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CHEMICAL, PHYSICAL AND SENCORY PROPERTIES OF FROZEN CHICKEN BURGER SUBSTITUTED WITH CHICKEN BY-PRODUCTS

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ABSTRACT: The present study aimed to develop an acceptable quality chicken burger by incorporation of poultry by-products *i.e.,* (heart, gizzard, liver, abdominal fat and skin) at a level of 20%. The resultant burger samples were analyzed for physicochemical properties and sensory evaluation during storage up to 6 months. The obtained results indicated that there was a gradual decrease in moisture and protein contents of all burger samples during frozen storage. Whereas, control burger (CB) had the highest value (67.00%) but burger contained fat (FB) showed the lowest value (63.10%) of moisture content. (CB) contained the highest value (17.00%) but (FB) contained the lowest value (13.55%) of protein content. There was an increasing in water holding capacity WHC and ash contents during frozen storage period whereas (CB) contained the highest value (3.50) but (FB) contained the lowest value (3.12%) of ash content. (FB) contained the highest value (68.87%) but liver burger (LB) contained the lowest value (54.03%) of WHC.Moreover, there was an increasing in cooking loss in all samples during frozen storage. At the end of freezing storage, the results indicated that incorporation of gizzard and heart (20%) in chicken burgers showed the best organoleptic properties as compared to the control burger samples. It is also observed that incorporation of 20% heart and gizzard exhibited higher sensory scores and physicochemical properties. The sensory scores of all tested attributes declined significantly with the progress of storage period.

Key words: Chicken burger, chicken by-products substituted, physicochemical characteristics, sensory properties.

INTRODUCTION

The increasing in the production of broilers followed by increasing in the quantities of offal's especially gizzards with high percentages of proteins and fats, which can contribute for human consumption. However, the high contents of fat makes gizzards tasty with pleasant flavour and popular to the consumer. Depending on the cultural context, offal's may be considered as waste material that is thrown away, or as delicacies that command a high price. The gizzards are muscular organ used for grinding and mixing of the food materials in preparation for digestion, thus replacing the mastication function of the teeth. The strength of the gizzard muscle and tough leather-like lining allow utilization of grit as well as the feed particles producing much friction in the grinding process. The physical breakdown of large feed particles increases their surface area, allowing more complete enzymatic digestion (**Maiti and Ahlawat, 2011**). Gizzards are consumed in several countries especially Asian countries. Many products are processed from gizzards, for example, in China, fermented sausage, and dried gizzrards are produced. In Jordon sandwiches are prepared from gizzards. The Sudanese and Egyptian utilize gizzards traditionally in various ways, one of these ways is to be fried with its own fat, or using the abdominal fat of chicken, after addition of some herbs. They also use another method in which gizzards are cooked with other giblets of chicken like livers, hearts,

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and neck, abdominal fat of chicken, plus onions, garlic, and several types of herbs added (**Elkhatim *et al.,* 2014**).

Poultry meat is comprised of about 20 to 23% protein, which comminuted products, such as frankfurters, bologna and sausages that typically contain about 17 to 20% protein, 0 to 20% fat and 60 to 80% water (**Smith, 2001**).

Poultry meat is also more popular to the consumer market because of advantages such as easy digestibility and acceptance by the majority of people and it contains all essential amino acids, a lot of minerals as sodium, potassium, calcium, iron, phosphorus besides traces of vitamins such as vitamin B12 and niacin required for maintaining life and promoting growth. It also characterized by a lower calorific value as it contains less fat which is rich in unsaturated fatty acids (**Grześkowiak *et al.*, 2001; Yashoda *et al.,* 2001; FAO, 2014**).

Poultry fat can be considered as a source of monounsaturated fatty acids (MUFA) since they constitute 45% to 50% of poultry fat (**Lee and Foglia, 2000**). Many efforts have been made to improve the quality and stability of burger because consumer demand for fast food has been increasing rapidly in recent years. The microbiological safety and quality of poultry meat are equally important to producers, retailers and consumers, and both involve microbial contaminants on the processed product (**Mead, 2004**).

However, the high contents of fat makes gizzards tasty with pleasant flavour and popular to the consumer. Depending on the cultural context, offal's may be considered as by-products or as delicacies that command a high price.

Therefore, the main aim of this research work was to evaluate the physiochemical and organoleptic characteristics of poultry burgers containing different substituted of gizzard, heart, liver, skin and fat. The changes in physiochemical and organoleptic characteristics of poultry burgers during frozen storage for six months were also evaluated.

MATERIALS AND METHODS

Materials

Chicken by-products (gizzard, heart, liver, skin and fat)

Chicken thigh meat, gizzard, heart, liver, abdominal fat and skin of broiler chicken were obtained from supermarket in Zagazig city, Sharkia Governorate, Egypt. They were washed by tap water, drained and packed separately in polyethylene bags then, stored in frozen at (-18 ± 1°C) until used. They were thawed and minced with 8 mm plate in a meat mincer (Mado Shop Mincer Junior, Germany) immediately before use.

Spices

Cumin, cubeb, nutmeg, cardamom, clove and celery were obtained from supermarket in, Zagazig city, Sharkia Governorate, Egypt.

Methods

Preparation of poultry burger

Chicken burger samples were prepared and divided into 8 equal proteins which have been replaced with different additives shown in Table 1. The chicken mixture was formed manually using a patty maker to obtain round tablets, 10 cm diameter and 0.5 cm thickness. The burgers were packed in polyethylene bags in the foam dish.

Analytical methods

Chemical composition

The moisture, protein, fat, carbohydrates and total ash content were determined for burger samples according to **AOAC (2000)**.

pH value

The PH value was determined according to the method mentioned by **AOAC** (**2005**).

Lipid extraction

The lipids of poultry burger samples were extracted using n-hexane as a solvent according to the method of **Association of Official Analytical Chemist (1990)**.

Table 1. The formulation of various suggested chicken burger treatments

Ingredient (g)	Treatment							
	CB	GHB	SB	FB	SFB	GB	HB	LB
Chicken thighs	3000	2400	2400	2400	2400	2400	2400	2400
Gizzards + heart (1:1)	-	600	-	-	-	-	-	-
Gizzards	-	-	-	-	-	600	-	-
Heart	-	-	-	-	-	-	600	-
Liver	-	-	-	-	-	-	-	600
Fat	-	-	-	600	300	-	-	-
Skin	-	-	600	-	300	-	-	-
Black pepper	15	15	15	15	15	15	15	15
Salt	45	45	45	45	45	45	45	45
Spices	15	15	15	15	15	15	15	15

CB: control burger sample. GHB: chicken burger substuted with gizzards +heart. SB: chicken burger substuted with skin. FB: chicken burger substuted with abdominal fats. SFB: chicken burger substuted with skin and abdominal fats. GB: chicken burger substuted with gizzards. HB: chicken burger substuted with heart. LB: chicken burger substuted with liver.

Thiobarbituric acid (TBA) test

Thiobarbituric acid value was measured according to the method described by **Fernandez *et al.* (2005).**

Water holding capacity (WHC)

Water holding capacity (WHC) was measured in burger samples by a centrifugation method described by Serdaroğl (2006).

Cooking properties of chicken burger samples

Cooking yield, fat and moisture retention were determined as described by **Alesson-Carbonell *et al.* (2005)**.

Cooking loss of chicken burger samples

Cooking loss (%) was calculated as described by **AOAC (2000)**.

After grilling on hot plate with little sunflower oil at 110-c for min.

$$\text{Cooking loss (\%)} = \frac{\text{Fresh burger weight} - \text{cooked burger}}{\text{Fresh burger weight}} \times 100$$

Sensory Evaluation

Sensory analysis was done with hedonic test as described by **Trindade *et al.* (2009)**.

Statistical Analysis

Three trials were conducted for each experiment and samples were analyzed in duplicate. The data recorded were analyzed using SPSS version 10.0 of windows (SPSS, Chicago, USA). One way analysis of variance (ANOVA) was applied on all parameters analyzed. The data were tabulated and significant effects were tested using the least significant difference (LSD) test (**Snedecor and Cochran, 1986**).

RESULTS AND DISCUSSION

Chemical Composition

The chemical evaluation of chicken meat by-products gives an idea about the nutritive value of that food (**El-Arby, 2004**).

Results presented in Table 2 show that the pH values were found to varied and ranged from 5.8-6.79.

The highest protein content (15.2%) in Table 2 was presented in liver part followed by heart (14.12%) and thigh (14.51%). Moreover, heart and thigh parts showed the highest moisture content and was found to be 75.81% and 75.37%, respectively.

Table 3 Shows the moisture contents in different burger samples, the result of moisture content of manufactured chicken burger was decreased for all investigated burger samples. Changes in such parameter reflect the extent of water holding capacity (WHC) of meat and directly affect yield of meat during cooking. The WHC contents of burger samples in Table 3, showed that the (FB) contained the highest value and ranged (68.87%) while, the (LB) was contained the lower value and ranged (67.78 %) as presented in Table 3. The highest cooking loss content was for the (LB) while, the lower cooking loss content was for the (CB).

Results presented in Table 4 show the protein content in burger samples during frozen storage for 6 months. It is clear that the decrease in protein content of all investigated samples was found to be around 17%. This finding may be due to addition of chicken by-product as a source of protein. From these results, it could be concluded that the loss in total protein content might be attributed to partially breakdown of proteins by proteolytic enzymes which are not completely inactivated during storage as well as due to the loss of nitrogen compounds, either as volatile substances caused by microbial effect or separated in drip during thawing the frozen meat samples (**Miller *et al.*, 1980**).

Results obtained from Table 4 showed that the pH value was decreased by 1.2-fold for CB sample during storage but still within the permissible limits of the Egyptian Organization for Standardization and Quality Control (**EOSQC, 2005**). The decrease in pH may be attributed to the breakdown of glycogen to the formation of lactic acid.

Fat content did not exceed 30% (maximum amount stipulated in the **FAO (2014)** in all tested burger samples. The fat contents was significantly decreased in the various burger samples, with the (SFB) contained the highest value (followed by (FB) (3.68%) then (SB) (3.66%) followed by and finally (CB) which contained the least value (2.97%) after 6 months of storage.

Table 6 shows the colour attributes (lightness, L*; redness, a*and yellowness, b*) ofburger samples after storage for 6 months. By the end of storage theL*, a* and b* values of chicken by products was ranged from 24.25to 42.24 for lightness, 3.01 to 9.93 for redness and 5.23 to 14.40 for yellowness.

In addition, the L* (39.20) and a* (8.22) values lightly were higher in case of sample (BSF) and (GB), respectively. The Δ E value of all investigated samples was almost around 45.10 with regard to the sample (BSF) that had higher value Δ E (48.30) by the end of storage.These variations may be due to the addition of chicken by- products to the burger.

Organoleptic Examination

Organoleptic examination is one of the main indicators, which measure quality of most foods. The results in Table 7 represented the organoleptic properties of chicken burger substituted with different chicken by-products including colour intensity, firmness, flavour, juiciness and overall acceptability. There were significant decrease ($p< 0.05$) in taste, juiciness, flavour and over all acceptability between all investigated samples. Meanwhile, the colour intensity was found to be reduced in all investigated samples. This may be due to the freezing and thawing processes which had a significant effect on colour and decrease in pH value which lead to the paleness of the colour. In general, samples (GHB) and (SB) had the highest score (9.5-9.6) of colour, taste juiciness, flavour and overall acceptability abtained by panliests.

These results agree with **Darwish *et al.* (2011)** who, used a different non meat ingredient (sweet potatoes) in formulation of beef burger and freezing storage at -18°C for 12 weeks induced significantly reduced ($p< 0.05$) the sensory panel scores for all the investigated parameters. The most pronounced effect was the effect on the flavour and overall acceptability. These results disagree with **Kumar *et al.* (2014)**. They found that the organoleptic attributes, as appearance, flavour, texture and overall palatability were not affected due to frozen storage except juiciness which decreased significantly after three months of storage.

Table 2. Physicochemical compositions of chicken thighs and chicken by-products used for making chicken burger

Chemical composition	Thigh	Heart	Gizzard	Liver	Fat	Skin
Moisture (%)	75.37	75.81	76 .00	77.00	32.5	51.02
Fat (%)	3.15	3.60	3.84	2.90	62.06	37.80
Protein (%)	14.51	14.12	13.55	15.2	2.12	8.22
Carbohydrates (%)	3.43	3.77	3.68	3.50	3.03	2.52
Ash (%)	3.54	2.70	2.98	1.40	0.29	0.46
pH	6.18	6.50	6.70	5.80	6.79	6.60

Table 3. Change in moisture, WHC and cooking loss in chicken burger samples as effected by frozen storage

Sample	Moisture (%)			(WHC) (%)			Cooking loss (%)		
	Freezing storage period (month)								
	0	3	6	0	3	6	0	3	6
CB	72.61	71.09	68.74	54.18	58.76	67.91	35.11	36.17	37.29
GHB	72.58	71.12	68.68	54.17	58.74	67.88	35.09	36.15	37.31
SB	70.93	69.35	66.47	56.09	62.64	68.85	34.97	36.14	37.32
FB	70.93	69.35	66.47	56.16	62.66	68.87	35.03	37.18	37.88
SFB	70.94	69.37	66.48	56.23	61.71	68.19	35.02	37.16	37.91
GB	72.54	71.09	68.70	54.15	58.73	67.85	35.01	37.15	37.91
HB	72.55	71.11	68.72	54.21	58.80	67.93	35.01	37.15	37.93
LB	72.59	71.12	68.76	54.03	58.66	67.78	34.98	37.11	37.95

CB: control burger sample. GHB: chicken burger substuted with gizzards +heart. SB: chicken burger substuted with skin. FB: chicken burger substuted with abdominal fats. SFB: chicken burger substuted with skin and abdominal fats. GB: chicken burger substuted with gizzards. HB: chicken burger substuted with heart. LB: chicken burger substuted with liver.

Table 4. Change in protein, pH and Ash contents in chicken burger samples as effected by frozen storage

Sample	Protein (%)			pH			Ash (%)		
	Freezing storage period (month)								
	0	3	6	0	3	6	0	3	6
CB	23.11	21.17	19.09	6.73	6.41	5.88	0.07	2.6	4.5
GHB	23.15	21.20	19.12	6.67	6.29	5.75	0.06	2.44	4.65
SB	21.26	19.27	17.06	6.86	6.46	5.91	0.39	1.59	4.5
FB	21.23	19.15	17.62	6.91	6.46	5.94	0.37	1.68	4.11
SFB	21.24	19.21	17.63	6.89	6.45	5.93	0.4	1.61	4.5
GB	23.22	21.30	19.10	6.69	6.32	5.76	0.06	2.14	4.03
HB	23.14	21.18	19.92	6.65	6.28	5.72	0.09	2.44	4.33
LB	23.16	21.23	19.14	6.64	6.26	5.70	0.05	2.78	4.47

CB: control burger sample. GHB: chicken burger substuted with gizzards +heart. SB: chicken burger substuted with skin. FB: chicken burger substuted with abdominal fats. SFB: chicken burger substuted with skin and abdominal fats. GB: chicken burger substuted with gizzards. HB: chicken burger substuted with heart. LB: chicken burger substuted with liver.

Table 5. Change in fat and Thiobarbituric acid (TBA) contents in chicken burger samples as effected by frozen storage

Sample	Fat (%)			Thiobarbituric acid (TBA)		
	Frozen storage period (month)					
	0	3	6	0	3	6
CB	3.19	3.11	2.97	-	0.616	1.19
GHB	3.15	3.03	2.87	-	0.614	1.14
SB	3.95	3.80	3.66	-	0.739	1.49
FB	3.98	3.83	3.68	-	0.742	1.50
SFB	3.97	3.82	3.69	-	0.743	1.52
GB	3.16	3.04	2.84	-	0.613	1.13
HB	3.13	3.01	2.84	-	0.611	1.12
LB	3.11	2.97	2.82	-	0.608	1.1

CB: control burger sample. GHB: chicken burger substuted with gizzards +heart. SB: chicken burger substuted with skin. FB: chicken burger substuted with abdominal fats. SFB: chicken burger substuted with skin and abdominal fats. GB: chicken burger substuted with gizzards. HB: chicken burger substuted with heart. LB: chicken burger substuted with liver.

Table 6. Hunter colour parameters of chicken burger containing different combinations of chicken by-products and chicken burger samples after storage for 6 months

Sample	L*	a*	b*	C*	h*	Δ E
Chicken thigh	24.25	4.54	5.23	6.93	49.00	85.30
Heart	21.76	6.99	7.42	10.20	46.70	87.00
Gizzard	24.32	7.00	5.33	8.80	37.30	41.90
Liver	21.22	9.93	7.89	12.70	38.50	45.20
Abdominal fats	39.21	3.01	14.40	14.70	78.20	49.20
Skin	42.24	3.51	11.33	11.80	72.70	46.30
CB	35.94	4.64	10.43	11.40	66.00	45.10
GHB	30.20	8.24	10.08	13.00	50.80	45.00
SB	35.41	4.77	11.90	12.80	68.20	46.60
FB	38.54	3.23	12.75	13.20	75.80	47.60
SFB	39.20	4.35	13.55	14.30	72.30	48.30
GB	30.28	8.22	10.5	13.30	51.90	45.40
HB	30.15	7.99	10.11	12.90	51.70	45.00
LB	30.11	8.35	10.21	13.20	50.70	45.10

CB: control burger sample. GHB: chicken burger substuted with gizzards +heart. SB: chicken burger substuted with skin. FB: chicken burger substuted with abdominal fats. SFB: chicken burger substuted with skin and abdominal fats. GB: chicken burger substuted with gizzards. HB: chicken burger substuted with heart. LB: chicken burger substuted with liver.

Table 7. Organoleptic evaluation of chicken burger containing different combinations of chicken by-products

Characteristics	Treatment							
	CB	**GHB**	**SB**	**FB**	**SFB**	**GB**	**HB**	**LB**
Colour	9.7 a	9.6 a	9.2 a	9.1 a	9.1 b	9.5 b	9.6 a	9.6 a
Taste	9.4 a	9.5 a	8.8 b	8.5 b	8.6 b	9.6a	9.6 a	9.1 b
Juiciness	9.7 a	9.5 a	8.9 b	8.9 b	8.9 b	9.5 a	9.5 a	9.3 a
Flavour	9.5 a	9.6 a	8.9 b	8.8 b	8.9 b	9.5 a	9.5 a	9.3 b
Overall acceptability	9.5 a	9.6 a	8.7 b	8.5 b	8.4 b	9.6 a	9.6 a	9.1 a

CB: control burger sample. GHB: chicken burger substuted with gizzards +heart. SB: chicken burger substuted with skin. FB: chicken burger substuted with abdominal fats. SFB: chicken burger substuted with skin and abdominal fats. GB: chicken burger substuted with gizzards. HB: chicken burger substuted with heart. LB: chicken burger substuted with liver.
Values in the same row followed by different letters are significantly different: * $P \leq 0.05$

These results also disagree with Kamel (2015) who revealed that 6th month storage at freezing temperature (-18°C) was the longest period for which broiler chicken fillets may be found to have impeccable sensory properties specially colour, odour and flavour and still within the acceptable range. These results are confirmed by Abu-Ruwida *et al.* (1996) who reported acceptability of chicken meat after 6-9 months of storage at –18ºC as there was no significance of the sensory parameter scores of the examined samples ($p > 0.05$).

Conclusion

Based on the results, the use of chicken gizzards is encouraged to produce meat products such as burger, at commercial scale. As the broiler chickens gizzards cost less than 50% of the beef price, and since the results of the present study indicate that the burger products made from gizzards and heart are safe acceptable by the panelists. Therefore, it is highly recommended to incorporate chicken gizzards and heart at a level of 20%.

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الخصائص الكيماوية والفيزيقية والحسية لبرجر الدجــاج المجمد المستبدل بالمنتجات الثانوية للدجاج

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تهدف هذه الدراسة إلى تطوير برجر الدجاج بالاستبدال بالمنتجات الثانوية للدواجن وهي القلب والقانصة والكبد والدهون من منطقة البطن والجلد بمعدل ٢٠%، وقد تم تحليل عينات البرجر الناتجة من حيث الخصائص الكيميائية والفيزيائية والحسية خلال فتره التخزين بالتجميد لمده ٦ أشهر وأظهرت النتائج التي تم الحصول عليها أن هناك انخفاضا تدريجيا في محتوى الرطوبة والبروتين من جميع عينات البرجر حيث احتوت عينه البرجر (CB)على أعلى قيمة (٦٧,٠٠%) من محتوى الرطوبة فى حين احتوت عينه (FB) على أقل قيمة (٦٣,١٠%) من محتوى الرطوبة، واحتوت عينه البرجر (CB) أعلى قيمة (١٧,٠٠%) من محتوى البروتين ولكن احتوت عينه البرجر (FB) على اقل قيمه (١٣,٥٥%) من محتوى البروتين، كان هناك زيادة في محتويات الكربوهيدرات والرماد خلال فترة التخزين المجمدة حيث احتوت عينه البرجر (CB) على أعلى قيمة (٣,٥٠) من محتوى الرماد ولكن احتوت عينه البرجر (FB) على اقل قيمه (٣,١٢%) من محتوى الرماد، احتوت عينه البرجر (FB) على أعلى قيمة (٦٨,٨٧%) من (WHC) محتوى القدرة على الاحتفاظ المياه و احتوت عينه البرجر (LB) على أقل قيمه (٥٤,٠٣%) من (WHC) محتوى القدرة على الاحتفاظ المياه، وعلاوة على ذلك، كان هناك زيادة في الفقد بالطبخ في جميع العينات أثناء التخزين بالتجميد، وفي نهاية مدة التجميد أشارت النتيجة أن دمج القانصة والقلب بنسبة (٢٠%) في برجر الفراخ أظهر أفضل الخصائص الحسية بالمقارنة مع عينات البرجر الأخرى، ولوحظ أيضا أن دمج ٢٠% من القلب والقانصة سجل أعلى درجات فى التقييم الحسى والخصائص الفيزيائية والكيميائية، انخفضت الدرجات لجميع الصفات الحسية بشكل ملحوظ مع تقدم فترة التخزين.

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