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Utilization of some Chicken Edible Internal Organs and Wheat Germ in Production of Sausage

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ABSTRACT

Relatively huge amounts of wheat germ are produced annually as a by-product of wheat milling industry in Egypt. Wheat germ had high amounts of protein, ash, fat, carbohydrates and bioactive compounds. The aim of the work was to study the possibility of using chicken's gizzard and liver in production of sausage and effect of substitution of gizzards and liver meat by wheat germ at levels 5, 10, 15 and 20% on proximate composition, physical properties, sensory characteristics and microbiological criteria and after storage at 4ºC for 15 day. A sensory evaluation showed that gizzards and liver sausage was very acceptable from the standpoint of color, taste, odor, juiciness, tenderness and overall acceptability. Storage at 4ºC for 15 day of studied sausage caused slightly decreased in moisture, crude protein and fat but increase in total carbohydrates. The results of microbiological analysis showed that refrigerated storage of gizzards and liver sausage samples lead to increase in the total viable bacterial count and psychrophilic count whereas all samples was free from coliform, *Salmonella* and *Shigella*. It is recommended to use chicken gizzards and liver in sausage processing after good and quick cleaning with a percentage exceeds 20% of wheat germ.

Keywords: Gizzards and liver sausage, Chemical composition, Microbiological aspects, Sensory evaluation, refrigerated storage

INTRODUCTION

Poultry is the world's second most consumed type of meat, and chicken meat dominates the world poultry consumption over 70% (Jokanovic *et al.*, 2014). The increasing price of lean meat and processed meat products encouraged researchers to study alternative protein sources, particularly chicken gizzards that are commonly used by in direct consumption without processing (Gorska *et al.*, 1988 and Ali, 2004).

Chicken by-products are eaten widely due to their low cost, their low content in fat and the short period of time needed in preparation (Alvarez-Astorga *et al*., 2002). In the last few decades, the amount of available meat byproducts from slaughterhouses, meat processors and wholesalers has increased considerably (Darine *et al*., 2010).

Liver sausages are basically consisted from ground meats, liver and fat to which may be added various cured meats, by-products or nonmeat ingredients, such as spices, milk powder, phosphates etc (FAO, 1985).

Many edible meat byproducts are down-graded because of the lack of a profitable market. Since the yield of edible by-products for chickens is from 5 to 6% of the live weight; more attention should be given to edible by-products, especially because the majority of by-products offer a range of foods which are nutritionally attractive, with high protein content and good nutritional properties due to the presence of many essential nutrients and have a wide variety of flavours and textures (Ockerman and Hansen, 1988; Daros *et al*., 2005). Liver can be baked, boiled, fried (often served as liver and onions) or eaten raw (liver sashimi), but is perhaps most commonly made into spreads, or sausages such as Braunschweiger and liverwurst (Myhre, 2003)

Wheat germ which constitutes only about 2% of the whole wheat grain is removed in the milling process for industrial reasons. Rolling milling by milling rolls are operated to separate wheat germ which forms an important and useful by-product of the milling industry (Attia and Abou-Ghariba, 2011). Moreover, wheat germ has relatively high content of protein, fat and minerals. It is a good source of vitamin B and E (El-Nagar, 2005). Also, Tsadik and Emire (2015) showed that the main of byproducts wheat milling industries, wheat germ and bran have been recognized as an outstanding sources of protein, dietary fiber, trace minerals, antioxidants, phytonutrients' and allied micronutrients. Defatted wheat germ (DWG), the main by-product in the wheat germ oil extraction process, has relatively high protein content (30%) and contains many other nutritional ingredients, such as carbohydrates, pigments, minerals, and B vitamins (Zhu *et al*., 2006).

The objectives of this study are to evaluate the effects of partial replacement of chicken gizzards and liver meat by wheat germ flour on the quality characteristics of sausage. Also, the effects of storage periods on the quality characteristics of gizzard and liver sausage are evaluated.

MATERIALS AND METHODS

Materials:

Chicken gizzards and liver were simultaneously taken on day of chicken slaughtering from factory that prepared ready to eat chicken products, Alexandria city, Egypt. Gizzard and liver were collected under hygienically conditions, cleaned and packed in polyethylene bags and stored in freezer (- 18ºC).

Wheat germ was obtained from Middle and West Delta Milling Company at Tanta, Egypt. Spices, salt and sugar were obtained from local market of Tanta.

Beef fat (Tallow) and spices were obtained from local market of Tanta city, Egypt. Fresh natural casings (sheep small intestines) were obtained from the local market at Tanta city, Egypt in clean scraped ready form. They were salted and kept in a freezer.

Methods:

Manufacture of sausage:

The frozen gizzard and liver were thawed overnight in the refrigerator and minced in meat mincer using 8 mm plate before use.

Sausages were prepared according to the recipe of Henrickson (1978) and El-Wakeil *et al*. (1994). The chicken gizzards and liver were ground into two parts (gizzards and liver) separately to pass through 44 mm sieve using electric grinder. The minced gizzards and liver meats were mixed manually with ingredients (Table 1) and water then further mixed uniformly using mixer grinder for 30 s. Two formulations were prepared for each sausage kind (gizzards sausage and liver sausage) by replacement of 0, 5, 10, 15 and 20% of wheat germ flour. Each batch of the sausage mix (1kg each) of both the chicken gizzards and liver was transferred to a stuffer for extruding into natural casing (sheep intestine). After stuffing each of the sausage mix into casing, each segment of about 50g each was tied with thread at both ends and labeled appropriately. Sausage were packed in polyethylene packages and stored under refrigerated storage condition for a period of 15 days (0, 5, 10 and15 days).

Table 1. Ingredient used in manufacturing gizzards or liver sausage

Ingredient	Amount (g)	Spices mixture*	Amount (g)
Gizzards or liver meat	70.0	Black pepper	30.0
Beef fat	12.0	Red pepper	8.0
Sodium chloride	2.3	Cumin	15.0
Water (as ice)	9.3	Nutmeg	8.0
Starch	3.0	All spices	15.0
Garlic	1.0	Cloves	8.0
Onion	1.2	Ginger	8.0
Spices mixture*	1.2	Coriander	8.0

Analytical methods

Gross Composition

Moisture, protein, total fat, total ash and crude fiber contents were determined according to the methods described in AOAC (2010). Total carbohydrates were calculated based on the following equation:

Total carbohydrates (g/100g) = 100 – (g moisture + g protein + g fat +g ash) (Barros *et al*., 2008).

All analyses were performed in duplicate

Minerals content:

Minerals content of calcium, magnesium, iron, manganese, copper and zinc was determined using Perkin Elmer Atomic Absorption Spectrophotometer (Model 2380) according to the AOAC (1998). Potassium and sodium were determined using flame Photometer according to the AOAC (1998). Phosphorus was determined by colorimetric method at 680 nm using speckol spectrocolorimeter (Pearson,1981).

Physical analysis

pH value

pH value of raw chicken gizzards and liver sausage samples was determined as described by Hood (1980). Ten grams of sample was homogenized with 100ml distilled water and measured using a digital pH-meter (Jenway 608 USA) conductivity and pH meter.

Cooking loss and cooking yield

Prepared gizzards and liver sausage samples were weighted before cooking and then allowed to cool after cooking to room temperature. After cooling, the cooked gizzards and liver sausage samples were reweighted and the cooking loss was calculated according to Lee *et al.* (2008) as follows:

$$\text{Cooking loss (g/100g)} = Wr - Wc \times 100 / Wr$$

Where

Wr: the weight of raw sausage (g).

Wc: the weight of cooked sausage (g)

Cooking yield of different sausage samples was measured by subtracting cooking loss from 100.

Water holding capacity

Water Holding Capacity (WHC) of different gizzards and liver sausage treatments were measured immediately after processing according to the filter press method of Soloviev (1966).

Sensory Evaluation

The sausages were shallow fried in vegetable oil for 5– 10 min and served to a panel of seventeen judges, were asked to evaluate the quality in terms of appearance, flavour, tenderness, and over all acceptability using eight-point hedonic scale (Keeton 1983). They were requested to record their preferences on an 8 point hedonic scale (8=like extremely, 1=dislike extremely).

Microbiological examination:

The microbiological examination of chicken gizzards and liver sausage samples was assessed on the basis of total plate count, moulds and yeasts, coliform group, *Salmonella*, *Shagilla* and psychrophilic count were carried out according to APHA (1992).

Statistical analysis:

The results were statistically analyzed by analysis of variance as described by SPSS (1997). Significant differences among individual means were analyzed by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical composition of chicken gizzards, liver and wheat germ

The highest moisture content was found in gizzard (76.22%), followed by liver (70.45%), while wheat germ recorded the lowest value (8.84%) (Table, 2). In this respect, Abu-Salem and Abou-Arab (2010) showed that raw chicken liver contained 24.60% protein, 6.00% fat, 1.40 % ash, and 66.80% moisture. It was also reported that gizzard meat is having the composition as 72.2% moisture, 4.2% fat, 18.2% protein with 118 calories per 100g and the meat is mostly utilized for flavoring in soup and stuffing mixes (Campbell and Brettkenny, 1994). Buclaw *et al*. (2018) reported that the highest ash content was found in liver (1.74%), followed by heart (1.20%) and gizzards (0.95%).

Wheat germ contained 25-30% protein, 8-10% fat 47% carbohydrate and supplied body with 374 kcal/ 100g USDA (2005).

Table 2. Gross chemical composition of gizzards, liver and wheat germ

Constituents (%)	Gizzard	Liver	DFWG
Moisture	76.22± 0.23	70.45± 0.07	8.84 ±0.09
Crude protein	16.06±0.16	19.42±0.33	33.92±1.03
Ether extract	1.21±0.42	3.29±0.15	12.6±0.31
Ash	0.89±0.53	1.42±0.06	7.37±0.22
Crude fiber	ND	ND	4.83±0.61
Total carbohydrates	5.62±0.13	5.42±0.24	32.44±0.06
pH	6.27	6.28	6.22
Minerals content (mg/100g)			
Calcium (Ca)	11.37	13.46	149.27
Potassium (K)	217.75	280.51	720.11
Magnesium (Mg)	21.12	24.06	211.09
Sodium (Na)	87.19	92.45	7.68
Phosphorus (P)	138.99	274.93	2489.53
Copper (Cu)	2.75	6.42	3.07
Iron (Fe)	18.06	80.86	6.26
Manganese (Mn)	0.937	3.47	12.72
Zinc (Zn)	18.64	26.13	1.28

ND = not determined

Results are expressed as mean values of triplicates ± standard deviations

The obtained results show that raw chicken liver contained higher content of Fe (868.6 mg/100g) and Zn (26.13 mg/100g) compared with gizzards (18.06 and 18.64mg/100g, respectively) and wheat germ 6.26 and 1.28mg/100g, respectively). These data are in accordance with those reported by Abu-Salem and Abou-Arab (2010), who found that raw chicken liver had high concentrations of

Fe (83.65µg/g) and Zn (50.75µg/g). Zhu *et al*. (2006) showed that the main mineral constituents of defatted wheat germ flour (DWGF) were potassium, magnesium and calcium.

Chemical composition of prepared sausage:

Data in Table (3) displays that crude protein, ash and crude fiber contents of fresh chicken gizzards and liver sausage were gradually increased as the amounts of defatted wheat germ (DFWG) in its formula increased, while moisture and ether extract contents decreased. For example, the protein content of control samples was 59.45 and 58.83 for gizzards and liver sausage increased to 36.84 and 37.87% in sausage contain 20% DFWG, respectively. This may be due to relatively high protein, ash and crude fiber in raw DFWG (Ahmed, 2008). Also, carbohydrate content decreased with the increased of replacement levels, the control sample had relatively the highest value of carbohydrate content

Influence of DFWG on physical properties of sausage prepared from chicken gizzards and liver:

Physical properties of sausage prepared from chicken gizzards and liver:

Table (3) shows physical properties of fresh chicken gizzards sausage and liver sausage contained different levels of DFWGF replacement (5, 10, 15 and 20%). pH value of gizzards and liver sausage increases by increasing substitution ratio of DFWG. This may be due to the specificity of plant protein and its alkaline ash (Karen *et al.*, 1997).

Yang *et al*., (2007) used cooking loss to measure the amount of juices lost during cooking, while the water-holding capacity was used to determine how well the juices were retained in the cooked product.

Water holding capacity (WHC) is the ability of meat to retain its water or added water during application of external forces such as cutting, heating, grinding or pressing (Judge *et al*., 1990).

Cooking loss of chicken gizzards and liver sausage samples gradually decreased and cooking yield increased by increasing the ratio of DFWG. Whereas, sausage made of gizzards and liver only (control) had the highest value of cooking loss (32.66 and 33.16%, respectively) and lowest value of cooking yield (67.34 and 66.83%, respectively). Cooking yield was gradually increased as the DFWG ratio in studies sausage increased to reach the maximum by 20% substitution 80.16 and 81.33% for gizzards and liver sausage respectively. These results are in the line with this reported by Gnanasambandam and Zayas (1992) who stated that addition of wheat germ protein flour to sausage or frankfurter decrease cooking loss.

From the tabulated data, it is clear that WHC increase as the substitution level of DFWGF increased. For instance, WHC of control gizzards and liver sausage was 64.04 and 58.56%, respectively increased to 76.55 and 72.59% in sausage contained 20% DFWG. These results are agreement with those of Ahmed (2008) who reported that the control sausage sample had relatively the lowest WHC and the sausage contained 15% wheat germ had highest WHC. The chicken gizzards and liver sausage samples were firm in texture. This may be due to the binding characteristics of the protein additives in the sausage samples; hence, the available moisture was bound with the sausages.

Table 3. Chemical and physical properties of gizzards and liver sausage containing wheat germ

Parameters (%)	Gizzard sausage					Liver sausage				
	0%	5%	10%	15%	20%	0%	5%	10%	15%	20%
					Chemical composition					
Moisture	59.45^{a}	58.22^{b}	57.52^{c}	56.86^{d}	55.19^{e}	58.83^{a}	58.36^{b}	57.54^{c}	56.67^{d}	55.86^{e}
Crude protein	32.60^{e}	33.62^{d}	34.50^{c}	36.40^{b}	36.84^{a}	34.56^{d}	34.78^{d}	35.54^{c}	37.36^{b}	37.87^{a}
Ether extract	19.64^{a}	19.23^{b}	18.63^{c}	18.32^{d}	17.54^{e}	19.54^{a}	18.67^{b}	18.23^{c}	17.57^{d}	17.31^{e}
Ash	3.82^{e}	4.29^{d}	5.55^{c}	6.32^{b}	7.86^{a}	3.66^{e}	4.35^{d}	4.88^{c}	6.35^{b}	7.18^{a}
Crude fiber	2.25^{d}	2.86^{d}	3.31^{c}	4.45^{b}	5.33^{a}	2.44^{e}	3.08^{d}	3.39^{c}	4.27^{b}	5.26^{a}
Carbohydrates	41.69^{a}	40.00^{b}	38.02^{c}	34.51^{d}	32.43^{e}	39.80^{a}	39.12^{a}	37.96^{b}	34.45^{c}	32.38^{d}
					Physical properties					
pH	6.18^{d}	6.26^{c}	6.33^{b}	6.39^{a}	6.48^{a}	6.14^{d}	6.22^{c}	6.24^{c}	6.30^{b}	6.41^{a}
Cooking loss (%)	32.66^{a}	28.45^{b}	27.32^{c}	22.63^{d}	19.84^{e}	33.17^{a}	28.34^{b}	23.56^{c}	20.66^{d}	18.67^{e}
Cooking yield (%)	67.34^{e}	71.55^{d}	72.68^{c}	77.37^{b}	80.16^{a}	66.83^{e}	71.66^{d}	76.44^{c}	79.34^{b}	81.33^{a}
WHC	64.04^{e}	68.42^{d}	70.36^{c}	74.78^{b}	76.55^{a}	58.56^{e}	61.25^{d}	64.32^{c}	68.50^{b}	72.59^{a}

Values are means, In column means having superscript letters are not significantly different at 5% level

Sensory evaluation

Sensory characteristics of fried gizzards and liver sausage samples as affected by defatted wheat germ (DFWG) substitution are given in Table (4). Color of fresh gizzards and liver sausage was influenced by presence wheat germ flour. Whereas, the color of control sausage samples had significantly ($p \leq 0.05$) higher scores than those of substituted ones with DFWG. For example, color of gizzards and liver sausage free from DFWG (control) was 7.6 and 6.7 decreased to 6.4 and 6.2, respectively in sausage containing 20% DFWG. The control sausage samples (processed from chicken gizzards or liver) scored high values in deviation from meat aroma that could be due to flavor of wheat germ flour. Aroma and flavor are probably the most important attributes that influence the sensory properties of comminuted meat product extended with non-meat protein additives (Ganasambandam and Zayas, 1992).

The relative high scores of tenderness and juiciness in the gizzards and liver sausage samples with replacement levels 10% may be due to high water binding of these samples which contain DFWG.

Table 4. Sensory characteristics of gizzards and liver sausage as affected by defatted wheat germ flour substitution

Substitution level %	Color	Taste	Odor	Juiciness	Tenderness	Overall acceptability
			Gizzards sausage			
0%	7.6^{a}	7.6^{b}	7.8^{a}	7.6^{b}	7.6^{c}	7.8^{b}
5%	7.4^{b}	7.9^{a}	7.3^{b}	7.7^{a}	7.7^{b}	7.9^{a}
10%	7.0^{b}	7.5^{b}	6.8^{c}	7.7^{a}	7.9^{a}	7.7^{c}
15%	6.7^{c}	7.0^{c}	6.4^{d}	6.7^{c}	6.8^{d}	6.9^{d}
20%	6.4^{d}	6.7^{d}	6.0^{e}	6.3^{d}	6.3^{e}	6.4^{e}
			Liver sausage			
0%	6.7^{c}	7.8^{a}	7.6^{a}	7.8^{a}	7.8^{b}	7.7^{a}
5%	6.8^{b}	7.6^{b}	7.4^{b}	7.5^{b}	7.9^{a}	7.5^{b}
10%	6.9^{a}	7.6^{b}	7.0^{c}	7.4^{c}	7.9^{a}	7.0^{c}
15%	6.5^{d}	7.2^{c}	7.1^{c}	7.4^{c}	7.0^{c}	6.8^{d}
20%	6.2^{e}	6.5^{d}	6.6^{d}	6.9^{d}	6.7^{d}	6.5^{e}

Values are means, In column means having superscript letters are not significantly different at level 5%

It can be noted from the same table that panelist's overall acceptability scores were markedly ($p \leq 0.05$) decreased as the substitution level of DFWG increased.

Effect of Storage period at 4ºC on Proximate Composition of gizzards and liver sausage

As shown in Table (5), storage at 4ºC for 15 day for prepared gizzards and liver sausage caused slightly decrease in moisture content. Since, moisture content of fresh sausage was 59.45 and 58.83% which decreased to 55.42 and 55.45%, respectively in gizzards and liver sausage without wheat germ (control). The lowest moisture content was found in gizzards and liver sausage contains 20% DFWG after 15 day storage at 4ºC (52.59 and 52.26%, respectively). The decrease in moisture content may be due to slight evaporation of moisture during storage. These results disagree with those reported by Abdelmageed *et al*. (2013) who found the moisture level of 100% GS increased significantly on storage period, this may be attributed to the absorption of moisture by the samples, and/or due to the water produced at the end product from the different constituents as a result of microbial activity.

The protein content was decreased during storage of sausage (both gizzards and liver). This may be due to the destruction of the protein by microorganisms. These results agree with Abdelmageed *et al*. (2013).

The fat level was decreased during the storage period; this could be attributed to the rancidity and destruction of fats or hydrolysis of triglycerides by the microorganisms or lipases.

Table 5. Proximate composition of gizzards and liver sausage supplemented with different levels of DFWG during storage period at 4ºC for 15 day

Storage period	Gizzards sausage					Liver sausage				
(day)	0	5	10	15	20	0	5	10	15	20
					Moisture content					
0	59.45^{a}	58.22^{a}	57.52^{a}	56.86^{a}	55.19^{a}	58.83	58.36	57.54	56.67	55.86
5	58.23^{b}	57.53^{b}	56.44^{b}	55.28^{b}	54.87^{b}	57.55	57.27	56.33	55.73	54.66
10	57.19^{c}	55.64^{c}	55.08c	54.52^{c}	53.25^{c}	56.45	56.33	55.56	54.45	53.43
15	55.42^{d}	54.47^{d}	54.42^{d}	53.66^{d}	52.54^{d}	55.43	55.21	54.29	53.38	52.26
					Crude protein					
0	32.60^{a}	33.62^{a}	34.50^{a}	36.40^{a}	36.84^{a}	34.56^{a}	34.78^{a}	35.54^{a}	37.36^{a}	37.87^{a}
5	32.33^{b}	33.05^{b}	33.89^{b}	35.76^{b}	36.21^{a}	34.14^{b}	34.05^{b}	35.11^{b}	36.87^{b}	37.13^{a}
10	31.49^{b}	32.77^{c}	33.06^{c}	34.55^{c}	35.88^{b}	33.78^{c}	33.84^{c}	34.96^{c}	35.74^{c}	36.68^{b}
15	30.88^{c}	31.84^{d}	32.56^{d}	33.36^{d}	34.52^{c}	32.33^{d}	33.01^{d}	34.25^{d}	35.00^{d}	35.54^{c}
					Ether extract					
0	19.64^{a}	19.23^{a}	18.63^{a}	18.32^{a}	17.54^{a}	19.54^{a}	18.67^{a}	18.23^{a}	17.57a	17.31a
5	19.22^{a}	18.67^{b}	17.75^{b}	17.72^{b}	17.10^{a}	18.77^{b}	18.14^{a}	17.67^{b}	17.04^{b}	16.38^{b}
10	18.34^{c}	18.34^{c}	17.08^{c}	17.15^{b}	16.73^{c}	18.32^{b}	17.64^{b}	17.04^{c}	16.57^{c}	15.89^{c}
15	17.56^{d}	17.87^{d}	16.48^{d}	16.34^{c}	16.00^{d}	17.23^{c}	15.88^{c}	16.49^{d}	15.85^{d}	15.16^{d}
					Ash					
0	3.82^{a}	4.29^{a}	5.55^{a}	6.32^{a}	7.86^{a}	3.66^{a}	4.35^{a}	4.88^{a}	6.35^{a}	7.18^{a}
5	3.71^{a}	4.02^{b}	5.28^{a}	6.11^{b}	7.49^{a}	3.45^{a}	4.20^{a}	4.65^{a}	6.03^{a}	6.89^{b}
10	3.54^{b}	3.79^{b}	5.04^{b}	5.96^{c}	7.14^{b}	3.20^{b}	3.89^{b}	4.38^{b}	5.77^{b}	6.36^{c}
15	3.23^{c}	3.45^{c}	4.75^{c}	5.78^{c}	6.87^{c}	2.89^{c}	3.67^{c}	3.89^{c}	5.21^{c}	5.93^{d}
					Crude fiber					
0	2.25^{a}	2.86^{a}	3.31^{a}	4.45^{a}	5.33^{a}	2.44^{a}	3.08^{a}	3.39^{a}	4.^{27a}	5.26^{a}
5	2.12^{b}	2.73^{b}	3.11^{b}	4.29^{a}	5.10^{b}	2.23^{b}	2.98^{a}	3.12^{b}	4.10^{b}	5.11^{b}
10	2.00^{c}	2.56^{c}	3.00^{c}	4.11^{b}	4.95^{c}	2.12^{c}	2.78^{b}	3.00^{a}	3.89^{c}	5.00^{c}
15	1.87^{d}	2.45^{c}	2.89^{d}	4.00^{c}	4.78^{c}	2.01^{d}	2.46^{b}	2.83^{d}	3.67^{c}	4.79^{d}
					Total carbohydrates					
0	41.69^{d}	40.00^{d}	38.02^{d}	34.51^{d}	32.43^{d}	39.80^{d}	39.12^{d}	37.96^{d}	34.45^{d}	32.38^{d}
5	42.72^{c}	41.53^{c}	39.97c	36.12^{c}	34.10^{c}	41.41^{c}	40.63^{c}	39.45^{c}	35.96^{c}	34.49^{c}
10	44.79^{b}	42.54^{b}	41.82^{b}	38.23^{b}	35.30^{b}	42.58^{b}	41.17^{b}	40.62^{b}	38.03^{b}	36.07^{b}
15	46.46^{a}	44.39^{a}	43.32^{a}	40.52^{a}	38.02^{a}	45.54^{a}	43.63^{a}	42.54^{a}	40.27^{a}	38.58^{a}

Values are means, in column means having superscript letters are not significantly different at 5% level
Crude protein, ether extract, ash and carbohydrates are represented based on dry weight bases

Microbial examination of gizzards and liver sausage supplemented with different levels of wheat germ during storage period at 4ºC for 15 day

The total plate count was gradually increased with the progress of cold storage of sausage made from gizzards and liver containing different level of wheat germ Table (6). Addition of chicken gizzard slightly increased total bacterial count of the sausage sample (Ali, 2014). However, fresh gizzards sausage (control) contained 2.3×10^{3} cfu/g total plate which increased to 6.4×10^{6} after 15 day at 4ºC. These results were acceptable as they fall within the confidence limits (10^{7} cfu/g) of total viable counts of (chilled and unfrozen) fresh meat products like burger, sausage, etc.) required by the Sudanese Standardization Metrology Organization (SSMO, 2001). Total bacterial count of burger samples slightly decreased during 6 days of cold storage at 4ºC whereas after day 6 there was gradual increase in all burger samples (Zaki, 2018).

Coliforms are group of microorganisms which include *E. coli* an organism that causes bacteria dysentery and food infection Abdelmageed *et al*. 2014). The data in Table (6) showed that coliforms, *Sallmonella* and *Shigella* were not detected in all sausage samples either fresh or during refrigerated storage at 15 days. This indicated good hygienic practices during processing and storage (Emam and Mohamed, 2004).

From the obtained results, it could be noticed that psychrophilic bacterial count increased as the storage time prolonged. The psychrophilic count was 12.66 and 14.32×102 cfu/g in fresh control gizzards and liver sausage respectively which increased to 16.20 and 17.41×102 cfu/g, respectively after 15 day of refrigerated storage.

Similarly, psychrophilic bacterial count of gizzards and liver sausage containing 20% wheat germ were 4.34 and 6.55×102 cfu/g increased to 9.13 and 10.26×102 cfu/g, respectively. Increase in psychrophilic count may be due to attributed to growth preference of psychrophilic organisms during storage at refrigeration temperature (Kumar, 2009). Kala *et al.* (2007) reported that the microbial quality with regard to yeast and mould counts was satisfactory up to 9th of storage at 4ºC.

It is obvious from the results that control sausage made from either gizzards or liver involved much psychrophilic bacteria than that found in the sausage supplemented with defatted wheat germ. This may be related to antimicrobial activity of bioactive compounds that present in defatted wheat flour (Mahmoud *et al*., 2015). These results accordance with those Zaki (2018) who reported that burger formulated with 3 and 5% of chia seeds showed lower count of psychrotrophic bacteria compared with control samples.

Table 6. Microbial examination of gizzards and liver sausage supplemented with different levels of wheat germ during storage period at 4ºC for 15 day (×cfu/g)

Storage	Gizzards sausage					Liver sausage				
period (day)	0	5	10	15	20	0	5	10	15	20
	Total bacterial count									
0	$2.3x10^4$	$4.2x10^3$	$4.0x10^3$	$8.3x10^2$	$6.1x10^2$	$6.3x10^4$	$4.7x10^3$	$3.2x10^3$	$5.3x10^2$	$2.6x10^2$
5	$5.2x10^4$	$1.9x10^4$	$2.3x10^4$	$1.4x10^3$	$7.3x10^3$	$5.1x10^5$	$3.3x10^4$	$1.3x10^4$	$2.4x10^3$	$3.5x10^2$
10	$1.3x10^5$	$4.4x10^4$	$4.6x10^4$	$9.3x10^3$	$9.2x10^3$	$7.4x10^5$	$6.2x10^4$	$3.2x10^4$	$3.3x10^3$	$4.1x10^3$
15	$6.4x10^6$	$2.3x10^5$	$1.3x10^5$	$1.3x10^4$	$1.3x10^4$	$3.5x10^6$	$4.3x10^5$	$1.3x10^5$	$4.6x10^4$	$6.0x10^3$
	Moulds and Yeasts ($\times10^2$ cfu/g)									
0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10	4.72	4.11	3.86	3.42	3.21	4.83	4.12	3.76	3.44	3.18
15	6.33	5.41	4.66	4.06	3.65	6.46	5.23	4.22	3.87	3.35
	Psychrophilic counts ($\times10^2$cfu/g)									
0	12.66	10.32	8.33	6.84	4.45	14.32	13.26	12.51	10.36	6.55
5	13.45	11.55	9.66	7.34	5.33	15.33	14.21	13.22	11.61	7.65
10	14.11	12.42	10.23	8.55	5.87	16.52	15.56	13.85	12.75	9.33
15	16.20	13.31	12.52	10.07.	9.13	17.41	16.17	14.37	13.43	10.26

CONCLUSION

Chicken gizzards and liver as a low cost alternative source of protein can be incorporated into sausages with a percentage greater than 25% which can produce a product with acceptable quality to the consumers and increased its protein and total minerals contents. It can be recommended production of gizzards and liver sausages with the addition of this valuable and cheap byproduct (wheat germ) to gain more functional, healthy and nutritional benefits.

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أستخدام بعض الأعضاء الداخلية للدجاج الصالحة للآكل وجنين القمح فى إنتاج السجق

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يتم إنتاج كميات كبيرة سنويا من جنين القمح فى مصر والذى ينتج كأحد النواتج الثانوية خلال عمليات صناعة طحن القمح. ويحتوى جنين القمح على كميات مرتفعة من البروتين , الرماد , الدهن , الكربوهيدرات والمركبات النشطة حيويا. لذا الهدف من الدراسة هو إمكانية إستعمال كل من قوانص وكبد الدجاج فى عمل سجق وتأثير إحلال لحم القوانص والكبد بجنين القمح عند مستويات ٥, ١٠, ١٥, ٢٠% على التركيب الكيماوى والخصائص الفيزيائية والحسية والجودة الميكروبية , وبعد التخزين على ٤°م لمدة ١٥يوم.أوضحت نتائج التقييم الحسى أن السجق المصنع من قوانص وكبد الدجاج كانت مقبولة جدا من ناحية اللون والطعم , الرائحة , العصيرية , الطراوة والقبول العام. التخزين على ٤°م لمدة ١٥ يوم أدى إلى إنخفاض محتوى كل من الرطوبة , البروتين الخام , والدهن وزيادة محتوى الكربوهيدرات. أوضحت نتائج التحليل الميكروبيولجى أن التخزين المبرد لعينات سجق قوانص وكبد الدجاج أدى لزيادة العد البكتيرى وأعداد البكتريا المحبة للبرودة , فى حين كانت كل العينات خالية من بكتريا الكوليفورم , السالمونيلا , والشيجيلا. لذا يوصى بإستعمال قوانص وكبد الدجاج فى تصنيع السجق بعد التنظيف الجيد والسريع والتدعيم بنسبة لا تزيد عن ٢٠% من جنين القمح.