

DETECTION OF CHEMICAL CHARACTERISTICS, HEAVY METALS, AND MICROBIAL CONTAMINATION IN POULTRY MEAT AVAILABLE IN LOCAL MARKETS

Raafat A. Abu- Almaaly¹, Doaa Adel Qasim²

¹Assistant Professor, Department of Commodity Evaluation and Service Performance, Market Research and Consumer Protection Center, University of Baghdad. Baghdad, Iraq, raafat@mracpc.uobaghdad.edu.iq

²Lecturer Dr., Department of Commodity Evaluation and Service Performance, Market Research and Consumer Protection Center, University of Baghdad. Baghdad, Iraq, doaa.a@mracpc.uobaghdad.edu.iq

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ABSTRACT

The study aimed to determine the physico-chemical properties that included (pH, peroxide value, percentage of free fatty acids) and microbial contamination that included the numbers of total bacteria, total coliform bacteria, *Staphylococcus aureus*, and *salmonella* bacteria, as well as contamination with heavy metals that included Zinc, lead, cadmium, and copper for some types of frozen chicken available in the local markets of Baghdad. The study results showed that the highest average peroxide value was 13.85 ± 0.82 ml equivalents/kg in chicken wings from the Kafeel product, while the percentage of free fatty acids was $1.93 \pm 0.26\%$ in wings from the Sadia product. Total bacterial counts, *Staphylococcus aureus* counts, and coliform counts were significantly increased, reaching 8×10^4 cfu/ml, 9×10^2 cfu/ml, and 6×10^2 cfu/ml, respectively. As for *Salmonella* bacteria, the samples showed that they were free of this bacteria. The highest values for heavy metals were found in the liver samples of the Al-Kafeel product, reaching 2.21 ± 0.17 mg/kg, which was higher than the permissible limit compared to the other samples in the study. The remaining elements were within the permissible limits.

Key words: frozen poultry meat, microbial contamination, Chemical properties, heavy metals.

الكشف عن الصفات الكيميائية والمعادن الثقيلة والتلوث الميكروبي في لحوم الدواجن المتوافرة في الاسواق المحلية

رأفت احمد ابو المعالي¹، دعاء عادل قاسم²

¹استاذ مساعد، قسم تقويم السلع وأداء الخدمات، مركز بحوث السوق وحماية المستهلك، جامعة بغداد، بغداد، العراق، raafat@mracpc.uobaghdad.edu.iq
²مدرس دكتور، قسم تقويم السلع وأداء الخدمات، مركز بحوث السوق وحماية المستهلك، جامعة بغداد، بغداد، العراق، doaa.a@mracpc.uobaghdad.edu.iq

الخلاصة

هدفت الدراسة إلى تحديد الخواص الفيزيائية والكيميائية التي شملت (الرقم الهيدروجيني، قيمة البيروكسيد، نسبة الأحماض الدهنية الحرة) والتلوث الميكروبي الذي شمل أعداد البكتيريا الكلية، بكتيريا القولون الكلية والمكورات العنقودية الذهبية، والسالمونيلا، بالإضافة إلى التلوث بالمعادن الثقيلة مثل الزنك والرصاص والكاديوم والنحاس لبعض أنواع الدجاج المجمد والمتوافر في الاسواق المحلية لمدينة بغداد.

أظهرت نتائج الدراسة أن أعلى متوسط لقيمة البيروكسيد بلغ 13.85 ± 0.82 ملي مكافئ/كجم في اجنحة الدجاج لمنتج الكفيل ونسبة الأحماض الدهنية الحرة كانت $1.93 \pm 0.26\%$ في الاجنحة لمنتج ساديا. ارتفعت أعداد البكتيريا الكلية والمكورات العنقودية الذهبية وبكتيريا القولون بشكل معنوي حيث بلغت 8×10^4 cfu/ml , 9×10^2 cfu/ml, و 6×10^2 cfu/ml على التوالي اما بالنسبة لبكتيريا السالمونيلا فكانت العينات خالية من هذه البكتيريا. أعلى القيم للعناصر الثقيلة كانت في عينات الاكباد لمنتج الكفيل إذ بلغت 2.21 ± 0.17 mg/kg وكانت أعلى من الحد المسموح به مقارنة ببقية المجموعات ضمن الدراسة. اما ببقية العناصر فكانت ضمن الحدود المسموح به.

الكلمات المفتاحية: لحوم الدواجن المجمدة، التلوث المايكروبي، الصفات الكيميائية، المعادن الثقيلة.



INTRODUCTION

Meat is one of the most important sources of nutrition for human, conceder a complex composition of tissues that contain nutrients with high benefit and contains a high percentage of proteins and fats. Meat protein is highly nutritional value, because it contains all acids and some mineral substances, especially Iron and essential amino to build human body tissues, as well as a good source of vitamins B (Kihara *et.al*, 2017).

At the present time, there is increasing use of poultry meat as food for humans in the world, as these meats are among the important food commodities in Iraq, especially after opening the neighboring countries borders (IQS 1150, 2017). Taking into consideration the improvement in the standard of living of citizens, the demand for imported meat increased significantly, especially for poultry meat by consumers, as a result of increased population growth, or lower prices as a result of the widespread demand for chicken meat, especially imported compared to locally produce (Abdulrazzaq & Al- Rubaee, 2024).

After consuming contaminated food, contaminated food is the opposite of healthy food, meaning that the food did not go through healthy conditions by the hands of healthy workers, and not following a healthy method, where the food is ultimately contaminated with pathogens (FAO/WHO, 2011). Pollution is a global problem that concerns all people and specialists in ecology in particular, because of the dire consequences for this problem for humans and the components of the ecosystem, and for its imbalance (WHO, 2016).

Poultry meat exposed to many different microorganisms during production and processing, and the pathogenic bacteria can be divided into two groups: the general pathogenic bacteria which is important to the public health of the consumer and the cause of food poisoning diseases in humans such as *Salmonella*, *Listeria monocytogenes*, *Campylobacter jejuni*, *Escherichia coli*, *Clostridium perfringens*, *Staphylococcus aureus* , and the bacteria that responsible for economic losses in the pharmaceutical industry, causing a reduction in the storage capacity of the product, such as *Pseudomonas*, *Acinetobacter*, *Enterobacter*, *Moraxella*, , and *Flavobacterium* (Zagorec *et.al.*, 2017 & EFSA, 2016). These microbes cause many damages, some of which are economic and others health-related. The economic damage is caused by the growth of microorganisms in food, which causes damage to its components and the formation of unpleasant odors and flavors that are undesirable to the consumer and may also be toxic and harmful compounds to health (Karanth *et al.*, 2023). As for the health damage, it is caused by the suitability of food for the growth and proliferation of pathogenic microbes (Aladhadh, 2023).

Heavy metal pollution leads to major environmental and health problems, such as elevated concentrations of these elements to toxic levels in animals and humans (Briffa *et al.*, 2020). The danger of heavy metals lies in their biological accumulation in the body, meaning that the chemical concentration of these metals in a living organism increases over time compared to their chemical concentration in the environment (Mitra *et.al*, 2020). Metal poisoning directly affects humans: Lead competes directly with calcium for protein absorption sites in the intestinal mucosa, and cadmium damages fatty acids. Excessive copper levels cause dermatitis, liver cirrhosis, and neurological disorders, and can also cause cancer (Witkowska *et.al*, 2021)



Meat is the main product of the consumer, because of its high nutritional value, so it is necessary to pay attention to what it is exposed to, especially from the chemical aspects, as a result of the adhesion of minerals, which cause many risks, so scientists in recent years have gone to conduct many studies, to determine the deposition of heavy metal concentrations In foods, meat, and fish, due to its increased risk to human health (**Kia et. al, 2024**).

Poultry meat is characterized by the taste appetite, fast absorption, contributes to building damaged tissue, and the production of energy necessary for the vital processes of the human body , Although we live in the twenty-first century, the era of technology and progress, many restaurants in Iraq still lack the simplest cultural requirements, in addition to the absence of health awareness, and this results from the role of health control is absent at the present time, as the role of health control has become Formally, there are no firm decisions when there are negative cases in restaurants or hotels (**Thulfiqar et. al, 2020& Al-Musawi 2022**).

As a result of the economic openness in Iraq, companies have begun importing many types of frozen meat from various origins, which have become a threat to consumer health, Therefore this study aimed to determine the physico-chemical properties of poultry meat through the study of contamination with microbial and heavy metals.

MATERIALS AND METHODS

Samples collection

Different types of frozen chicken were obtained, with totally of 48 samples, and divided into four groups, each group containing (12 samples of chicken breast, 12 samples of chicken thighs, 12 samples of livers, and 12 samples of wings) from the local markets of Baghdad for the period June to September 2023, The information label of the samples was examined in accordance with the Iraqi standard specification for the information label of packaged and canned foodstuffs namely Sadia (Brazilian), Al-Kafeel (Iraqi), Banvit (Turkish), and Bawadi (Iraqi). The studied sample was placed in sterile polyethylene bags and closed tightly, then placed in containers and transferred to the microbiology laboratory for examination. The following measurements and tests were carried out:

Note: The studied samples consisted of 4 samples, with three replicates for each sample.

Table (1): The Information Label of Frozen Chicken Sample.

Product brand	Producing company	Sample type	Sample weight	Production date	Expiry date	Packing type
Sadia	Brazilian	breast	450 g	28/12/2022	29/12/2023	Plastic tray
		thighs	900 g	25/3/2023	26/3/2024	Plastic tray
		livers	450 g	19/5/2023	20/10/2023	Plastic tray
		wings	900 g	20/3/2023	26/3/2024	Plastic tray
Al-Kafeel	Iraqi	breast	900 g	20/12/2022	19/12/2023	Plastic tray
		thighs	900 g	14/10/2022	13/10/2023	Plastic tray
		livers	450 g	2/6/2023	3/11/2023	Plastic tray
		wings	450 g	9/10/2022	8/10/2023	Plastic tray
Bawadi	Iraqi	breast	450 g	9/8/2023	8/8/2024	Plastic tray
		thighs	900 g	6/8/2023	5/8/2024	Plastic tray
		livers	900 g	21/8/2023	21/11/2023	Plastic tray



Banvit	Turkish	wings	900 g	6/8/2023	5/8/2024	Plastic tray
		breast	1000 g	03/2023	02/224	Plastic tray
		thighs	550g	05/2023	04/2024	Plastic tray
		livers	1000g	07/2023	10/2023	Plastic tray
		wings	550g	12/2022	11/2023	Plastic tray

Qualitative Tests

PH Measurement

The pH of chicken samples was measured according to **Pearson (1981)** method by mixed 5 g of minced chicken meat with 100 ml of distilled water in a graduated glass beaker and left for 5 minutes. The pH bulb was then inserted into a graduated glass beaker using pH meter Electronic Instruments (LTD/ England) which provided pH values.

Estimate of Peroxide Value

It is a guide that reflects the degree or level of rancid fat. The peroxide value was estimated according to the method mentioned by **Pearson (1981)** using the following formula:

$$\text{Peroxide value} = \frac{\text{Na}_2\text{S}_2\text{O}_3 \text{ ml} * \text{N} * 1000}{\text{Wt. of sample (gm)}}$$

Estimates of Free Fatty Acids

The free fatty acids (FFA) was estimated according to the method referred to by **Pearson (1981)** using the following equation:

$$\text{Free fatty acid \%} = \frac{\text{Titration KOH (A-B)} * \text{N} * 282 * 100}{1000 * \text{Weight of sample (gm)}}$$

*282 = molecular weight of oleic acid.

Microbial Tests

Peptone water of 0.1% was used to make serial dilution of bacterial cultures, by dissolve 1 g of peptone with 1 liter of distilled water, then distribute it in test tubes with a volume of 9 ml per tube, and sterilize with autoclave at a temperature of 121°C and pressure 1.5 bar for 15 minutes. A series of dilutions were performed for the sample up to 10^{-6} , Nutrient Agar, MacConkey agar, Staph 110 and for *salmonella* bacterial media was prepared according to the manufacturing country, the inoculated plates was incubated according to the temperature of the bacterial. The results of bacterial count of the samples were estimated based on (**Iraqi Standards, 2000**).

Estimate of Heavy Metals

The samples were dried in a 105 ° C electric oven for 3 hours. Then the tissues were ground using a ceramic mortar, then the samples were digested to extract the heavy elements in the tissues, 0.5 g of the dried chicken meat sample was taken and digested in 3 ml of HClO₄ and Nitric Acid HNO₃ in a (1: 1) ratio in glass tubes, then left (12-16) hours to complete the



initial digestion and then placed the tubes in a 70 ° C with water bath for 30 minutes, Then the tubes were transferred to the hot plate to complete the digestion, cadmium, copper, lead and zinc were measured using Atomic Absorption Spectrometer (AAS7000) at Market Research and Consumer Protection Center/University of Baghdad. (Abu-Almaaly, 2022).

Statistical Analysis

The data were analyzed to detect the effect of difference samples in study parameters using Statistical Packages of Social Sciences-**SPSS (2019)** program and the results of this study were significant compared between means (ANOVA/ One way) using the lowest significant mean difference of LSD at (0.05).

RESULTS AND DISCUSSION

Peroxide value and free fatty acid percentage

Table (2) shows a significant increase at the level of $p < 0.05$ in relation to the value of peroxide of chicken samples, the highest percentage in peroxide found in wings samples of Al-Kafeel mark was 13.85 ± 0.82 mEq / kg while the lowest percentage found in Breast samples of Banvit mark which was 5.45 ± 0.39 mEq / kg, With significant differences between samples of each trade mark, while in the table (3) shows the highest percentage of free fatty acids found 1.93 ± 0.26 % for the wings samples of trade mark (Sadia), while the lowest percentage found 0.44 ± 0.08 % in the breast samples of Al-Kafeel. The variation in peroxide and free fatty acid levels among the various trade mark may be due to the prolongation of the storage or storage period under poor conditions, differences between the time of sample collection and the time of sample testing, in addition to the number of times the samples may be thawed and refrozen, especially in super markets, as was mention by (FAO, 1999) and (Saad *et al.*, 2013) and (Hazhaow *et al.*, 2013). and it is worth noting that the peroxide and free fatty acid value for all chicken samples of our study it was similar to the results obtained by was within the acceptable limits (below 10 mEq / kg) in Peroxide value and (2%) with free fatty acid that which approved by the Iraqi standard specification for frozen chicken (IQS 1150, 2017).

Table (2): Peroxide value for the studied samples.

trade marks	Mean $\pm$ SE			
	Breast	Thighs	Livers	Wings
Sadia	7.98 ± 0.52 ab	8.13 ± 0.61 c	6.57 ± 0.42 b	11.63 ± 0.74 bc
Al-Kafeel	6.34 ± 0.38 bc	11.36 ± 0.74 b	8.49 ± 0.58 ab	13.85 ± 0.82 a
Bawadi	8.78 ± 0.61 a	13.63 ± 0.81 a	9.97 ± 0.71 a	13.47 ± 0.80 ab
Banvit	5.45 ± 0.39 c	9.67 ± 0.72 bc	8.95 ± 0.62 a	9.96 ± 0.74 c
L.S.D.	1.983 *	2.077 *	1.994 *	2.163 *
Means having with the different letters in same column differed significantly. * ($P \leq 0.05$).				



Table (3): Comparison between difference samples in free fatty acid.

Trade mark	Mean $\pm$ SE			
	Breast	Thighs	Livers	Wings
Sadia	0.89 $\pm$ 0.21 a	1.33 $\pm$ 0.07 ab	0.67 $\pm$ 0.14 ab	1.93 $\pm$ 0.26 a
Al-Kafeel	0.44 $\pm$ 0.08 b	1.31 $\pm$ 0.10 ab	0.79 $\pm$ 0.23 ab	1.75 $\pm$ 0.21 a
Bawadi	0.76 $\pm$ 0.16 ab	1.16 $\pm$ 0.08 b	0.87 $\pm$ 0.18 a	1.57 $\pm$ 0.35 a
Banvit	0.55 $\pm$ 0.10 b	1.64 $\pm$ 0.16 a	0.45 $\pm$ 0.06 b	0.67 $\pm$ 0.08 b
L.S.D.	0.332 *	0.372 *	0.351 *	0.502 *
Means having with the different letters in same column differed significantly. * ($P \leq 0.05$).				

PH Measurement

Table 4 shows the pH values of the studied trades marks as the highest percentage found in wings samples of Al-Kafeel mark was 6.55 ± 0.39 , while the lowest percentage found in thighs samples of Bawadi mark which was 5.19 ± 0.14 with differed significantly ($P \leq 0.05$) between trademarks of studied chicken samples. It is noted that the pH value for most of the samples was within the acceptable limits of 5.5- 6.5, except for some samples in which the pH value began to decrease moved toward acidity, These results were consistent with those of the study conducted by (Fernandes *et al.*, 2016), as their findings on the pH levels of frozen chicken samples did not differ significantly from our results. One of the most important factors that cause changes in the decrease and increase of the pH value of frozen chicken is the presence of factors such as the formation of lactic acid during the glycogen breakdown process, in addition to the increase in free alkali groups as a result of partial protein breakdown or during anaerobic metabolism that occurs in certain parts of the chicken meat (Hassanien *et al.* 2016).

Table (4): pH results of the studied Samples.

Trade mark	Mean $\pm$ SE			
	Breast	Thighs	Livers	Wings
Sadia	5.59 $\pm$ 0.32 ab	5.30 $\pm$ 0.28	5.87 $\pm$ 0.32	5.91 $\pm$ 0.46 b
Al-Kafeel	5.34 $\pm$ 0.29 b	5.21 $\pm$ 0.19	5.49 $\pm$ 0.46	6.55 $\pm$ 0.39 a
Bawadi	5.26 $\pm$ 0.24 b	5.19 $\pm$ 0.14	5.97 $\pm$ 0.37	6.37 $\pm$ 0.41 ab
Banvit	5.85 $\pm$ 0.38 a	5.44 $\pm$ 0.24	5.65 $\pm$ 0.41	5.87 $\pm$ 0.42 b
L.S.D.	0.437 *	0.302 NS	0.338 NS	0.602 *
Means having with the different letters in same column differed significantly. * ($P \leq 0.05$).				

Bacterial contamination

The results obtained indicate the presence of microbial contamination in all samples that underwent total aerobic bacterial count. Table (5) shows high levels of microbial contamination, with the highest contamination rates observed in thighs samples of Sadia and Al-Kafeel brands, in addition to the breast samples of Banvit brand, where the total count for all these brands was 8×10^4 cfu/ml, While the least contamination appeared in the Wings samples of Banvit brand, where the total count was 1×10^4 cfu/ml.



This is consistent with what was mentioned by (Alsoufi *et.al*, 2016) which indicated that there was a difference in the bacterial counts of frozen chicken, but they were within the microbial limits allowed according to the Iraqi standard specification for frozen chicken (IQS 1179, 1987).

(Al-Temimi, 2010) indicated that the reason for this contamination is the adoption of incorrect storage conditions during its importation or handling until it reaches the consumer, in addition to its frequent melting, as the melting process contributes to providing conditions that encourage the growth of this group of microorganisms, and then the deterioration of its quality and spoilage over time.

Table (5): Comparison between difference groups in Total count bacteria.

marks	Mean $\pm$ SE			
	Breast	Thighs	Livers	Wings
Sadia	$6 \times 10^4 \pm 0.32$ b	$8 \times 10^4 \pm 0.35$ a	$5 \times 10^4 \pm 0.32$ a	$6 \times 10^4 \pm 0.36$ a
Al-Kafeel	$5 \times 10^4 \pm 0.23$ b	$8 \times 10^4 \pm 0.42$ a	$4 \times 10^4 \pm 0.21$ a	$3 \times 10^4 \pm 0.11$ bc
Bawadi	$3 \times 10^4 \pm 0.07$ c	$4 \times 10^4 \pm 0.17$ c	$2 \times 10^4 \pm 0.09$ b	$4 \times 10^4 \pm 0.15$ ab
Banvit	$8 \times 10^4 \pm 0.41$ a	$6 \times 10^4 \pm 0.38$ b	$5 \times 10^4 \pm 0.27$ a	$1 \times 10^4 \pm 0.02$ c
L.S.D.	1.26 *	1.094 *	1.652 *	2.053 *
Means having with the different letters in same column differed significantly. * ($P \leq 0.05$).				

Table (6) shows the results of the coliform bacteria test for frozen chicken. This table reveals a high level of coliform bacteria contamination, with the highest contamination rate observed in thighs samples of Al-Kafeel brand with 6×10^2 cfu/ml and the lowest contamination was found with breast and wings samples of banvit brand with 1×10^2 cfu/ml with significant differences between the different samples. These results of high contaminated samples with coliform bacteria are non-compliant with Iraqi standard specifications (IQS, 1987) and unfit for human consumption. These results were consistent with those obtained in a study (Al Shemery, 2014), which found a high level of contamination with coliform bacteria and attributed the high contamination to a flaw in intensive poultry farming practices. Another study that done through the study of (Mohammed *et.al*, 2020) which identified low value of coliform bacteria in the chicken liver samples in which 8×10^2 cfu/ml, while (Alsoufi *et.al*, 2016), indicated that samples of imported frozen chicken in the markets of Baghdad city were free of coliform bacteria, they attributed this to their exposure to environmental stress as a result of freezing, which led to their damage as they were weakly resistant to low temperatures, which led to a decrease in their numbers and disappearance by freezing.

**Table (6):** Comparison between difference groups in Total Coliform bacteria.

marks	Mean $\pm$ SE			
	Breast	Thighs	Livers	Wings
Sadia	$2 \times 10^2 \pm 0.07$ b	$4 \times 10^2 \pm 0.25$ b	$2 \times 10^2 \pm 0.08$ b	$3 \times 10^2 \pm 0.11$ a
Al-Kafeel	$3 \times 10^2 \pm 0.12$ a	$6 \times 10^2 \pm 0.34$ a	$3 \times 10^2 \pm 0.13$ ab	$4 \times 10^2 \pm 0.17$ a
Bawadi	$3 \times 10^2 \pm 0.12$ a	$5 \times 10^2 \pm 0.26$ ab	$4 \times 10^2 \pm 0.17$ a	$4 \times 10^2 \pm 0.22$ a
Banvit	$1 \times 10^2 \pm 0.03$ c	$2 \times 10^2 \pm 0.11$ c	$2 \times 10^2 \pm 0.06$ b	$1 \times 10^2 \pm 0.06$ b
L.S.D.	0.892 *	1.256 *	1.074 *	1.170 *
Means having with the different letters in same column differed significantly. * ($P \leq 0.05$).				

Regarding contamination with *Staphylococcus* bacteria, the results in Table (7) indicate that all types had low levels of this bacteria. The highest contamination rate was found in livers samples of Bawadi brand in which 9×10^2 cfu/ml, but breast samples of Banvit brand had the lowest content of this bacteria compared to the other types in which count with 2×10^2 cfu/ml. All types were uncontaminated and fit for consumption according to the (Iraqi Standard Specification, 1987).

These results were consistent with the findings of researchers (Al Shemery, 2014) and (Alsoufi et.al, 2016). *Staphylococci* are microbes that are part of the normal flora, but it is important to investigate their presence in frozen poultry meat, as their presence at levels higher than acceptable limits of standard specifications poses a health risk and compromises the safety of manufacturing processes.

Table (7): Comparison between difference groups in Total *Staphylococcus aureus* bacteria.

marks	Mean $\pm$ SE			
	Breast	Thighs	Livers	Wings
Sadia	$6 \times 10^2 \pm 0.25$ a	$5 \times 10^2 \pm 0.24$ b	$6 \times 10^2 \pm 0.24$ b	$9 \times 10^2 \pm 0.52$ a
Al-Kafeel	$8 \times 10^2 \pm 0.37$ a	$3 \times 10^2 \pm 0.16$ c	$8 \times 10^2 \pm 0.41$ ab	$7 \times 10^2 \pm 0.38$ a
Bawadi	$8 \times 10^2 \pm 0.32$ a	$8 \times 10^2 \pm 0.32$ a	$9 \times 10^2 \pm 0.56$ a	$8 \times 10^2 \pm 0.41$ a
Banvit	$2 \times 10^2 \pm 0.18$ b	$4 \times 10^2 \pm 0.09$ bc	$3 \times 10^2 \pm 0.18$ c	$4 \times 10^2 \pm 0.28$ b
L.S.D.	2.466 *	1.974 *	2.305 *	2.258 *
Means having with the different letters in same column differed significantly. * ($P \leq 0.05$).				

The current study did not detect *Salmonella* contamination in any of the studied samples, and these results were consistent with Iraqi standard specifications (1179, 1987), unlike the results obtained by (Alsoufi et.al, 2016), who observed the presence of (*Salmonella ohio*) in the studied samples. Contamination with *Salmonella* is considered one of the most dangerous types to the consumer health. Food must be free from contamination by this bacteria, as the presence of even a single cell in food leads to its rejection and deeming it unhealthy. The presence of this bacteria is attributed to the possibility that poultry meat may be carrying the bacteria, or to unsanitary conditions affecting workers, equipment, and packaging materials (Al-Temimi, 2010).

Heavy metals contamination

(Table 8) shows the concentration of Zinc that detected in the breast, thigh, liver, and wings samples of frozen chicken, It was found that there was an increase in the percentage of zinc in the liver samples, with the highest percentage found in the liver samples belonging to product Al-



kafeel , where the zinc concentration reached 9.021 mg/kg, followed by product Al-Bawadi, which also recorded a high percentage of zinc concentration, with the percentage 8.761 mg/kg, while the lowest zinc concentration was recorded in wings samples Sadia product , where the percentage reached 3.113 mg/kg. The samples was found with the acceptable limits for zinc concentration in chicken muscle of 10-50 mg/kg that were approved by (FAO/WHO 2011) These results were similar to those obtained by (Hussain *et.al*, 2012), where it was found that zinc concentrations in chicken livers available in Basra markets were within standard limits, while in the study of (Ali *et.al*, 2020) in Erbil north of Iraq thy found significant differences in zinc concentrations between chicken livers, which ranged between 8.60 - 54.86 mg /Kg,

Table (8): Comparison between difference groups in Heavy metals contamination (zinc Zn).

marks	Mean $\pm$ SE			
	Breast	Thighs	Livers	Wings
Sadia	4.126 $\pm$ 0.22 bc	4.104 $\pm$ 0.19 b	6.974 $\pm$ 0.32 ab	3.113 $\pm$ 0.14 b
Al-Kafeel	5.831 $\pm$ 0.37 ab	6.548 $\pm$ 0.38 a	9.021 $\pm$ 0.63 a	4.416 $\pm$ 0.22 a
Bawadi	6.546 $\pm$ 0.41 a	5.297 $\pm$ 0.24 ab	8.761 $\pm$ 0.57 a	4.836 $\pm$ 0.25 a
Banvit	3.896 $\pm$ 0.18 c	4.255 $\pm$ 0.18 b	4.521 $\pm$ 0.22 b	3.324 $\pm$ 0.19 b
L.S.D.	1.906 *	1.544 *	2.391 *	0.988 *
Means having with the different letters in same column differed significantly. * ($P \leq 0.05$).				

The results of Table 9 show that the highest concentration of lead was in the livers samples of Al- kafeel brand, where the average was 2.21 $\pm$ 0.17 mg/kg, which was exceeded the acceptable limits for the concentration of lead that approved by the (FAO/WHO 2011) in chicken muscles, which should not exceed 0.2- 1 mg/kg, while the lower concentration was found in thighs samples of Sadia brand in which the lead concentration was 0.04 mg/kg with significant different among other samples , lead contamination in chicken may be attributed to their consumption of feed and water, and inhalation of polluted air in areas with numerous chemical factories, in addition to contamination present during manufacturing processes in the countries from which frozen poultry is imported (Ciobanu *et.al*, 2012). These results were contradicted to those obtained by (Hussain *et.al*, 2012), as the highest lead concentration was found in the Sadia brand, reaching 1.105 mg/kg, while the Al-Kafeel brand contained the lowest lead concentration, reaching 0.171 mg/kg

Table (9): Comparison between difference groups in Heavy metals contamination (lead Pb).

marks	Mean $\pm$ SE			
	Breast	Thighs	Livers	Wings
Sadia	0.12 $\pm$ 0.02 b	0.04 $\pm$ 0.01 b	1.02 $\pm$ 0.14 b	0.11 $\pm$ 0.02 b
Al-Kafeel	0.31 $\pm$ 0.05 a	0.14 $\pm$ 0.03 ab	2.21 $\pm$ 0.17 a	1.12 $\pm$ 0.08 a
Bawadi	0.24 $\pm$ 0.02 a	0.18 $\pm$ 0.04 a	1.11 $\pm$ 0.08 b	1.21 $\pm$ 0.11 a
Banvit	0.06 $\pm$ 0.01 b	0.02 $\pm$ 0.01 b	0.02 $\pm$ 0.00 c	0.02 $\pm$ 0.00 b
L.S.D.	0.191 *	0.122 *	0.341 *	0.470 *
Means having with the different letters in same column differed significantly. * ($P \leq 0.05$).				

The highest mean concentration of cadmium was 0.315 mg/kg in liver samples of AL-Bawadi brand, while the second high concentration was found in wings samples of Al-Kafeel



brand as shown in table 10, while the low concentration was found in wings samples of Sadia brand, it is worth noting that the cadmium concentrations of chicken samples is within the acceptable limits of 0.5 mg/kg that approved by the **(Codex Alimentarius Commission 1995)**. These results were consistent with those obtained by **(Abbas, 2017; Kamaly and Sharkawy, 2023)**, in which the cadmium content in the frozen chicken samples was within the permissible limits. Prolonged and continuous exposure to cadmium from pollution in chemical Factories and industrial complexes leads to the accumulation of cadmium in the liver and kidneys. It also affects the absorption of minerals in the body, such as phosphorus and calcium, and consequently impacts bone metabolism **(Akan et.al. 2010)**.

Table (10): Comparison between difference groups in Heavy metals contamination (Cadmium Cd).

marks	Mean $\pm$ SE			
	Breast	Thighs	Livers	Wings
Sadia	0.029 $\pm$ 0.001 ab	0.024 $\pm$ 0.003	0.028 $\pm$ 0.002 b	0.011 $\pm$ 0.002 b
Al-Kafeel	0.013 $\pm$ 0.003 b	0.034 $\pm$ 0.002	0.291 $\pm$ 0.04 a	0.312 $\pm$ 0.026 a
Bawadi	0.022 $\pm$ 0.003 b	0.038 $\pm$ 0.005	0.315 $\pm$ 0.04 a	0.261 $\pm$ 0.019 a
Banvit	0.067 $\pm$ 0.005 a	0.021 $\pm$ 0.002	0.026 $\pm$ 0.003 b	0.102 $\pm$ 0.004 b
L.S.D.	0.040 *	0.019 NS	0.078 *	0.103 *
Means having with the different letters in same column differed significantly. * ($P \leq 0.05$).				

Table 11 shows the highest concentration of copper element that recorded within the thighs samples of AL-Kafeel brand which was 0.664 mg/ kg while in wings samples of the same brand was 0.642 mg/kg. But on the contrary, the lowest percentage of copper was 0.0024 mg/kg which was found in livers samples of Banvit brand. It is noted that the copper concentrations in all samples were within the acceptable limits approved by **(FAO/WHO, 2000)**, one of the most important characteristics of copper is its inability to easily decompose in the environment; therefore, it will accumulate in the soil, and consuming animal products containing high concentrations of copper significantly affects consumer health **(Hu et.al., 2018)** Copper is a widely found element in the environment and has several uses in agriculture and industry, in addition to being present in the living body as it is an essential element in the formation of enzymes. However, if its levels exceed the permissible limit, it may cause damage to the kidneys and liver **(Elsharawy, 2015)**.

Table (11): Comparison between difference groups in Heavy metals contamination (Copper Cu).

marks	Mean $\pm$ SE			
	Breast	Thighs	Livers	Wings
Sadia	0.483 $\pm$ 0.07	0.354 $\pm$ 0.05 b	0.0058 $\pm$ 0.001 b	0.461 $\pm$ 0.15 b
Al-Kafeel	0.585 $\pm$ 0.11	0.664 $\pm$ 0.07 a	0.0211 $\pm$ 0.004 a	0.642 $\pm$ 0.12 a
Bawadi	0.524 $\pm$ 0.08	0.518 $\pm$ 0.10 ab	0.0365 $\pm$ 0.002 a	0.551 $\pm$ 0.12 ab
Banvit	0.427 $\pm$ 0.07	0.461 $\pm$ 0.07 ab	0.0024 $\pm$ 0.001 b	0.442 $\pm$ 0.09 b
L.S.D.	0.147 NS	0.205 *	0.0133 *	0.152 *
Means having with the different letters in same column differed significantly. * ($P \leq 0.05$).				



CONCLUSION

The conclusions drawn from this investigation provided insight into the fact that stored chicken meat is subjected to microbial and heavy metals contamination.

Among the heavy metals analyzed, pb was the most widespread, heavy metal concentrations were within the allowable limits for all but the element Pb was higher than this limits, *S. aureus* was the most common bacterial contaminants. Consequently, it reinforces the need to increase public awareness and education with increasing poultry health care and improving sanitation, in addition to using sterile water before slaughter, as well as adhering to health conditions and thermal treatments after slaughter and exporting meat to avoid the widespread transmission of hazards through food to the consumer.

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