

## DETERMINATION OF SOME MINERALS IN BREAST, THIGH, LIVER AND GIZZARD OF CHICKEN

**Short title:** Evaluation of minerals in chicken

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### ABSTRACT

The present study aimed to assess the mineral content in chicken meat (thigh and breast) and organs (liver and gizzard) in Assiut City, Egypt. 100 random samples of fresh chicken samples (25 for each) were collected during the period from March to May 2021 from different butcher's markets. Samples were subjected to sensory and chemical evaluation. The findings revealed that the examined samples have satisfied scores of sensory in which color means were  $8.24 \pm 0.13$ ,  $8.20 \pm 0.13$ ,  $8.20 \pm 0.13$ ,  $8.12 \pm 0.13$  odor means were  $8.24 \pm 0.12$ ,  $8.08 \pm 0.14$ ,  $8.24 \pm 0.13$ ,  $8.16 \pm 0.14$  taste means were  $8.04 \pm 0.14$ ,  $7.76 \pm 0.13$ ,  $7.80 \pm 0.13$ ,  $8.04 \pm 0.14$  and overall acceptance means were  $8.20 \pm 0.12$ ,  $8.16 \pm 0.13$ ,  $8.00 \pm 0.12$ ,  $8.12 \pm 0.15$  in thigh, breast, liver and gizzard, respectively. The findings revealed that the examined samples have satisfied scores of minerals content in which Ca scores were  $36.24 \pm 1.71$ ,  $23.56 \pm 1.46$ ,  $24.88 \pm 1.25$ ,  $25.65 \pm 2.09$  Ph scores were  $148.00 \pm 5.01$ ,  $79.24 \pm 4.94$ ,  $100.70 \pm 5.29$ ,  $72.87 \pm 5.94$ ; Fe scores were  $3.20 \pm 0.17$ ,  $3.70 \pm 0.25$ ,  $10.22 \pm 0.52$ ,  $3.29 \pm 0.35$ ; Mg scores were  $18.57 \pm 2.06$ ,  $10.24 \pm 0.88$ ,  $3.47 \pm 0.38$ ,  $3.57 \pm 0.25$  and Zn scores were  $1.19 \pm 0.06$ ,  $0.77 \pm 0.12$ ,  $2.27 \pm 0.20$ ,  $3.01 \pm 0.26$  in thigh, breast, liver and gizzard, respectively. In chicken meat, phosphorus is thought to be the most prevalent trace element, followed by calcium, magnesium, iron, and zinc.

**Keywords:** Chicken, minerals, liver, gizzard.

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### INTRODUCTION

The global consumption of poultry meat and its byproducts is increasing (Mielnik *et al.*, 2002). The second most popular form of meat consumed worldwide

is poultry, and over 70% of that consumption is made up of chicken flesh. According to Somsen *et al.* (2004), the current pace of global growth is around 5% per year. Due to its affordable pricing compared to other meats and its health benefits, poultry is steadily growing in popularity across the globe (Bostami *et al.*, 2017). In most religions and cultures around the world, chicken is one of the most commonly consumed meat varieties. This suggests that a sizable number of by-products from chicken slaughterhouses are produced every day (Seong *et al.*, 2015).

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Internal organs (heart, liver, spleen, and kidney), which account for a sizable portion of a chicken's live weight and produce yields ranging from 5 to 6 percent depending on the age of the animal, are among the edible chicken by-products in general (Ockerman and Basu, 2004). Minerals are essential building blocks for hormones, enzymes, and other physiologically active substances. A number of minerals are crucial for the immune system to function at its best. Both the innate immune system and the adaptive immunological response are affected by this. As a result, the availability of minerals can affect one's susceptibility to infections and can also affect how chronic diseases manifest (Calder *et al.*, 2020; Maggini *et al.*, 2018). Minerals are considered micro-nutrients since the body only requires trace amounts of these substances. Major minerals (macro-minerals) and trace minerals (micro-minerals) are the two main categories into which minerals are separated. Calcium (Ca), magnesium (Mg), and phosphorus (P) are among the major minerals. Zinc (Zn) and iron (Fe) are trace minerals. Minerals play important roles in the human body's ability to carry out essential tasks for a healthy and long life, such as transferring nerve signals and developing strong bones. A variety of minerals can be used to create various hormones, as well as control a regular heartbeat. Most micro-elements (Fe, Mg, and Zn) are crucial as structural components in many human enzymes, but some macro- and micro-elements are found in the structure of teeth (Ca and P) and bones (Ca, Mg, and P). In comparison to microelements (I), macroelements (Ca, Mg, and P) have far more significant functions in nerve cells (transmission and signaling). Although macrominerals like Ca have a strong ability to modulate blood pressure, microelements like Fe play important roles in the production of erythrocyte cells. According to Gharibzahedi and Jafari (2017), the minerals Ca, Mg, and Zn are also engaged in the immune system.

## MATERIALS AND METHODS

### 1. Collection of samples:

One hundred samples in total were taken from the chicken flesh. According to the type of meat, the samples were taken and divided into four groups with 25 samples each: group "A" for thigh, group "B" for breast, group "C" for liver, and group "D" for gizzard. All samples were analyzed for moisture, dry matter, and ash using sensory and proximate methods. The content of several macro- and micro-minerals (calcium, phosphorus, iron, zinc, and magnesium) was examined in samples from each group. Each sample was packaged separately in a polyethylene bag, stored in the icebox, and then delivered to the Faculty of Veterinary Medicine's Laboratory of Meat Hygiene Section, Assiut University for preparation and analysis. The samples were collected and chilled (4 °C) for 24 to 48 hours, before further preparation and analysis.

### 2. Preparation of samples (AOAC, 2012):

Samples were cut into small pieces and thoroughly minced through a mincing machine to obtain a homogeneous mass used for proximate composition analysis. Samples were packed in plastic bags, sealed, kept chilled at 4°C, and examined for sensory analysis (color, odor, and flavor).

The materials were examined chemically in duplicate using the accepted techniques.

### 3. Sensory analysis (Hayes *et al.*, 2014):

Five judges evaluated the sensory quality of chicken meat using a nine-point hedonic scale, with 1 denoting "extreme dislike," 2 signifying "dislike very much," 4 denoting "dislike slightly," 5 denoting "neither like nor dislike," 6 denoting "slight liking," 7 denoting "like moderate liking," and 8 denoting "extreme liking."

For the examined muscles and organs, the following qualities were evaluated: meat colour, odor, flavor, and general approval.

#### 4. Proximate composition of chicken meat:

The prepared samples were analyzed for moisture and ash contents. The samples were analyzed in duplicates. The methods adopted were as the following:

##### 4.1. Determination of moisture content (AOAC, 2012):

Ten grams of the prepared wet sample were added to a dry moisture dish that had already been weighed.

The sample was dried for 24 hours in a hot air oven at 65°C and then for 6 hours at 105°C. After being taken out of a hot air oven, the sample was quickly weighed after cooling in a desiccator.

##### 4.2. Determination of dry matter content (AOAC, 2012):

The dry matter percentage was calculated by difference:

$$\text{Dry matter \%} = 100 - \text{moisture \%}$$

##### 4.3. Determination of ash content (AOAC, 2012):

In clean, dry porcelain crucibles with dry weights, 1 gm. of the dry sample was weighed. The crucibles were placed in the muffle furnace and burned at 550°C for 6 hours to produce grayish-white ash. The samples were moved to desiccators, allowed to cool, and then weighed after the oven had cooled to about 200°C. According to Jurgens and Bregendahl (2007), the acquired values on a dry-weight basis were transformed on a wet-weight basis using the following equation:

$$\text{Ash \%} = \frac{\text{Weight of the ash}}{\text{Weight of the sample}} \times 100$$

##### 4.4. Determination of Element (Minerals) composition (ISO, 1996 and 1998)

Sample mineralization for the purpose of identifying "minerals" (incineration method):

A dry sample weighing 1 gm. was placed in the crucible and heated to 500–550°C for five hours. 10 ml of nitric acid 1+2 (v/v) (one

volume of nitric acid 65% mixed with two volumes of water and thoroughly mixed) was added to the produced ash. A watch glass was used to cover the solution, which was heated in a bath of boiling water for 30 minutes before cooling. The substance was transferred to a 100-ml volumetric flask, diluted with deionized water to the proper concentration, and thoroughly mixed. The first 5 to 10 ml of the filtrate were discarded after the dilution was filtered using filter paper. The sample was prepared when the filtrate was placed in a brown glass bottle.

##### 4.4.1. Determination of phosphorus content (ISO, 1996 and 1998):

According to procedures of Phosphorus, Inorganic kits "Spectrum- Diagnostics, Germany IFUFCC34"

##### 4.4.2. Determination of calcium content (ISO, 1996 and 1998):

According to procedures of Calcium O-CPC kits "Spectrum-diagnostics, Germany IFUFCC07"

##### 4.4.3. Determination of iron content (ISO, 1996 and 1998):

According to procedures of Iron kits "Spectrum-diagnostics, Germany IFUFCC94"

##### 4.4.4. Determination of magnesium content (ISO, 1996 and 1998):

According to procedures of magnesium kits "Spectrum-diagnostics, Germany IFUFCC103"

##### 4.4.5. Determination of zinc content (ISO, 1996 and 1998):

According to procedures of zinc kits "Spectrum-diagnostics, Germany IFUFCC56"

#### 5. Statistical Analysis:

**Graph Pad Prism version 8.0.2 (263)** software was used for all statistical analysis. A one-way analysis of variance (ANOVA) was used to analyze the collected data. The gathered information was displayed as a mean SE. Tukey's multiple-range tests were

used to compare groups when significant differences were found at P 0.05. A comparison of Duncan's test was used to

determine the statistical significance of mean differences.

## RESULTS

**Table 1:** Statistical results scores of sensory assessment of the chicken samples (N= 25)\*

Group	Color	Odor	Flavor	Overall acceptance
<b>A (Thigh)</b>	8.24±0.13	8.24±0.12	8.04±0.14	8.20±0.12
<b>B (Breast)</b>	8.20±0.13	8.08±0.14	7.76±0.13	8.16±0.13
<b>C (Liver)</b>	8.20±0.13	8.24±0.13	7.80±0.13	8±0.12
<b>D (Gizzard)</b>	8.12±0.13	8.16±0.14	8.04±0.14	8.12±0.15

\*Duplicate analysis on a wet basis

**Table 2:** Statistical results of the moisture content (%), dry matter content (%), and ash content (%) of chicken samples (N= 25)\*

Group	Moisture content (%)			Dry matter content (%)			Ash content (%)		
	Min	Max	Mean±SE	Min	Max	Mean±SE	Min	Max	Mean±SE
<b>A (Thigh)</b>	81.87	86.09	85.04±0.25	13.91	18.13	14.96±0.25	0.46	0.87	0.64±0.02
<b>B (Breast)</b>	81.10	88.67	85.48±0.38	11.33	18.90	14.52±0.38	0.42	0.90	0.65±0.02
<b>C (Liver)</b>	81.12	87.97	85.18±0.44	12.03	18.88	14.82±0.44	0.44	1.08	0.72±0.03
<b>D (Gizzard)</b>	80.95	92.35	88.04±0.67	7.68	19.05	11.96±0.66	0.24	3.45	0.63±0.13

\*Duplicate analysis on a wet basis

**Table 3:** Statistical results of phosphorus content (mg/100gm) of the chicken samples (N=25)\*

Group	Min.	Max.	Mean±SE
<b>Thigh</b>	106.70	214.70	148.00±5.01
<b>Breast</b>	60.81	172.70	79.24 ± 4.94
<b>Liver</b>	60.93	145.20	100.70±5.29
<b>Gizzard</b>	48.01	149.10	72.87± 5.94

\*Duplicate analysis on a wet basis

**Table 4:** Statistical results of calcium content (mg/100gm) of the chicken samples (N=25)\*

Group	Min.	Max.	Mean±SE
<b>Thigh</b>	24.90	49.20	36.24 ±1.71
<b>Breast</b>	10.99	34.62	23.56±1.46
<b>Liver</b>	15.38	37.66	24.88±1.25
<b>Gizzard</b>	12.98	43.95	25.65±2.09

\*Duplicate analysis on a wet basis

**Table 5:** Statistical results of iron content (mg/100gm) of the chicken samples (N=25)\*

Group	Min.	Max.	Mean±SE
Thigh	1.93	4.97	3.20± 0.17
Breast	1.29	7.25	3.70 ±0.25
Liver	5.97	15.47	10.22± 0.53
Gizzard	1.68	8.07	3.29± 0.35

\*Duplicate analysis on a wet basis

**Table 6:** Statistical results of magnesium content (mg/100gm) of the chicken samples (N=25)\*

Group	Min.	Max.	Mean± SE
Thigh	6.35	32.75	18.57 ±2.06
Breast	5.62	19.09	10.24± 0.88
Liver	1.43	8.82	3.47± 0.38
Gizzard	2.11	5.56	3.56 ±0.25

\*Duplicate analysis on wet basis

**Table 7:** Statistical results of zinc content (mg/100gm) of the chicken sample (N=25)\*

Group	Min.	Max.	Mean± SE
Thigh	0.66	1.84	1.19± 0.06
Breast	0.13	2.55	0.77± 0.12
Liver	1.04	3.99	2.27± 0.20
Gizzard	1.07	5.57	3.01± 0.26

\*Duplicate analysis on a wet basis

## DISCUSSION

### 1. Sensory assessment:

For the sensory evaluation, breast and thigh meat samples Ten semi-trained panelists (n = 10) were asked to record their preference using 9-point hedonic scales (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither dislike nor like, 6 = like slightly, 7 = like moderately, 8 = like very much, 9 = like

extremely) according to the method of (Hayes *et al.*, 2014).

The sensory parameters tested were color, odor, texture, taste, juiciness, and the overall acceptance (Jeon *et al.*, 2010). A normal person uses five senses (sight, smell, hearing, taste, and touch) and engages all of these in different ways and with various intensities to establish the quality of food products (Wadhwa and Capaldi-Phillips, 2014).

The data obtained in Table 1 showed that no significant difference ( $P > 0.05$ ) was found between thigh, breast, liver, and gizzard samples in all sensory parameters that were tested (color, odor, taste, and overall acceptance). The color scores of the chicken samples with mean values of  $8.24 \pm 0.13$ ,  $8.20 \pm 0.13$ ,  $8.20 \pm 0.13$  and  $8.12 \pm 0.13$  for thigh, breast, liver, and gizzard, respectively. The odor scores of the chicken samples with mean values  $8.24 \pm 0.12$ ,  $8.08 \pm 0.14$ ,  $8.24 \pm 0.13$  and  $8.16 \pm 0.14$  for thigh, breast, liver, and gizzard, respectively. While the flavor scores of the chicken sample with the mean value  $8.04 \pm 0.14$ ,  $7.76 \pm 0.13$ ,  $7.80 \pm 0.13$  and  $8.04 \pm 0.14$  for thigh, breast, liver, and gizzard, respectively. The overall acceptance scores of the chicken meat samples with the mean values of  $8.20 \pm 0.12$ ,  $8.16 \pm 0.13$ ,  $8 \pm 0.12$  and  $8.12 \pm 0.15$  for thigh, breast, liver, and gizzard, respectively.

Taste is an essential factor in how individuals feel about food because they can distinguish between five flavors-sweet, sour, salty, bitter, and umami at up to 30 intensity levels (Breslin, 2013). The findings of this study were in line with those of (Abu-Salem and Abou Arab, 2010), who conducted a sensory evaluation of liver paste made from the chicken liver (mean SD) and discovered that color was  $8.5 \pm 0.26$  and the odor was  $8.5 \pm 0.28$ , but the taste was  $8.6 \pm 0.31$  and overall acceptability was  $8.8 \pm 0.20$ . According to Shaltout *et al.* (2016), the average color of the chicken carcass samples they investigated was  $7.8 \pm 0.14$ , which is less than what was observed in this

investigation, but the average odor was  $8.4 \pm 0.12$ , which was more.

## 2. Chemical composition of chicken meat:

The proximate composition analyses include moisture and ash percent, also important for quality determination.

### 2.1. Moisture:

Data for the moisture content of chicken meat in Table 5 showed a significant difference ( $P < 0.05$ ) between the four studied muscles and organs with the gizzard recording the higher mean value of moisture. The means of moisture content were  $85.04 \pm 0.25$ ,  $85.48 \pm 0.38$ ,  $85.18 \pm 0.44$  and  $88.04 \pm 0.67\%$ ; respectively, for thigh, breast, liver, and gizzard. The results in this study were higher than that recorded by (Moreiras *et al.*, 2005) Water (g) content (in whole was 70.3 and breast was 75.4) and by (Seong *et al.*, 2015) in liver was  $(76.68 \pm 0.10)\%$  and in gizzard was  $(79.94 \pm 0.3)\%$ , and higher than that reported by (Jokanović *et al.*, 2014) was 75.9 % in (liver) and 81.5% in (gizzard), also higher than (Bostami *et al.*, 2017) who found  $(72.13 - 73.61\%)$ ;  $(74.87-75.70\%)$  in thigh and breast meat of broilers fed diet with dietary fat sources, respectively. There were no significant differences in breast meat moisture content.

### 2.2. Dry matter:

The means of dry matter content (%) of chicken meat revealed in Table 6 were  $14.96 \pm 0.25$ ,  $14.52 \pm 0.38$ ,  $14.82 \pm 0.44$  and  $11.96 \pm 0.66\%$ ; for thigh, breast, liver, and gizzard, respectively. Thigh, breast and liver showed significantly ( $P < 0.05$ ) higher mean value of dry matter over gizzard, while no difference ( $P > 0.05$ ) between dry matter content of thigh, breast and liver was found. The current results were lower than that reported by (Sogunle *et al.*, 2010): the thigh dry matter was 28.73%, and breast dry matter was 29.88% in Marshal MY strains and in Arbor acre strains, breast dry matter was  $27.78 \pm 0.055$ , and thigh dry matter was  $26.25 \pm 0.067$ . and also, lower than (Al-Yasiry *et al.*, 2017) who analyzed the content

of basic nutrients ( $\text{g kg}^{-1}$ ) and found that dry matter was 25.89 in breast muscle of broiler chickens in natural matter, and 26.04 in drumstick muscle of broiler chickens in natural matter.

### 2.3. Ash content:

The data in Table 7 summarize the ash content % in the examined chicken meat samples with means  $0.64 \pm 0.02$ ,  $0.65 \pm 0.03$ ,  $0.72 \pm 0.03$  and  $0.63 \pm 0.13$ ; for thigh, breast, liver, and gizzard. No significant difference was found between the ash content % of the four studied muscles and organs ( $P > 0.05$ ).

The current results were lower than reported by (Jokanović *et al.*, 2014), who recorded total ash content was 0.9% in gizzard and in liver was 1.3% and by (Al-Yasiry *et al.*, 2017) who analyzed the content of basic nutrients ( $\text{g kg}^{-1}$ ) and found that crude ash was 1.12 in breast muscle of broiler chickens in natural matter, and crude ash was 1.03 in drumstick muscle of broiler chickens in natural matter and also lower than (Bostami *et al.*, 2017) who found that there were no significant differences in thigh and breast meat crude ash content,  $(1.06-1.12$  and  $1.42 - 1.51$ , respectively) in broilers fed diet with dietary fat sources.

### 2.4. Mineral elements in chicken meat:

#### 2.4.1. Phosphorus contents (mg/100gm) in the examined chicken meat samples:

The presented data in Table 8, showed that the mean value of phosphorus contents (mg/100gm) in the examined chicken meat samples were  $148 \pm 5.01$  for thigh;  $79.24 \pm 4.94$  for breast;  $100.7 \pm 5.29$  for liver, and  $72.87 \pm 5.94$  for gizzard. The significantly higher mean value of phosphorus was recorded for thigh samples ( $P < 0.05$ ), while no significant difference was found between breast and gizzard samples ( $P > 0.05$ ).

The results in this study were higher than the results recorded by Pinto e Silva (2008), who recorded that phosphorous content was  $125.00 \pm 0.50\%$  of the chicken meat

hydrolysates. But lower than that recorded by (Seong *et al.*, 2015) for liver ( $293.446 \pm 87.92\%$ ); and for gizzard ( $166.159 \pm 27.04\%$ ), and by Jokanović *et al.* (2014) for liver (223.5 %); and gizzard (119.1%). Also, the results were lower than the findings of Wood, (2017), Probst (2009) and Geldenguys *et al.*, (2013) in chicken meat (198 mg), in raw chicken breast (231 mg) and broiler chicken breast ( $208.7 \pm 16.0$ ), respectively.

According to the USDA (2016), chicken meat contains 228 mg of phosphorus per 100 grams. The reference daily intake values for phosphorus were 22.35% (mg/100 g) in the liver and 11.91% (mg/100 g) in the gizzard, based on a caloric intake of 2,000 calories for adults and children four years of age and older (US FDA, 2009).

**Table 8: A summary of the discussion of mineral contents in chicken meat:**

	Pinto e Silva (2008)	Jokanović <i>et al.</i> (2014)	(Seong <i>et al.</i> , 2015)	Probst (2009) (mg/100gm)	USDA (2016) (mg/100gm)	Wood (2017) (mg/100gm)	Current study (mg/100gm)
<b>Ph</b>	125.00 % chicken meat	Liver (223.5 %) gizzard (119.1%).	liver (293.446) gizzard (166.159)	chicken breast (231)	chicken meat (228)	chicken meat 198)	Thigh (148.00) Breast (79.24) Liver (100.70) Gizzard (72.87)
<b>Ca</b>	7.5 % chicken meat	Liver (13.1%) gizzard (11.0 %)	Liver (8.93%) Gizzard (11.74%)	Chicken breast (12).	chicken meat (15)	chicken meat (10)	Thigh (36.24) Breast (23.56) Liver (24.88) Gizzard (25.65)
<b>Fe</b>	chicken meat 0.36 %	liver 8.2% Gizzard 1.9 %.	Liver (7.93 %) Gizzard (1.65 %).	chicken breast (0.4)	chicken meat (1.04)	chicken meat (1)	Thigh (3.20) Breast (3.70) Liver (10.22) Gizzard (3.29)
<b>Mg</b>		Liver (26.3%) gizzard (25.4%)	Liver 21.7%) Gizzard. (16.8%)	chicken breast (28)	chicken meat (29)	chicken meat (23)	Thigh (18.57) Breast (10.24) Liver (3.47) Gizzard (3.56)
<b>Zn</b>		Liver (2.32%) gizzard (1.95%)	Liver (2.99%) gizzard (2.6 %)	chicken breast (0.7)		chicken meat (1.2)	Thigh (1.19) Breast (0.77) Liver (2.27) Gizzard (3.01)

#### 2.4.2. Calcium contents (mg/100gm) in the examined chicken meat samples:

Data for the calcium content of chicken samples in Table 9 showed a significant difference ( $P < 0.05$ ) between the four studied muscles and organs, where the thigh recorded the higher mean value of calcium.

The results pointed out that the mean value of calcium levels (mg/100gm) of the chicken meat samples were  $36.24 \pm 1.71$ ;

$23.56 \pm 1.46$ ;  $24.88 \pm 1.25$  and  $25.65 \pm 2.09$  for the thigh, breast, liver, and gizzard, respectively.

The results in this study were higher than those recorded by Pinto e Silva (2008), which was  $7.5 \pm 0.03$  % of the chicken meat hydrolysates. Seong *et al.*, (2015) reported that the calcium levels in liver ( $8.93 \pm 3.44\%$ ) and gizzard ( $11.74 \pm 7.54\%$ ), were higher than that reported by Jokanović *et al.* (2014) in liver (13.1%) and in gizzard (11.0 %), and

by Wood, (2017) in chicken meat (10mg/100g), and by Probst, (2009) in raw chicken breast (12 mg/100g). Also, by Skalická (2019) chicken breast calcium was  $4.2\pm 0.6$ , and chicken thigh calcium was  $3.1\pm 1$ mg/100g.

About 26 to 30 g of calcium are present in the body during birth. After birth, this amount increases significantly, reaching 1,200 g for women and 1,400 g for males by adulthood. These levels remain the same in men, but they begin to decline in women as a result of increased bone remodeling brought on by the beginning of menopause and a decrease in estrogen production (Institute of Medicine, 2011). Malwina (2022) demonstrated that the addition of micronized experimental oilseeds to feed combinations increased the levels of Ca and Fe in the proventriculus and liver content. The reference daily intake values for adults and children aged four or older based on a 2,000-calorie caloric intake are 1.31% in the liver and 1.10% in the gizzard in terms of calcium contents (mg/100 g). According to the USDA (2016), chicken meat contains 15 mg of calcium per 100 grams. To create meat enhanced with functional nutrients, it is possible to modify the content of chicken feed by adding various types of lipids, vitamins, microelements, and amino acids (Kralik *et al.*, 2017).

#### **24.3. Iron contents (mg/100gm) in the examined chicken meat samples:**

Results in Table 10 pointed out that the mean values of iron levels (mg/100gm) of the chicken meat samples were  $3.20\pm 0.17$ ;  $3.70\pm 0.25$ ;  $10.22\pm 0.53$  and  $3.29\pm 0.35$  in thigh, breast, liver, and gizzard, respectively. The significantly higher mean value of iron levels was recorded for liver samples ( $P<0.05$ ).

The iron in this study was higher than that recorded by Seong *et al.* (2015) in liver,  $7.93\pm 1.96\%$ , and in gizzard,  $1.65\pm 0.69\%$ . Also, it is higher than results recorded by Jokanović, *et al.* (2014) in liver 8.2% and in gizzard 1.9%. Furthermore, Wood (2017)

found that the iron content was 1 mg/100g in chicken meat. Probst (2009) mentioned that iron content was 0.4 mg/100g in raw chicken breast. The iron content was also higher than that of the chicken meat hydrolysates,  $0.36\pm 0.01\%$  (Pinto e Silva 2008). However, iron content was lower than that recorded by Butt *et al.* (2016) who found that the concentration of iron in different tissues of broiler chicken collected from five different regions. 1) in Karim Park was  $8.66\pm 1.48$ ,  $2.19\pm 0.25$ ,  $1.06\pm 0.08$  and  $1.06\pm 0.01$  mg/100g in liver, breast muscle, thigh muscle and gizzard; respectively. 2) In Amin Park was  $5.69\pm 0.48$ ,  $1.69\pm 0.62$ ,  $1.20\pm 0.34$  and  $0.92\pm 0.05$  mg/100g in liver, gizzard, thigh muscle and breast muscle; respectively. 3) In Shahdara was  $6.12\pm 1.01$ ,  $1.92\pm 0.63$ ,  $1.75\pm 0.93$  and  $0.26\pm 0.08$  mg/100g in liver, gizzard, thigh muscle and breast muscle; respectively. 4) In Lohari was  $7.67\pm 2.34$ ,  $2.16\pm 0.41$ ,  $0.75\pm 0.07$  and  $1.04\pm 0.07$  mg/100g in liver, gizzard, thigh muscle and breast muscle; respectively. 5) In Outfall Road was  $16.04\pm 0.57$ ,  $1.74\pm 0.41$ , and  $0.81\pm 1.01$  and  $0.64\pm 0.13$  mg/100 g in liver, gizzard, thigh muscle and breast muscle respectively.

The iron concentrations (mg/100 g) in the liver and gizzard, respectively, were 45.79% and 10.89% of the Reference Daily Intake values for adults and children four years of age and older, as determined by the US FDA in 2009. According to the USDA (2016), there was 1.04 mg of iron in every 100 grams of chicken meat.

#### **2.4.4. Magnesium contents (mg/100gm) in the examined chicken meat samples:**

Data in Table 11 showed that the mean value of magnesium content (mg/100gm) of the chicken meat samples were  $18.57\pm 2.06$ ;  $10.24\pm 0.88$ ;  $3.47\pm 0.38$  and  $3.57\pm 0.25$  for thigh, breast, liver, and gizzard, respectively. The results showed a significant difference ( $P<0.05$ ) between the four studied muscles and organs with the thigh recording the higher mean value of magnesium content,



while no significant difference was found between liver and gizzard samples ( $P>0.05$ ).

The magnesium contents in this study were lower than that recorded by many researchers. Seong *et al.* (2015) found that the magnesium level was  $21.7\pm 7.56\%$  in liver and  $16.8\pm 6.92\%$  in gizzard. Jokanović *et al.* (2014) also recorded 26.3 % in liver and 25.4 % in gizzard. Wood (2017) recorded 23 mg/100g in chicken meat, Probst (2009) recorded 28 mg/100g in raw chicken breast, and Skalická (2019) recorded Mg in chicken breast ( $4.7\pm 0.3$  mg/100g) and in chicken thigh ( $4.1\pm 0.4$ ).

The reference daily intake levels for adults and children aged four or older based on a 2,000-calorie caloric intake are 6.58% in the liver and 6.35% in the gizzard in terms of magnesium content (mg/100gm). According to the USDA (2016), there were 29 mg of magnesium in every 100 grams of chicken meat.

#### 2.4.5. Zinc contents(mg/100gm) in the examined chicken meat samples:

Data for zinc level of chicken samples in Table 12 showed a significant difference ( $P<0.05$ ) between the four studied muscles and organs with the gizzard recorded the higher mean value of zinc, while no significant difference was found between the thigh and breast samples ( $P>0.05$ ). The results showed that the mean value of zinc contents (mg/100gm) were  $1.19\pm 0.06$  for thigh;  $0.77\pm 0.12$  for breast;  $2.27\pm 0.20$  for liver, and  $3.01\pm 0.26$  for gizzard. Higher results recorded by Seong *et al.* (2015) in liver was  $2.99\pm 3.64$  % but they recorded lower results for gizzard  $2.6\pm 0.57$  %, while nearly similar results recorded by Jokanović *et al.*, (2014) 2.32 % in liver, but lower in gizzard 1.95%, also by Wood (2017) 1.2 mg/100g in chicken meat and Probst (2009) 0.7 mg/100g in chicken (breast, raw). The results in this study were lower than that of Skalická (2019)  $16.85\pm 1.71$  mg/100g in chicken breast and  $14.42\pm 1.52$  mg/100g in chicken thigh. The reference daily intake levels for adults and children aged four or older based

on a 2,000-calorie caloric intake are 15.48% in the liver and 13.03% in the gizzard in terms of zinc contents (mg/100 g). Intakes of zinc from food range from 7.6 to 9.7 mg per day for children aged 2 to 11, 10.1 mg per day for children and teenagers aged 12 to 19, 13 mg per day for men over the age of 19, and 9.2 mg per day for women (U.S. Department of Agriculture, 2021).

## IN CONCLUSION

Chicken meat could be considered a good source of essential minerals, particularly iron and phosphorus from different muscles. Phosphorus is considered the abundant trace element in chicken meat followed by calcium, magnesium, iron and zinc, respectively.

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## تقدير بعض العناصر المعدنية في صدور وأفخاذ وأكباد وقوانص الدجاج

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هدفت الدراسة الحالية إلى تقييم المحتوى المعدني في لحوم الدجاج (الفخذ والصدر) والأعضاء (الكبد والقوانص) في مدينة أسيوط، مصر. تم جمع 100 عينة عشوائية من الدجاج الطازج (25 لكل منها) خلال الفترة من مارس إلى مايو 2021 من محلات الجزارة المختلفة. تم إخضاع العينات للتقييم الحسي والكيميائي. أوضحت النتائج أن العينات التي تم فحصها قد استوفت درجات حسية حيث كانت متوسطات اللون  $0.13 \pm 8.24$ ،  $0.13 \pm 8.20$ ،  $0.13 \pm 8.20$ ،  $0.13 \pm 8.12$ ، والرائحة  $0.13 \pm 8.24$ ،  $0.12 \pm 8.08$ ،  $0.14 \pm 8.24$ ،  $0.13 \pm 8.16$ ،  $0.14 \pm 8.16$ ،  $0.14 \pm 8.04$ ،  $0.13 \pm 7.76$ ،  $0.13 \pm 8.24$ ،  $0.13 \pm 7.80$ ،  $0.14 \pm 8.04$ ، وكان متوسط القبول الكلي  $0.12 \pm 8.20$ ،  $0.12 \pm 8.16$ ،  $0.13 \pm 8.00$ ،  $0.12 \pm 8.12$ ،  $0.15 \pm 8.15$  في الفخذ والصدر والكبد والقوانص على التوالي. كشفت النتائج أن العينات التي تم فحصها قد استوفت درجات محتوى المعادن حيث كانت نسبة الكالسيوم  $1.71 \pm 36.24$ ،  $1.46 \pm 23.56$ ،  $1.25 \pm 24.88$ ،  $1.25 \pm 25.65$ ،  $2.09 \pm 25.65$ ، وفي الفوسفور كانت  $5.01 \pm 148.00$ ،  $4.94 \pm 79.24$ ،  $5.29 \pm 100.70$ ،  $5.29 \pm 72.87$ ،  $5.94 \pm 5.94$ ؛ كانت نسبة الحديد  $17 \pm 3.20$ ،  $25 \pm 3.70$ ،  $52 \pm 10.22$ ،  $35 \pm 3.29$ ؛ كانت نسبة الماغنسيوم  $2.06 \pm 18.57$ ،  $2.06 \pm 10.24$ ،  $0.88 \pm 10.24$ ،  $0.38 \pm 3.47$ ،  $0.25 \pm 3.57$ ، وكانت نسبة الزنك  $1.19 \pm 0.06$ ،  $0.77 \pm 0.12$ ،  $0.27 \pm 0.20$ ،  $0.26 \pm 0.26$  في الفخذ والصدر والكبد والقوانص، على التوالي. في لحوم الدجاج، يُعتقد أن الفوسفور هو العنصر الأكثر انتشارًا، يليه الكالسيوم والماغنسيوم والحديد والزنك.