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Comprehensive Analysis of Chemical and Microbial Safety in Grilled Meat and Poultry from Baiji City Markets: A Focus on Red and White Varieties

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Abstract

THIS study investigated the chemical composition and pollution levels, including heavy metals such as copper, cadmium, lead, zinc, and cobalt, and microbial contamination, in four types of grilled meat sold in the markets of Beiji City. The samples were collected from three different regions in the city between March 15, 2022, and mid-April. Results showed good levels of moisture, protein, and fat in the studied meat samples by A.O.A.C. with the highest moisture content recorded in chicken kebab samples (72.81%) and the lowest moisture content recorded in chicken shawarma (69.32%). Protein levels ranged from 16.87% to 19.23%, with the highest level in beef kebab and the lowest level in chicken shawarma. Results of the study showed an increase in zinc levels in all samples, with the highest level recorded in beef kebab (7.738 ppm). Zinc levels in chicken kebab, beef shawarma, and chicken shawarma were 6.911 ppm, 6.780 ppm, and 6.036 ppm, respectively. Lead levels were high in all studied meat samples, ranging from 0.1334 ppm to 0.1444 ppm. The highest cobalt level was recorded in chicken shawarma at 0.067 ppm. Copper levels varied with the type of meat, with the highest level recorded in beef kebab at 5.251 ppm and the lowest level recorded in beef shawarma at 3.038 ppm. Cadmium levels were highest in chicken kebab at 1.600 ppm and lowest in chicken shawarma at 1.018 ppm. Beef shawarma and chicken kebab had total bacterial counts of 64.12 x 103 CFU/g and 48.26 x 10^3 CFU/g, respectively. Microbial pollution showed the highest total bacterial count in beef kebab at 86.13 x 10^3 colony-forming units (CFU)/g and the lowest in chicken shawarma at 33.14 x 10^3 CFU/g. We conclude from the results of our current study the high level of moisture in the tissues of chicken kebabs, and that the highest level of protein was in the tissues of chicken kebabs, as well as the highest percentage of fat in meat shawarma.

Keywords: Chemical, Microbial, Grilled meat, Poultry sold**,** A.O.A.C.

Introduction

Restaurant food is an important source of regular nutrition for some people who depend on these foods and is one of the options available to consumers in most cities. As a result of eating restaurant food and fast food, many diseases have been detected. In low-income developing countries, popular restaurants are in high demand because they are cheap [1]. The consumption of meat and its products has increased recently as a result of the high levels of per capita income and the desire of consumers to obtain a main meal from this meat because it is an essential source of protein, fats, and some vitamins and minerals. The nutritional value of meat is linked to its good content of these ingredients. Meat and meat products are delicate and quickly affected by oxidation and spoilage through the physical and chemical changes they undergo after slaughtering animals. Fat oxidation in meat and meat products leads to undesirable flavors and odors of meat during storage

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due to aldehydes, acids, alcohols, and ketones produced by the process [2], Food is considered contaminated if it contains pathogenic microorganisms or is contaminated with chemicals or radioactive substances, which can cause food poisoning, accelerate signs of spoilage, and render it unsuitable for human consumption [3]. Numerous studies have shown that heavy metal contamination in animal meat is a major concern for consumer health because even if they are present at low levels, they pose a risk to consumer health [4]. Water and science may be a source of mineral pollution [5]. Studies have shown that contamination with heavy metals in the meat of farm animals, especially lead, if it exceeds permissible levels, will have negative effects on human health since they accumulate in the human body, causing damage to muscle tissue [6]. The study aimed to evaluate the microbial and chemical contamination in four types of grilled meat dishes (beef kebab, chicken kebab, meat shawarma, and chicken shawarma) served in fast food restaurants in the city of Baiji to compare it with the maximum accepted standards of human health.

Material and Method

Sample Collection: Samples of meat were collected from local restaurants in Beiji City from March 15th, 2022 to mid-April 2022. The study included four types of samples (beef kebab, chicken kebab, beef shawarma, and chicken shawarma).

Chemical composition estimation: The following properties were estimated for each meat sample: moisture, protein, fat, and ash.

Moisture estimation: Moisture content was estimated using the method described in A.O.A.C. (2008). After weighing empty dishes, 3 grams of the sample was added. The dishes were then placed in an oven at 100°C for 3 hours and weighed after cooling until a constant weight was reached. Moisture content was calculated as follows:

Moisture % = ((Weight after drying with sample - Weight before drying with sample) / Sample weight) × 100

Protein estimation: Protein content was estimated by the Kjeldahl method described in A.O.A.C. (2008). Two grams of the sample were digested using concentrated sulfuric acid (H_2SO_4) in three stages: digestion, distillation, and titration. In the digestion stage, the nitrogen in the food material is converted to ammonia by oxidizing the organic matter using H_2SO_4. The ammonia is distilled and collected in a boric acid solution containing appropriate indicators during the distillation stage. Hydrochloric acid (HCl) is used to neutralize the ammonia during the titration stage. The total nitrogen content was calculated using the following equation:

Total Nitrogen % = ((100 x 0.014 x Acid Titer x HCl Volume) / Sample weight)

Total Protein % = Total Nitrogen % x 6.25

Estimation of Fat: Fat content was estimated using the method described in A.O.A.C. (2008). The fat was extracted by continuous extraction to estimate the raw fat in a fat estimation unit (Extraction Unit E-812 Soxhlet), using petroleum ether as an extracting solvent with a boiling point of 40-60°C. Three grams of the meat sample were taken and placed in a filter paper and put in the extraction flask, and the extraction continued for 6 hours to ensure complete extraction of fat from the sample, after which the solvent was evaporated until a constant weight was reached. The amount of fat was calculated based on the difference in weight of the sample before and after extraction, and then the fat content was calculated as grams of fat/100 grams of dry weight.

Estimation of Ash: Ash content was estimated using the method described in A.O.A.C. [7]. The percentage of ash content was estimated by taking a weight of 2 grams of the meat sample and placing it in a pre-dried and weighed porcelain crucible. It was then dried in an electric oven at a temperature of 100°C to remove moisture and then transferred to a muffle furnace at a temperature of 600°C until a white or gray powder was obtained. The percentage of ash was calculated using the following equation:

Ash % = ((Weight of empty crucible - Weight of crucible with ash) / Sample weight) × 100

Estimation of Heavy Metals: Heavy metals were estimated according to the method described by [8], which involved the following steps,

A 2-gram sample of meat containing fat or liver is taken and placed in an incinerator at a temperature of 500-600°C. Weigh the remaining ash and add 5 mL of nitric acid (HNO_3) solution.

Concentrations of the following heavy metals (cadmium, cobalt, lead, copper, and zinc) were measured in meat and liver samples of the studied treatments using a flame atomic absorption spectrophotometer (FAAS) equipped with specific hollow cathode lamps for each element.

Calculate the concentration of heavy metals in the studied samples using the following equation:

$$\text{PPM element concentration} = \frac{V \times R}{D}$$

R = reading in the atomic absorption device

V = final sample volume

D = eye dry weight

Total bacterial counts were determined using the inverted plate count, in which 1 ml of the appropriate dilution was transferred to a sterile Petri dish containing nutrient agar medium. The samples were mixed well and allowed to stand, then the plates were incubated upside down at 35°C for 24 hours. Count bacterial colonies in the plate using a colony counter (9), *E. coli* bacteria were estimated by transferring 1 mL of the third dilution onto pre-cast MacConkey agar plates that were spread using a glass spray. The plates were then incubated upside down at 37 °C for 24 h, and bacterial colonies in the plates were counted using a colony counter device [10].

Results & Discussion

The results presented in Table (1) show the moisture, protein, fat, and ash content of the studied meat tissues (beef kebab, chicken kebab, beef shawarma, and chicken shawarma). The results indicate that the moisture level was highest in chicken kebab tissue at 72.81%, while the lowest moisture level was recorded in chicken shawarma tissue at 69.32%. The percentage of moisture in beef kebab and beef shawarma tissue was 71.23% and 70.12%, respectively.

The highest protein level was recorded in chicken kebab tissue at 19.23%, while the lowest was in beef shawarma at 16.87%. The protein level in beef kebab and chicken shawarma tissue was 18.91% and 17.82%, respectively.

The fat content of all meat samples tested was good. The highest fat content was found in roast beef kebab tissue at 7.82%, while the lowest was in chicken kebab slices at 7.82%. The fat content of beef kebabs and chicken shawarma was 8.19% and 8.15%, respectively. All samples tested had low ash content, with ash contents of 0.98%, 0.86%, 0.72%, and 0.87% for beef skewers, chicken skewers, beef shawarma, and chicken shawarma, respectively.

The variations in the values of meat components among the studied samples may be attributed to several factors, including differences in the source of meat, whether it is red or white meat, and the location of the muscle from which the meat was taken, as indicated by [11].

The results in Table (2) indicate the concentration of heavy elements (ppm), including zinc, lead, cobalt, copper, and cadmium, in grilled meat and chicken prepared by different methods from the study area (Beiji Industrial City). Zinc levels were found to be elevated in all study samples, with the highest level recorded at 7.738 ppm in the beef kebab tissue. Meanwhile, values for zinc in chicken kebab, beef shawarma, and chicken shawarma tissue were 6.911, 6.780, and 6.036 parts per million respectively. The zinc levels in our study were lower than those reported by [12] in their study of fresh sheep and poultry meat in Algeria, where zinc levels reached 23.51 parts per million in sheep meat and 147.82 parts per million in poultry meat .Lead levels were also found to be high in all studied meat samples, ranging from 0.1444 to 0.1334 parts per million, respectively. However, lead levels in all study samples did not exceed the permissible limits set by the [13], which range from 1.7 to 1.7 parts per million in food. The highest level of cobalt was recorded in chicken shawarma tissue at 0.067 parts per million, while cobalt levels in beef kebab, chicken kebab, and beef shawarma were 0.031, 0.027, and 0.042 parts per million, respectively. The results showed that the recorded cobalt ratios were below the internationally allowed limits (0.1 parts per million) as per ATSDR.

The study also found that the beef roast tissue had the highest copper content at 5.251 ppm, while the beef roast tissue had the lowest copper content at 3.038 ppm. These results are consistent with those of [14] who found that the copper content in mutton in the North Hebei region was the highest at 4.92 parts per million. Chicken kebab tissue had the highest level of cadmium at 1,600 parts per million, while chicken shawarma tissue had the lowest level of cadmium at 1,018 parts per million. These results are similar to those of [15], who investigated heavy metal contamination in cooked and uncooked poultry meat sold in markets in Basrah province.

In summary, our study shows that the levels of heavy metals in grilled meat and chicken prepared by different methods in Beiji Industrial City are generally within permissible limits, with zinc being the most abundant heavy metal.

Microbiological indicators

Fig. 1 shows the microbiological contamination of beef kebab, chicken kebab, beef shawarma, and chicken shawarma. The study included total bacterial counts and coliform bacteria. Direct exposure to fire during grilling resulted in a decrease in the total bacterial count. Chicken shawarma recorded the highest total bacterial count of 8.9 log CFU/g, while beef kebab recorded the lowest level of 5.7 log CFU/g. The recorded total bacterial counts in all studied samples were higher than the permissible limits set by Iraqi specifications, which is 107 × 1 log CFU/g, conducting other studies on meat displayed in markets and restaurants to give a final description approved by the Ministries of Health and Agriculture regarding the level of microbial and chemical contamination of meat and fast food.

Conclusions

We conclude from the results of our current study the high level of moisture in the tissues of chicken kebabs, and that the highest level of protein was in the tissues of chicken kebabs, as well as the highest percentage of fat in meat shawarma.

TABLE 1. Chemical composition of the schooled meat samples % chemical composition

Materials	Ash	Fat	Protein	Moisture
Meat Kebab	0.98±0.01	8.19±0.34	18.91±1.06	71.23±**2.7**
Chicken kebab	0.86±0.01	7.82±0.62	19.23±0.92	72.81±**3**.6
Meat shawarma	0.72±0.04	9.98±0.39	16.87±0.83	70.12±1.09
Chicken Shawarma	0.87±0.01	8.15±0.53	17.82±0.47	69.32±**1.45**

TABLE 2. Average concentration of heavy metals in the tissue of the studied meat (ppm).

	Heavy element concentration				
Materials	**Cadmium**	**Copper**	**Cobalt**	**Lead**	**Zinc**
Meat Kebab	1.100±0.1	5.251±0.35	0.031±0.72	0.1444±0.01	7.738±0.83
Chicken kebab	1.600±0.05	4.747±0.29	0.027±0.92	0.1373±0.08	6.911±0.48
Meat shawarma	1.023±0.24	4.035±1.04	0.042±0.27	0.1365±0.03	6.780±0.27
Chicken Shawarma	1.018±0.03	3.038±0.93	0.067±0.48	0.1334±0.09	6.036±0.61

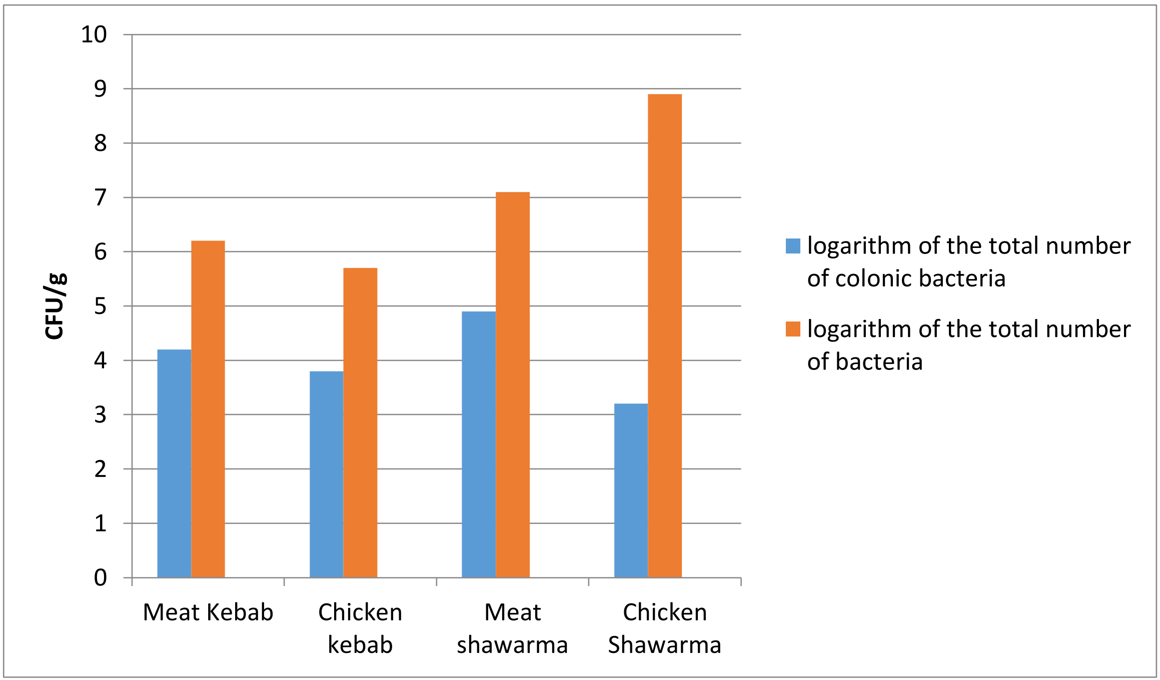

Fig. 1. Microbiological indicators of the total number of bacteria for *E. coli* bacteria

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The authors declare that the present study has no financial issues to disclose.

Conflict of interest

None

Authors contributions

Farkad Hawas Musa, Zainab Agab Altaee: Practical work

Tariq Kh.M. Albashr: statistical analysis

Nada Ali Attallah and Eman Naji Saleh: Manuscript writing and editing

References

1. Abdulilah, H.A.Q., Ali Abed Al-Asa, E. and Hameed, A.T. Role of rhizobia (Rhizobium meliloti) of alfalfa in the bioremediation Of contaminated soil with hydrocarbons. *Plant Archives,* **19**, 146–152 (2019)
2. Agency for Toxic Substances and Disease Registry (ATSDR). Agency for Toxic Substances and Disease R egistry, Division of Toxicology, Clifton Road, NE, Atlanta, GA.Available from http ://www.atsdr.cdc. gov/ toxprofile (2004).
3. Badis, B., Rachid, Z. and Esma, B. Levels of Selected Heavy Metals in Fresh Meat from Cattle, Sheep, Chicken and Camel Produced in Algeria. *Annu. Res. Rev. Biol.,* **4**(8), 1260-1267 (2014).
4. Hameed, A.T., Dawd, S.M. and Al Bahadly, Z.K. Ecological Study and Peroxidase Activity of Some Medical Plant (Asteraceae) Growth Wildly in Anbar Governorate – Iraq. *Journal of Physics: Conference Series*, **1818**(1), 012037(2021).
5. Doulgeraki , A. I., Ercolini, D., Villani, F. and Nychas, G.-J. E.. Spoilage microbiota associated with the storage of raw meat in different conditions. *International Journal of Food Microbiology,* **157** (2), 130– 141(2012).
6. Harrigan , W. F. and McCance, M. E.. Laboratory Methods in Foodand Dairy Microbiology. Academic Press. INC, London: 57-88(1976).
7. A.O.A.C.. Official Methods of Analysis, 15th Edn.. Association of Official Analytical Chemists. Arlington. Virginia (2008).
8. Hoha, G. V., Costăchescu, E., Leahu, A. and Păsărin, B. Heavy metals contamination levels in processed meat marketed in Romania. Environmental *Engineering and Management Journal,* **13** (9), 2411-2415 (2014).
9. Hamood, K., Hameed, A. T., Azzam, M. R. and Mohammed, I. H. Chemical composition and antimicrobial activities of the flavonoids Ammi majus L growing broadly in Western Iraq. In AIP Conference Proceedings (Vol. 2547, No. 1). (2022, December).
10. Ibraheem, M. W. Studying the residues of Heavey Metals and some quality characteristics of Awassi Ram and imported meat in three Areas in Salah AL-din provinces. dissertation of Ph.D.in meat science. College of Agriculture, University of Tikrit. (2013).
11. Kareem, M.H., Ali, R.K.,Khaleel, S.J., Hasan, M.S and Saleh, E. N.. Experimental Study of Prepared Killed Vaccine for *S. Aureus* in Local Rabbits. *Medico-legal Update*, **20**(3), 1127(2020).
12. Listrat, A., Lebret, B., Louveau, I., Astruc, T., Bonnet, M., Lefaucheur, L. and Bugeon, J. How Muscle Structure and Composition Influence Meat and Flesh Quality. *The Scientific World Journal*, 1–14 (2016).
13. Makki Ghaida Ali. Detection of microbial contamination and heavy metals in cooked poultry meat displayed in local markets in Basra Governorate. *Syrian Journal of Agricultural Research*, **6**(2), 212-220 (2019).
14. Mohammed, I.H., Hameed, A.T. and Salman, H.F. Phytochemical and biological of Anthemis nobilis (Asteraceae family) a native herbs of Iraq. *Systematic Reviewsin Pharmacy*, **11**(2), 458-461(2020).
15. Rane, S. Street vended food in developing world: hazard analyses. *Indian J. Microbiol.,* **51** (1),100-106 (2011).

الكشف عن التلوث الكيميائي والميكروبي للحوم الحمراء والبيضاء المطبوخة بطريقة الشواء والمعروضة في اسواق مدينة بيجي

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يتضمن البحث دراسة التركيب الكيميائي والتلوث الكيميائي وشمل العناصر الثقيلة وهي كل من عنصر (النحاس و الكادميوم والرصاص و الزنك والكوبالت) والتلوث الميكروبي في اربع انواع من اللحوم المطبوخة بطرية الشواء والمعروضة في اسواق مدينة بيجي والتي تم جمعها من ثلاث مواقع مختلفة في المدينة في المدة من 2022/3/15 ولغاية منتصف شهر نيسان 2022 ، سجلت نتائج الدراسة التركيب الكيميائي لعينات اللحم المدروسة سجلت مستويات جيدة من الرطوبة و البروتين والدهن اذ بلغت اعلى قيمة للرطوبة في عينات كباب الدجاج (72.81)% وادنى مستوى للرطوبة بلغ (69.32)% في شاورما الدجاج ، سجل البروتين مستويات بلت (18.91 ، 19.23 ، 16.87 ، 17.82)% في عينات كباب اللحم وكباب الدجاج وشاورما اللحم وشاورما الدجاج على التوالي ، كما سجلت اعلى قيمة للدهن في شاورما اللحم بغلت (9.98)%. اظهرت نتائج دراسة التلوث الكيميائي بالعناصر الثقيلة ارتفاع مستوى عنصر الزنك في جيع عينات الدراسة اذ سجل اعلى مستوى له (7.738)ppm في نسيج كباب اللحم بينما بلغت قيم عنصر الزنك (6.911 ، 6.780 ، 6.036) جزء بالمليون في نسيج كباب الدجاج وشاورما اللحم وشاورما الدجاج على التوالي ، سجل عنصر الرصاص مستويات مرتفعة في جميع عينات اللحم المدروسة اذ بلغت (0.1444 ، 0.1373 ، 0.1365 ، 0.1334) جزء بالمليون ، بينما اعلى نسبة لعنصر الكوبلت كانت في عينات شاورما الدجاج بلغت (0.067) جزء بالمليون ، اختلفت قيم النحاس باختلاف النسيج اللحمي المدروس اذ سجلت اعلى قيمة للنحاس في نسيج لحم الكباب المدروس اذ بلغ (5.251) جزء بالمليون بينما اقل قيمة نحاس سجلت (3.038) جزء بالمليون في نسيج شاورما اللحم ، بلغت قيم للكادميوم في نسيج لحم كباب الدجاج اذ بلغت (1.600) جزء بالمليون بينما اقل قيمة للكادميوم سجلت (1.018) جزء بالمليون في نسج شاورما الدجاج . اظهر التلوث الميكروبي ان اعلى قيمة في لوغاريتم لعدد الكلي لبكتريا بلغت (86.13×103) وحدة مستعمرة بكتيرية / غم عند في نسيج كباب اللحم بينما سجلت ادنى قيمة في لوغارتيم العدد الكلي للبكتريا (33.14×103) وحدة مستعمرة بكتيرية / غم في نسيج شاورما الدجاج ، في حين سجلت قيم لوغاريتم العدد الكلي لبكتريا نسب بلغت (64.12×103 ، 48.26×103) وحدة مستعمرة بكتيرية / غم في كل من نسيج كباب الدجاج وشاورما اللحم ، وقد اثبتت الدراسة ان جميع تراكيز العناصر الثقيلة موضع الدراسة في لحوم الاسماك المدروسة اقل من مستوى التركيز المنخفض (ERL) كما اوضحت ان كمية العناصر الثقيلة المسموح بها للفرد اسبوعيا(PTWI) بالنسبة للعناصر المدروسة الكادميوم والرصاص والنحاس والكادميوم (العناصر المتاحة نتائجها عالميا) في لحوم الاصناف الحمراء والبيضاء موضوع الدراسة اقل بكثير من الحدود المسموح بها وبالتالي فأن استهلاك الاشخاص من مواقع الدراسة لا تمثل خطر على الصحة العامة .

الكلمات الدالة: التلوث الكيميائي ، التلوث الميكروبي، اللحوم الحمراء.