{4}	9.3×10^{4}	3.3×10^{5}
	B	Treatment	1.6×10^{3}	2.1×10^{3}	3.6×10^{3}	1.2×10^{4}
		Control	3.9×10^{3}	4.3×10^{4}	8.5×10^{4}	2.9×10^{5}
Ps.B.	A	Treatment	1.3×10^{2}	2.5×10^{3}	4.6×10^{3}	6.6×10^{3}
		Control	4.4×10^{2}	8.9×10^{3}	2.3×10^{4}	7.3×10^{4}
	B	Treatment	1.2×10^{2}	2.1×10^{3}	4.3×10^{3}	5.2×10^{3}
		Control	3.8×10^{2}	7.6×10^{3}	1.3×10^{4}	4.5×10^{4}
H.B.	A	Treatment	8.5×10^{1}	1.5×10^{2}	4.1×10^{2}	8.5×10^{3}
		Control	5.6×10^{2}	3.0×10^{3}	9.0×10^{3}	2.6×10^{4}
	B	Treatment	9.5×10^{1}	3.0×10^{2}	5.6×10^{3}	9.6×10^{3}
		Control	6.4×10^{2}	7.0×10^{3}	9.4×10^{4}	3.2×10^{4}

* Immediately after processing.

A = Chicken burger patties.

B = Turkey burger patties.

Treatment = Burger patties with liquid smoke that was added by direct mix at level of 0.5 %.

T.P.C. = Total plate count. P.B. = Proteolytic bacteria. L.B. = Lipolytic bacteria.

Ps.B. = Psychrophilic bacteria. H.B. = Halophilic bacteria.

Table 6. Pathogenic bacteria *(cfu /g)* of chicken and turkey burger patties as affected by adding liquid Smoke and storage at -18°C for 6 months.

Microorganisms	Samples		Liquid–smoked and control samples stored at –18°C (in months)			
			Zero time*	2	4	6
St. aureus	A	Treatment	-	-	-	-
		Control	-	-	-	-
	B	Treatment	-	-	-	-
		Control	-	-	-	-
E. coli	A	Treatment	-	-	-	-
		Control	-	-	-	-
	B	Treatment	-	-	-	-
		Control	-	-	-	-
Salmonella	A	Treatment	-	-	-	-
		Control	-	-	-	-
	B	Treatment	-	-	-	-
		Control	-	-	-	-

* Immediately after processing.

A = Chicken burger patties.

B = Turkey burger patties.

Treatment = Burger patties with liquid smoke that was added by direct mix at level of 0.5 %.

(-) no growth.

Table 7. Sensory evaluation of chicken and turkey burger patties as affected by adding liquid Smoke immediately after processing (zero time).

Treatments	Mean scores of sensory properties				
	Color	Taste	texture	Aroma	Overall acceptability
Chicken burger without addition liquid smoke	7.30^{a}	8.00^{bc}	7.50^{a}	$7.0b^{c}$	7.45^{ab}
Turkey burger without addition liquid smoke	7.00^{a}	7.80^{c}	7.30^{a}	6.70^{c}	7.20^{b}
Liquid-smoked Chicken burger	7.50^{a}	8.50^{a}	7.50^{a}	7.50^{a}	7.75^{a}
Liquid-smoked Turkey burger	7.30^{a}	8.30^{ab}	7.40^{a}	7.25^{ab}	7.56^{ab}
LSD at 0.05 level	0.52^{ns}	0.43^{*}	0.66^{ns}	0.42^{*}	0.48^{*}

Where: Mean values in the same column with the same letter are not significant difference at 0.05 level.
ns = non significant * Low significance

Table 8. Sensory evaluation of liquid-smoked burger patties of chicken and turkey by the end of frozen storage.

Sensory properties	Mean of scores for liquid-smoked burger patties at the end of frozen storage		LSD at 0.05 level
	Chicken	Turkey	
Color	6.85^{a}	6.80^{a}	0.47^{ns}
Taste	5.50^{a}	5.50^{a}	0.35^{ns}
Texture	7.25^{a}	7.00^{a}	0.43^{ns}
Aroma	7.00^{a}	7.00^{a}	0.38^{ns}
Overall acceptability	6.65^{a}	6.57^{a}	0.41^{ns}

Where: Mean values in the same row with the same letter are not significantly difference at 0.05 level. ns = nonsignificant

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تأثير إضافة سائل التدخين والتخزين بالتجميد لمدة ٦ شهور على -١٨ م°علي خصائص الجودة الطبيعية والكيماوية والميكروبية والحسية لأقراص برجر الدواجن

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يتزايد الطلب على المنتجات المدخنة – خاصة الأغذية العضلية المدخنة – وذلك نتيجة للون والطعم والرائحة المميزة لهذه المنتجات ومع ذلك هناك بعض الأشكال السلبية المرتبطة بالمنتجات المدخنة تقليديا والتي قد تؤثر على صحة المستهلك. لذلك يجب أن يكون هناك اهتمام نحو تطبيق النظم التكنولوجية الحديثة والآمنة (سائل التدخين) في تدخين الأغذية. كذلك ومع زيادة إنتاج لحوم الدواجن في مصر ، فإنه يجب إمداد السوق بمنتجات الدواجن المدخنة بسائل التدخين.

لذلك أجرى هذا البحث بهدف انتاج كل من أقراص برجر الدجاج والرومي المدخنة بسائل التدخين بالاضافة الى عينات الكنترول وهى عبارة عن أقراص برجر الدجاج والرومي المصنعة بدون سائل تدخين ، وقد تم تخزين هذه العينات جميعا بالتجميد علي -١٨ °م لمدة ٦ أشهر.

تم تقييم التركيب الكيماوي وخصائص الجودة الطبيعية والكيماوية والميكروبية بعد التصنيع مباشرة وأثناء مدة التخزين ، كما تم تقييم المنتجات المدخنة حسياً وذلك بعد التصنيع مباشرة وبنهاية مدة التخزين بينما المنتجات الغير مدخنة تم تقييمها حسياً فقط بعد التصنيع مباشرة نظراً لإرتفاع محتواها من المركبات النيتروجينية الطيارة وحامض الثيوباربتيوريك والعد الكلى للبكتيريا فى نهاية مدة التخزين طبقاً للمواصفات القياسية المصرية.

وقد أوضحت النتائج بصورة إجمالية أن أقراص برجر الدجاج والرومي المجهزة بسائل التدخين (طريقة الخلط المباشر بسائل التدخين علي مستوي ٠،٥ %) كانت صالحة للاستهلاك الآدمي بعد ٦ أشهر من التخزين بالتجميد علي -١٨ °م ، وكذلك أظهرت نتائج التقييم الحسي أن جميع أقراص البرجر المدخنة بسائل التدخين كانت مقبولة بنهاية مدة التخزين بالتجميد وأن أقراص برجر الدجاج كانت افضل من أقراص برجر الرومي ، ويقترح إنتاج هذه المنتجات علي نطاق تجاري.