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QUALITY ATTRIBUTES OF CHICKEN BURGER FORMULATED WITH DIFFERENT LEVELS OF GIZZARD OR MECHANICAL DEBONED CHICKEN MEAT DURING FROZEN STORAGE

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ABSTRACT: ***The chicken burgers were formulated with 20, 40 and 60% levels of gizzard or mechanically deboned chicken meat (MDCM). The chemical, physicochemical, microbiological and sensory properties of chicken burgers were evaluated during storage at -18±1ºC for 6 months. The chicken burgers formulated with gizzard had higher (p ≤ 0.05) moisture (70.56%), crude protein (17.23%), total ash (2.97%) and lower (p ≤ 0.05) total volatile nitrogen (14.46 mg/100g), thiobarbituric acid (0.54 mg malonaldehyde/kg sample), peroxide value (3.74 meq/kg fat), pH (6.42), water holding capacity value (3.50 cm2/0.3g) and plasticity (3.11 cm2/0.3g) than chicken burgers formulated with MDCM. The crude protein and total ash contents of the chicken burgers were (p ≤ 0.05) decreased and crude fat, total volatile nitrogen, and thiobarbituric acid increased (p ≤ 0.05) by increasing the levels of gizzard or MDCM. Increasing the levels of gizzard in the chicken burgers led to reducing total bacterial count, psychrophilic bacteria and Staphylococcus aureus counts compared with control chicken burger. However, MDCM had an opposite trend. The sensory properties of the chicken burgers formulated with gizzard had rating scores described as like very much (7.52-8.05). However, chicken burgers formulated with MDCM had rating scores ranged between like moderately (6.80) and like very much (7.03-7.64). Although TVN, TBA, PV and microbial load of the chicken burgers increased and sensory properties decreased during the storage period, the chicken burger still had an acceptable quality.***

Key word: ***Chicken burger, chicken meat, gizzard, mechanical deboned chicken meat.***

INTRODUCTION

Poultry meat is a very popular food commodity around the world and its consumption has increased over the last decades. In many countries some of the reasons for the popularity are the relatively low cost of production, low fat content and the high nutritional value of poultry meat (Chouliara *et al.*, 2007). However, the poultry industry generates by-products which are generally underutilized, for example poultry liver, gizzard and mechanical deboned poultry meat.

Gizzard is one of the principal edible by-products of poultry processing which is being marketed as variety meats along with dressed chicken. It forms nearly3% of dressed chicken (Charonpong and Chen 1980) and as such it is less preferred by the consumer due to its peculiar flavor and texture. Gizzard contains approximately 20% proteins (Kondaiah and Panda 1987 and Rao *et al.*, 1994) and has potential for using in cost effective, convenient ready to eat chicken products.

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Mechanically deboned chicken meat (MDCM) is obtained by deboning or separation techniques of edible tissue on chicken bones. Generally, MDCM consist high amount of lipid and ash, when compared to fresh meat, and it also contains free heme groups because bone marrow and bone components are included in MDCM (Ockerman and Hansen, 2000). For these reasons, MDCM is vulnerable to oxidation and spoilage, and the addition of MDCM to meat products could have a negative effect on the sensory properties, mainly color, flavor, and texture (Pereira *et al.*, 2011). Nevertheless, the inexpensive cost and nutritional value, to provide the effective use of animal resources, are main reasons why studies about the effects of MDCM on the quality characteristics of meat products are still underway. Perlo *et al.* (2006) reported that addition of washed MDCM up to 40% increased the fat content but decreased the protein content of chicken nuggets. Therefore the objective of this study was to formulatechicken burgerby replacing chicken meat with 20,40 and 60%of gizzard or MDCM. The proximate composition, chemical, physical, microbiological quality attributes and sensory properties of chicken burger immediately after preparation and during storage at -18±1°C for 6 months were evaluated.

MATERIALS AND METHODS

Materials

Chicken meat

Broiler carcasses (7-8 weeks age with average weight 1.5-2.0 kg) were purchased from the local market at Giza, Egypt. The chicken was slaughtered, allowed to bleed for 5 minutes, scalded for 2 min at 60°C, plucked by hand, eviscerated, rinsed with tap water and deboned. On receipt at the laboratory, they were skinned, washed carefully then the chicken meat was stored at -18±1oC for 24 hours and then minced coarsely using a sterilized meat mincer before used in the formulation of chicken burgers.

Fresh chicken gizzard

Fresh chicken gizzard was obtained from El-Abed mall, Banha, qalyubia Governorate, Egypt. On receipt at the laboratory in the icebox, it was washed with cold tap water and stored at -18±1oC for 24 hours then minced coarsely using a sterilized meat mincer before used in the formulation of chicken burgers.

Mechanically deboned chicken meat (MDCM):

The frozen MDCM was purchased from Al-Kahera Slaughtering Company for poultry, Cairo, Egypt.

Texturized soy:

Texturized soy was obtained from the Food Technology Research Institute, Agricultural Research Center, Giza, Egypt. It was rehydrated by water at a ratio of 1:2 (w/v) and minced twice through 3 mm plate.

Spices mixture

The spices were purchased from the local market in Cairo, Egypt. The spices (60.0% fennel, 27.0% coriander, 3.0% Chinese cubeb, 3.0% white pepper, 3.0% clove, 2.0 % laurel leaf powder and 2.0 % cardamom.) were mixed together then ground to pass through a 60 mesh sieve and kept in a tight jar.

Methods:

Technological methods

Preparation of chicken burgers:

Fresh chicken burgers were prepared as described by Mikkelson (1993) and Abd EL-Qader (2004). The control chicken burger consisted of 71.50% minced chicken meat (included fat), 12.0% rehydrated texturized soy, 6.30% fresh eggs, 7.0% fresh onion, 1.50% salt, 1.70% spices. The frozen chicken meat was cut into approximately 5 cm cubes and minced by using meat mincer. The other ingredients were added and mixed by using a laboratory blender (Hobart Kneading machine, Italy) together. After blending, the chicken mixture was shaped manually using a patty maker (stainless steel model "Form") to obtain round discs of 10 cm diameter and 0.50 cm thickness. The other chicken burgers were formulated by replacing chicken meat with 20, 40 and 60% levels of gizzard or MDCM. After the formulation of chicken burgers, it was aerobically packaged in the foam plates, wrapped with polyethylene film and stored at -18±1°C for 6 months. The samples were taken for analysis every month.

Analytical methods

Proximate composition:

AOAC (2012) methods were used to determine moisture, crude fat, crude protein, and total ash contents of the chicken burger. Total carbohydrate content of the chicken burger was calculated by difference.

Total volatile nitrogen (TVN):

The TVN of the chicken burger was determined by the method described by Winton and Winton (1958).

Thiobarbituric acid (TBA):

The TBA of the chicken burger was determined according to the method described by Kirk and Sawyer (1991). The TBA values were expressed as mg malonaldehyde/ kg of sample.

Peroxide value (PV):

The PV of the chicken burger was determined by the titration method according to AOAC (2012) and expressed as meq/kg of fat.

pH values:

The pH values of the chicken burger were measured using a pH-meter (Jenway 3510 pH meter) at room temperature 25 ±1°C.

Physical properties:

Water Holding Capacity (WHC) and plasticity of the chicken burgers were measured according to the filter - press method of Wierbicki and Deatherage (1958). Drip loss was measured by the difference between the weight of complete frozen burger and weight of the same burger after thawing. The drip loss was calculated as the percentage of weight change (AMSA 1995).

Microbiological analysis

Sample preparation:

Ten grams of a representative and homogenized sample were mixed with 90 ml of sterile buffered 0.1% peptone water in a sterile blender, under sterile conditions, to give 1/10 dilution. Serial dilutions were prepared to be used for counting several types of bacteria and yeast and mold counts.

Bacteriological methods:

Total bacterial count (TBC), *Staphylococcus aureus*, psychrophilic bacteria and yeast and mold counts of the chicken burgers were determined by using Nutrient agar, Baird-parker agar, Nutrient agar, and Potato Dextrose agar media, respectively according to the procedures described by APHA (1976) and Difco Manual (1984). Incubations were carried out at 37°C/48 h for TBC; at 37°C /24h for *Staphylococcus aureus,* at 8°C/5days for psychrophilic bacteria and 25°C/5 day for yeasts and molds count.

Salmonella:

The presence or absence of salmonella of the chicken burger was determined according to 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 was used as a selective plating media.

Sensory evaluation:

The thawed chicken burgers were grilled on a hot plate with little sunflower oil at 110°C for 4 minutes and left to cool at room temperature for 15 min. Sensory properties of cooked chicken burgers were carried out according to Mansour and Khalil (1999) by ten-trained panelists. Randomly coded samples were served to panelists individually. Five sensory attributes were evaluated (taste, odor, color, texture, and overall acceptability) using ten points hedonic scale for each trait where 9-10 = like extremely, 7-8 = like very much, 6 = like moderately, 5 = neither like nor dislike, 4 = dislike moderately, 3 = dislike very much and 1-2 = dislike extremely.

Statistical analysis:

Proximate composition of raw materials was analyzed by one-way analysis of variance. A completely randomized 2 (type of by-products) × 4 (replacement levels) × 7 (storage period) × 3 (replication) factorial design was used for chicken burger data. An analysis of variance was conducted using Costat version 6.311 (Copyright 1998-2005, CoHort software). When a significant main effect was detected, the means were separated with the Student Newman Keuls test. The predetermined acceptable level of probability was 5% ($P \le 0.05$) for all comparisons.

RESULTS AND DISCUSSION

Proximate composition and microbial load of raw materials

The chicken meat had ($p \le 0.05$) higher crude protein and total ash than chicken gizzard or MDCM (Table 1). The gizzard had ($p \le 0.05$) higher moisture and lower ($p \le 0.05$) crude fat than chicken meat and MDCM. The MDCM had ($p \le 0.05$) higher crude fat andlower ($p \le 0.05$) moisture, crude protein and total ash contents than chicken meat and gizzard. A non-significant difference ($p > 0.05$) was observed in total carbohydrates content among the raw materials. These results are in agreement with those reported by Wattanachant *et al.* (2004) and Abd El-Qader (2004) for chicken meat, Maiti and Ahlawat (2011) and Wani and Majeed (2014) for gizzard and Botka-Petrak *et al.* (2011) for MDCM.

Table (1): Proximate composition and microbial load of chicken meat, gizzard and MDCM

	Chicken meat	Gizzard	MDCM	LSD
Chemical composition (%)				
Moisture	73.08^{b}	78.96^{a}	69.37^{c}	0.71
Crude protein	19.67^{a}	17.13^{b}	15.41^{c}	0.43
Crude fat	5.62^{b}	2.65^{c}	14.27^{a}	0.32
Total ash	1.46^{a}	1.13^{b}	0.84^{c}	0.17
Total carbohydrates	0.17^{a}	0.13^{a}	0.11^{a}	0.09
Microbial load (cfu/g)				
Total bacterial	2.71×10^{4}	4.35×10^{3}	9.2×10^{4}	
Psychrophilic bacteria	4.63×10^{2}	2.71×10^{2}	7.58×10^{2}	
Staphylococcus aureas	1.74×10	1.11×10	3.91×10	
Salmonella Spp.	ND	ND	ND	
Yeast and mold	ND	ND	ND	

Means in the same row with different letters are significantly different ($p \le 0.05$)
ND= not detected

The total bacterial counts of chicken meat in the present study were 2.7×10^4cfu/g. The total bacterial counts of raw materials did not exceed the maximum levels 10^5cfu/g of microbiological criteria for fresh and frozen poultry given by Egyptian standard specifications (2009). Chicken meat, gizzard and MDCM were completely free from *Salmonella spp* and yeast and mold. Comparable total bacterial counts (2.32-8.83×10^4cfu/g) and the similar *Salmonella spp* and yeast and mold (not detected) of chicken breast and leg were reported by Mohammed *et al.* (2017). The MDCM had higher total bacterial count, psychrophilic bacteria and *staphylococcus aureas* than chicken meat and gizzard. The chicken meat had higher total bacterial, psychrophilic bacteria and *staphylococcus aureas* counts than gizzard.

Proximate composition of chicken burgers

The chicken burger formulated with gizzard had higher ($p \le 0.05$) moisture, crude protein and total ash and lower ($p \le 0.05$) crude fat than chicken burger formulated with MDCM (Table 2). The total carbohydrates content was similar ($p > 0.05$) in the chicken burgers formulated with gizzard or MDCM. The control chicken burger had higher ($p \le 0.05$) crude protein and total ash contents and lower ($p \le 0.05$) crude fat content than chicken burger formulated with different levels of gizzard and MDCM. The Non-significant ($p > 0.05$) differences were observed in moisture and total carbohydrate contents among all burgers. The crude protein and total ash contents of chicken burgers were decreased ($p \le 0.05$) by increasing the level of gizzard and MDCM. On the contrary, the crude fat content was increased ($p \le 0.05$) by increasing the level of gizzard and MDCM. Maha and Hassan (2016) found that incorporation of chicken gizzards at 25% and 50% in beef sausage increased the crude fat content and decreased the total ash content. Daros *et al.* (2005) observed a decrease in crude protein and total ash contents in sausage with the increasing of mechanically deboned poultry meat.

The moisture content of the chicken burger was ($p \le 0.05$) gradually decreased by increasing the storage period. However, total carbohydrates content had an opposite trend. The crude protein, crude fat and total ash contents were not affected ($p > 0.05$) by the storage period. The reduction of moisture content might be due to the drip loss and evaporation of moisture during frozen storage periods. The increase in total carbohydrates content was attributed to the reduction in moisture content during the storage period. Mahdavi *et al.* (2018) reported that the moisture content of the chicken burger was decreased in all chicken burger samples with increasing the frozen storage time.

Chemical quality attributes of chicken burgers

The total volatile nitrogen (TVN), thiobarbituric acid (TBA) and peroxide value (PV) of the chicken burgers were significantly affected ($p \le 0.05$) by gizzard or MDCM and their levels except for the PV. The PV was not affected ($p > 0.05$) by the levels of gizzard or MDCM (Table 3). The chicken burger formulated with MDCM had significantly higher ($p \le 0.05$) TVN, TBA and PV values than chicken burger formulated with a gizzard. This might be due to the MDCM had higher crude fat content than gizzard and chicken meat (Table 1). Bigolin *et al.*, (2013) reported that MDCM has a high content of crude fat therefore; it is very susceptible to oxidative reactions.

The control chicken burger had lower ($p \leq 0.05$) TVN and TBA values than chicken burgers formulated with different levels of gizzard and MDCM. The TVN and TBA values were increased by increasing the levels of gizzard and MDCM. However, PV values were not affected ($p > 0.05$) by the levels of gizzard and MDCM. The acceptability recommended rate for TVN and TBA in poultry meat products are 20 mg N/100g and 0.9 mg malonaldehyde/kg, respectively (Egyptian standard specifications, 2009). In the present study, TVN values (8.8-19.78 mg N/100g) and TBA values (0.192-0.908 mg malonaldehyde/kg) of all chicken burgers were within the acceptable range.

Table (2): Proximate composition of chicken burgers as affected by different types and levels of by-products during storage at -18±1°C for 6 months

	Moisture	Crude protein	Crudefat	Totalash	Total Carbo-hydrates
			(%)		
Type of by-products					
Gizzard	70.56[a]	17.23[a]	4.15[b]	2.97[a]	5.09[a]
MDCM	68.05[b]	16.75[b]	7.44[a]	2.88[b]	4.88[a]
LSD	0.45	0.34	0.23	0.07	0.27
Level of by-products (%)					
0	68.96[a]	17.95[a]	4.98[d]	3.06[a]	5.05[a]
20	69.21[a]	17.47[b]	5.40[c]	2.99[b]	4.93[a]
40	69.29[a]	16.99[c]	5.79[b]	2.93[c]	4.99[a]
60	69.42[a]	16.50[d]	6.19[a]	2.86[d]	5.03[a]
LSD	0.39	0.35	0.21	0.04	0.24
Storage period (month)					
0	69.91[a]	17.21[a]	5.73[a]	2.91[a]	4.25[g]
1	69.70[b]	17.18[a]	5.71[a]	2.92[a]	4.45[f]
2	69.49[c]	17.16[a]	5.70[a]	2.93[a]	4.73[e]
3	69.22[d]	17.13[a]	5.68[a]	2.94[a]	5.03[d]
4	69.03[e]	17.10[a]	5.66[a]	2.96[a]	5.26[c]
5	68.81[f]	17.07[a]	5.65[a]	2.97[a]	5.50[b]
6	68.62[g]	17.04[a]	5.62[a]	2.99[a]	5.73[a]
LSD	0.18	0.16	0.09	0.08	0.15

Means in the same column with different letters are significantly different ($p \leq 0.05$)

Table (3): Chemical quality attributes of chicken burgers as affected by different types and levels of by-products during storage at -18±1°C for 6 months

	TVN	TBA	PV
Type of by-products			
Gizzard	14.46^{b}	0.540^{b}	3.74^{b}
MDCM	16.69^{a}	0.750^{a}	4.38^{a}
LSD	0.29	0.05	0.13
Level of by-products (%)			
0	14.46^{d}	0.610^{d}	4.04^{a}
20	15.45^{c}	0.621^{c}	4.04^{a}
40	16.50^{b}	0.690^{b}	4.05^{a}
60	16.78^{a}	0.696^{a}	4.10^{a}
LSD	0.22	0.04	0.16
Storage period (month)			
0	8.80^{g}	0.192^{g}	0.32^{g}
1	10.97^{f}	0.334^{f}	1.58^{f}
2	13.56^{e}	0.498^{e}	2.50^{e}
3	15.92^{d}	0.640^{d}	3.97^{d}
4	17.10^{c}	0.775^{c}	5.60^{c}
5	18.08^{b}	0.858^{b}	6.75^{b}
6	19.78^{a}	0.908^{a}	7.68^{a}
LSD	0.25	0.02	0.19

Means in the same column with different letters are significantly different ($p \leq 0.05$)

The TVN, TBA and PV values of the chicken burger were significantly ($p \leq 0.05$) increased as the storage period increased. The increase in TVN values might be due to the bacterial breakdown during storage of chicken burger (Osheba and Abd El-Bar, 2007). The increase in TBA and PV values during the storage period might be due to continuous oxidation of lipids and consequently the production of oxidative by-products. These results are in agreement with those obtained by Mohamed (2011) who observed a significant increase in TVN and PV values of chicken burger with frozen storage (-18°C) time. Mohammed *et al.* (2017) reported that TVN and TBA values of chicken kobeba were significantly ($p \leq 0.05$) increased as storage (-18°C) period increased.

Physical properties of chicken burgers

The pH, WHC, plasticity and drip loss of chicken burgers were significantly affected ($p \leq 0.05$) by gizzard or MDCM and their levels as well as storage period except for the WHC. The WHC was not affected ($p > 0.05$) by the levels of gizzard or MDCM (Table 4). The chicken burger formulated with MDCM had significantly higher ($p \leq 0.05$) pH, and plasticity values and lower ($p \leq 0.05$) WHC and drip loss than chicken burger formulated with a gizzard.The increment of pH value in burger formulated with MDCM might be attributed to the incorporation of bone marrow constituents and the denaturation of protein during the mechanical deboning process.

Table (4): Physical properties of chicken burgers as affected by different types and levels of by-products during storage at -18±1°C for 6 months

	pH	WHC	Plasticity	Drip loss
Type of by-product				
Gizzard	6.42^{b}	3.50^{a}	3.11^{b}	5.67^{a}
MDCM	6.81^{a}	2.87^{b}	3.64^{a}	4.62^{b}
LSD	0.19	0.21	0.29	0.19
Level of by-products (%)				
0	6.35^{b}	3.30^{a}	3.10^{d}	5.36^{a}
20	6.59^{a}	3.27^{a}	3.23^{c}	5.12^{b}
40	6.61^{a}	3.11^{a}	3.37^{b}	5.14^{b}
60	6.67^{a}	3.18^{a}	3.52^{a}	5.19^{b}
LSD	0.20	0.21	0.12	0.15
Storage period (month)				
0	6.37^{f}	2.75^{g}	3.83^{a}	3.85^{g}
1	6.41^{ef}	2.88^{f}	3.67^{b}	4.34^{f}
2	6.48^{de}	3.05^{e}	3.51^{c}	4.71^{e}
3	6.56^{cd}	3.17^{d}	3.35^{d}	5.15^{d}
4	6.65^{bc}	3.33^{c}	3.20^{e}	5.63^{c}
5	6.73^{ab}	3.49^{b}	3.05^{f}	6.06^{b}
6	6.80^{a}	3.69^{a}	2.89^{g}	6.47^{a}
LSD	0.14	0.11	0.09	0.16

Means in the same column with different letters are significantly different ($p \leq 0.05$)

The control chicken burger had lower ($p \leq 0.05$) pH and plasticity values and higher ($p \leq 0.05$) drip loss than chicken burgers formulated with different levels of gizzard and MDCM. A non-significant difference ($p > 0.05$) was observed in WHC between the control and other chicken burgers. The plasticity was increased ($p \leq 0.05$) by increasing the levels of gizzard and MDCM. However, pH and drop loss values were not affected ($p > 0.05$) by increasing the levels of gizzard and MDCM. The drop loss was improved by the addition of gizzard or MDCM in a chicken burger at different levels. Increasing the TVN values of chicken burger with the increasing the levels of gizzard or MDCM (Table 3) supporting the increase in their pH values.

The WHC and drip loss values were increased ($p \leq 0.05$) and plasticity decreased ($p \leq 0.05$) by increasing the storage period. The relationships among WHC, drip loss and plasticity values in this study were corrected. The increment of WHC values of chicken burger during storage might be attributed to protein denaturation and loss of protein solubility (Abd El-Qader, 2004). The pH values of the chicken burger were increased ($p \leq 0.05$) with increasing the storage period. The increase of pH values during the storage period could be due to the breakdown of protein and formation of protein metabolites mainly amines (Reddy *et al.,* 2013). The similar results were reported by Darwish *et al.* (2012) who observed that drip loss of chicken burger was progressively increased by extending the frozen storage period at -18°C for 6 months.

Microbial load of chicken burgers

The microbial load of chicken burgers was affected by gizzard or MDCM and their levels as well as the storage period (Table 5). The total bacterial counts of chicken burgers from beginning up to the end of storage did not exceed the maximum levels 10^5cfu/g of microbiological criteria for fresh and frozen poultry given by Egyptian standard specifications (2009). *Salmonella Spp* and yeast and mold were not detected in all chicken burgers during the storage period, which proved the sanitary conditions of raw materials. Mohammed *et al.* (2017) reported that *Salmonella Spp* was not detected in all kobeba during the storage period.

Table (5): Microbial load of chicken burgers as affected by different types and levels of by-products during storage at -18±1°C for 6months

	Storage period (month)	Control	Gizzard (%)			MDCM (%)		
			20	40	60	20	40	60
Total bacterial	0	6.89×10^4	5.83×10^4	4.78×10^4	3.72×10^4	7.23×10^4	8.12×10^4	8.65×10^4
	1	5.67×10^4	4.96×10^4	2.87×10^4	1.94×10^4	6.11×10^4	6.83×10^4	7.34×10^4
	2	5.94×10^4	5.18×10^4	4.12×10^4	3.66×10^4	6.36×10^4	6.95×10^4	8.21×10^4
	3	6.93×10^4	6.72×10^4	5.18×10^4	3.91×10^4	7.12×10^4	7.85×10^4	9.67×10^4
	4	7.97×10^4	7.32×10^4	6.60×10^4	4.81×10^4	8.05×10^4	9.67×10^4	1.96×10^5
	5	9.15×10^4	8.45×10^4	7.81×10^4	5.70×10^4	9.35×10^4	1.12×10^5	3.73×10^5
	6	1.48×10^5	9.52×10^4	8.11×10^4	6.67×10^4	2.15×10^5	4.71×10^5	7.90×10^5
psychrophilic bacteria	0	7.50×10^2	7.20×10^2	6.35×10^2	5.72×10^2	7.87×10^2	8.96×10^2	9.87×10^2
	1	6.92×10^2	6.57×10^2	5.48×10^2	4.97×10^2	7.34×10^2	8.18×10^2	8.92×10^2
	2	6.34×10^2	5.91×10^2	4.73×10^2	4.55×10^2	7.00×10^2	7.60×10^2	8.34×10^2
	3	5.81×10^2	4.76×10^2	3.62×10^2	3.26×10^2	6.16×10^2	7.25×10^2	7.81×10^2
	4	7.29×10^2	5.93×10^2	4.86×10^2	3.98×10^2	7.36×10^2	7.93×10^2	8.29×10^2
	5	7.73×10^2	6.65×10^2	6.43×10^2	4.82×10^2	7.98×10^2	8.35×10^2	8.73×10^2
	6	2.45×10^3	9.02×10^2	8.45×10^2	7.31×10^2	2.86×10^3	3.67×10^3	4.21×10^3
Staphylococcus aureus	0	2.35×10	2.25×10	1.95×10	1.63×10	4.76×10	6.12×10	7.63×10
	1	2.16×10	2.09×10	1.86×10	1.27×10	4.36×10	5.20×10	6.96×10
	2	1.92×10	1.78×10	1.53×10	1.02×10	4.17×10	4.91×10	6.32×10
	3	1.67×10	1.62×10	1.31×10	0.92×10	5.24×10	6.34×10	7.42×10
	4	2.02×10	1.97×10	1.67×10	1.36×10	6.58×10	7.25×10	8.41×10
	5	2.46×10	2.21×10	1.99×10	1.83×10	7.97×10	8.16×10	9.56×10
	6	2.93×10	2.35×10	2.16×10	2.11×10	8.46×10	9.82×10	1.33×10^2

Salmonella Spp and yeast and mold not detected

The chicken burgers formulated with different levels of gizzard had lower total bacterial, psychrophilic bacteria and *Staphylococcus aureus* counts than control chicken burger. These microbial loads were decreased by increasing the levels of the gizzard. However, the chicken burgers formulated with different levels of MDCM had higher total bacterial, psychrophilic bacteria and *Staphylococcus aureus* counts than control chicken burger. These microbial loads were increased by increasing the levels of the MDCM. This might be due to MDCM had higher microbial load than fresh raw chicken meat and raw gizzard as shown in Table (1). Mohamed and Mansour *et al.* (2012) reported that *psychrotrophic bacteria* counts of beef patties prepared with MDCM (200 g/kg) were significantly higher than those of control beef patties.

The total bacterial counts of all chicken burgers were reduced until the first month of storage followed by a gradual increase up to the end of the storage period. The psychrophilic bacteria were reduced until the third month of storage followed by a slight increase up to the end of the storage period. The *Staphylococcus aureus* of chicken burgers formulated with different levels of gizzard was reduced until the third month of storage followed by a slight increase up to the end of the storage period. However, *Staphylococcus aureus* of chicken burgers formulated with different levels of MDCM was reduced until the second month of storage followed by a slight increase up to the end of the storage period. The reduction of microorganism counts during 1-3 months of storage might be due to the breakdown of the microorganisms cell wall by ice-crystals formed during the freezing process. After these periods of storage, the increase in microorganism counts might be due to the increasing of amino acids and fatty acids produced by hydrolysis of protein and fat during storage consequently lead to suitable conditions for the growth of microorganisms. The similar results were reported by Mohammed *et al.* (2017) for total bacterial and psychrophilic bacteria counts of kobeba.

Sensory properties of chicken burger

Sensory properties of chicken burgers were significantly affected ($p \leq 0.05$) by gizzard or MDCM and their levels as well as storage period (Table 6). Chicken burgers formulated with gizzard had higher ($p \leq 0.05$) scores of taste, odor, color, texture and overall acceptability than chicken burger formulated with MDCM. The sensory properties of chicken burgers formulated with gizzard had rating scores described as like very much (7.52-8.05). However, chicken burgers formulated with MDCM had rating scores ranged between like moderately (6.80) and like very much (7.03-7.64). The chicken burgers formulated with gizzard were more acceptable to Egyptians because it was usual to add gizzard in some foods.

The control chicken burger had significantly higher ($p \leq 0.05$) odor and color scores than chicken burgers formulated with different levels of gizzard and MDCM. The odor and color scores were decreased ($p \leq 0.05$) by increasing the levels of gizzard and MDCM. The non-significant ($p > 0.05$) differences were observed in taste, texture and overall acceptability between control chicken burger and chicken burger formulated with gizzard or MDCM up to 40%. The chicken burger formulated with 60% gizzard or MDCM had lower ($p \leq 0.05$) taste and overall acceptability scores and higher ($p \leq 0.05$) texture score than control chicken burger and chicken burger formulated with gizzard or MDCM up to 40%. The control chicken burger and chicken burgers formulated with different levels of gizzard or MDCM had rating scores described as like very much (7.20-8.54). Generally, the chicken burger could be formulated up to 60% gizzard or MDCM with acceptable sensory properties.

The sensory properties of the chicken burgers were decreased ($p \leq 0.05$) by increasing the storage period. The decrement of sensory properties during storage period might be due to the oxidation potential of fatty acids present in the chicken burger. At the end of the storage period, sensory properties of chicken burgers had rating scores described as like moderately (6.10-6.24). Abdelmageed *et al.* (2013) reported that gizzard can be incorporated into sausages with a percentage greater than 25% with acceptable quality.

Table (6): Sensory properties of chicken burgers as affected by different types and levels of by-products during storage at -18±1°C for 6 months

	Taste	Odor	Color	Texture	Overall acceptability
Type of by-products					
Gizzard	7.90^{a}	7.52^{a}	7.99^{a}	8.05^{a}	7.86^{a}
MDM	7.32^{b}	7.03^{b}	7.64^{b}	6.80^{b}	7.20^{b}
LSD	0.22	0.21	0.33	0.23	0.26
Level of by-products					
0	7.76^{a}	7.78^{a}	8.54^{a}	7.32^{b}	7.85^{a}
20	7.91^{a}	7.63^{b}	8.14^{b}	7.30^{b}	7.75^{a}
40	7.72^{a}	7.35^{c}	7.90^{c}	7.40^{b}	7.59^{a}
60	7.20^{b}	7.20^{c}	7.41^{d}	7.57^{a}	7.35^{b}
LSD	0.21	0.13	0.22	0.16	0.26
Storage period (month)					
0	8.52^{a}	8.43^{a}	8.78^{a}	8.22^{a}	8.49^{a}
1	8.34^{b}	8.21^{b}	8.57^{b}	8.03^{b}	8.29^{a}
2	8.06^{c}	7.93^{c}	8.36^{c}	7.86^{c}	8.05^{b}
3	7.79^{d}	7.61^{d}	8.13^{d}	7.66^{d}	7.80^{c}
4	7.56^{e}	6.99^{e}	7.78^{e}	7.26^{e}	7.40^{d}
5	6.90^{f}	6.49^{f}	7.28^{f}	6.76^{f}	6.86^{e}
6	6.24^{g}	6.10^{g}	6.52^{g}	6.06^{g}	6.23^{f}
LSD	0.16	0.21	0.19	0.15	0.22

Means in the same column with different letters are significantly different ($p \leq 0.05$)

Conclusion

From the above results, it could be concluded that chicken burger formulated with gizzard or MDCM up to 60% as low-cost by-product resulted inacceptable products with good chemical, physical, microbiological and sensory properties throughout the storage period at -18±1°C for 6 months.

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خصائص جودة برجر الدجاج المحضر بمستويات مختلفة من القانصة ولحم الدجاج المنزوع العظم ميكانيكيا أثناء التخزين بالتجميد

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الملخص العربي

تم انتاج برجر من لحم الدجاج و ذلك باستبدال لحم الدجاج بنسب ٢٠، ٤٠، ٦٠٪ بكل من القانصه ولحم الدجاج المنزوع العظم ميكانيكيا وتم تقييم التركيب الكيميائى، وخصائص الجودة الفيزيائية والكيميائية والتحاليل الميكروبيولوجية والخصائص الحسية لبرجر الدجاج أثناء التخزين بالتجميد على -١٨ºم لمدة ستة أشهر. وكان برجر الدجاج المنتج باستبدال لحم الدجاج بالقانصه أعلى في الرطوبه ٧٠,٥٦٪ والبروتين الخام ١٧,٢٣٪ والرماد الكلي (٢,٩٧٪ وأقل في النيتروجين الكلى المتطاير ١٤,٤٦مجم/١٠٠جم وحامض الثيوباربيوتريك ٠,٥٤ مجم مالونالدهيد/كجم عينة) ورقم البيروكسيد ٣,٧٤ مللي مكافئ/كيلوجرام دهن ورقم الحموضة ٦.٤٢ وقيم القدرة على الإحتفاظ بالماء ٣,٥٠ سم٢/٠,٣جم والبلاستيكيه ٣,١١ سم٢/٠,٣جم مقارنة بالبرجر المنتج باستبدال لحم الدجاج بلحم الدجاج المنزوع العظم ميكانيكيا، ويقل المحتوي من البروتين الخام والرماد الكلي بينما يزداد المحتوي من الدهن الخام والنيتروجين الكلى المتطاير وحامض الثيوباربيوتريك بزيادة نسبة استبدال القانصة أو لحم الدجاج المنزوع العظم ميكانيكيا في برجر الدجاج، ويحدث إنخفاض فى العد الكلى للبكتريا، والبكتريا المحبة للبرودة وبكتيريا الإستافيلوكوكس إيريس بزيادة نسبة استبدال القانصة في برجر الدجاج ويحدث عكس هذه النتائج بزيادة نسبة استبدال لحم الدجاج المنزوع العظم ميكانيكيا وحصل برجر الدجاج المنتج باستبدال لحم الدجاج بالقانصة على درجات تقييم جيد جدا (7.52-8.05) فى جميع الخصائص الحسيه، بينما حصل البرجر المحضر باستبدال لحم الدجاج بلحم الدجاج المنزوع العظم ميكانيكيا على درجات التقييم تتراوح ما بين المتوسط (6.80) الى جيد جد ا (7.03-7.64)، وبالرغم من حدوث زيادة في كل من النيتروجين الكلى المتطاير وحامض الثيوباربيوتريك ورقم البيروكسيد والحمل الميكروبي بينما تنخفض الخصائص الحسية بزيادة مدة التخزين بالتجميد الا ان عينات البرجر احتفظت بجوده مقبولة.

الكلمات الدالة: برجر الدجاج – لحم الدجاج – القانصة– لحم الدجاج المنزوع العظم ميكانيكيا.

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