IRAQI Academic Scientific Journals
العراقية المجلات الأكاديمية العلمية
University of Kut Journal
ISSN (E): 2616 - 7808 II ISSN (P): 2414 - 7419
js.uokut.edu.iq
k.u.c.j.sci@alkutcollege.edu.iq
Vol. 11 , Issue 1 , June 2026

Detection of Lead and Cadmium Concentration in some popular Fruits and Vegetables Available in the Market of Kut

Wisam Basim Al-Tmemy [1] , Oday Jawad Jasim [2] , Othman Hashem Mohammed [3] , Majida Hammadi Almayahey [4]

Abstract

This study aimed to shed light on the contamination of the most important foods with heavy metals, which were collected from vendors in the most crowded markets in the Wasit Province, Iraq. The content of lead and cadmium in eleven types of vegetables and fruits were estimated, as they are among the most dangerous toxic foods contaminated with heavy metals, which are among the most important components of the basic meals of Iraqi citizens. An atomic absorption spectrophotometer (Model Phoenix–986 AAS) was used to assess heavy metals. The results showed that the concentration of lead in some vegetables ranged between (0.021 to 1.05 µg/g) and in fruits it reached (0.25 to 0.39 µg/g). As for the cadmium element, the results showed that its concentration was less than the concentration of lead, as it reached (0.073 to 0.182 µg/g) in vegetables and (0.065 to 0.133 µg/g) in fruits. The study revealed potential health risks associated with the consumption of different types of vegetables and fruits. The results showed that the concentration of lead and cadmium in most of the studied samples exceeded the permissible limit recommended by the World Health Organization and the Food and Agriculture Organization, which may assist Iraqi regulatory bodies in developing new strategies to reduce risks to humans.

Keywords: Food, Vegetables, Fruits, Heavy Metals, Atomic absorption spectrometry

Affiliations of Authors

[1, 2, 3] Department of Medical Laboratory Technologies, University of Kut, Iraq, Wasit, 52001

[4] Office of the Vice Chancellor for Scientific Affairs, University of Wasit, Iraq, Wasit, 52001

[1] PAD.24.012@alkutcollege.edu.iq
[2] PAD.24.018@alkutcollege.edu.iq
[3] Pad.24.027@alkutcollege.edu.iq
[4] Malmayahy@uowasit.edu.iq

[1] **Corresponding Author**

Paper Info.
Published: Jun. 2026

الكشف عن تركيز الرصاص والكادميوم في بعض الفواكه والخضروات الشعبية المتوفرة في اسواق مدينة الكوت

وسام باسم التميمي [1] ، عدي جواد جاسم [2] ، عثمان هاشم محمد [3] ، ماجدة حمادي المياحي [4]

المستخلص

هدفت هذه الدراسة إلى تسليط الضوء على تلوث أهم الأغذية بالمعادن الثقيلة والتي تم جمعها من الباعة في أكثر الأسواق ازدحاماً في محافظة واسط بالعراق، وتم تقدير محتوى الرصاص والكادميوم في إحدى عشر نوعاً من الخضار والفواكه المحلية، باعتبارها من أخطر الأغذية السامة الملوثة بالمعادن الثقيلة والتي تعد من أهم مكونات الوجبات الأساسية للمواطنين العراقيين، وتم استخدام جهاز مطياف الامتصاص الذري Phoenix – 986 AAS لتقييم المعادن الثقيلة، وأظهرت النتائج أن تركيز الرصاص في بعض الخضار تراوح بين (0.021 إلى 1.05 ميكروغرام/غرام) وفي الفواكه وصل إلى (0.25 إلى 0.39 ميكروغرام/غرام)، أما عنصر الكادميوم فقد أظهرت النتائج أن تركيزه كان أقل من تركيز الرصاص حيث وصل في الخضار إلى (0.073 إلى 0.182 ميكروغرام/غرام) وفي الفواكه (0.065 إلى 0.133 ميكروغرام/غرام). وكشفت الدراسة عن المخاطر الصحية المحتملة المرتبطة بتناول أنواع مختلفة من الخضار والفواكه، وأظهرت النتائج أن تركيز الرصاص والكادميوم في أغلب العينات المدروسة تجاوز الحد المسموح به الذي أوصت به منظمة الصحة العالمية ومنظمة الأغذية والزراعة، الأمر الذي قد يساعد الهيئات الرقابية العراقية على وضع استراتيجيات جديدة للحد من المخاطر على الإنسان.

الكلمات المفتاحية: الغذاء، الخضروات، الفواكه، المعادن الثقيلة، مطيافية الامتصاص الذري

انتساب الباحثين

[1، 2، 3] قسم تقنيات المختبرات الطبية، جامعة الكوت، العراق، واسط، 52001

[4] مكتب مساعد رئيس الجامعة، جامعة واسط، العراق، واسط، 52001

[1] PAD.24.012@alkutcollege.edu.iq
[2] PAD.24.018@alkutcollege.edu.iq
[3] Pad.24.027@alkutcollege.edu.iq
[4] Malmayahy@uowasit.edu.iq

[1] **المؤلف المراسل**

معلومات البحث
تأريخ النشر : حزيران 2026

Introduction

Heavy metal contamination is one of the forms of environmental pollution resulting from human industrial or agricultural activity, and in recent years scientists have been interested in studying heavy elements in terms of their presence in the environment, their biological effects, and their relationship to human health. Food is one of the main sources of human exposure to these elements [1, 2].

Vegetables and fruits have long constituted an important component of the human diet, and their importance derives from their high nutritional value, as they contain elements and trace minerals essential for human health [3], where the heavy metal content of vegetables and fruits varies not only according to the accumulation of these minerals during their growth but also because of their pollution during harvesting processes [4].

Contamination with heavy elements in the soil leads to major environmental and health problems such as the high concentration of these elements to the point of toxicity in plants, animals and humans [5, 6]. Heavy metal contamination of vegetables and fruits cannot be underestimated as they are an important part of our diet. Consumption of fruits and vegetables contaminated with heavy metals introduces health-damaging toxins into the target organs of the body [7]. These toxins continue to metabolize and accumulate directly in the bloodstream and cell tissues [8].

The food offered in the markets and streets of cities is one of the most vulnerable foodstuffs to heavy metal pollution, so access to these foods is easy and affordable for the population because of its low monetary value compared to other foodstuffs, Therefore, this study aims to assess the lead and cadmium content of selected vegetables and fruits and to evaluate their safety relative to the maximum limits set by the World Health Organization and the Food and Agriculture Organization.

2. Materials and methods

2.1. Study design and sampling

A field study was conducted for nine months, from November 2023 to July 2024, in Wasit province, Iraq. Eleven different types of vegetable and fruit samples were collected from six different local markets located in Wasit province. The investigated areas were Al-Suwaira, Al Aziziyah, Al Numaniyah, Badara, Al Kut and Al Hayy. Sampling sites are shown in Figure 1, which was generated using ArcGIS 10.5 software. For each type, three replicate samples of vegetables and fruits were collected from each market. In total, 198 samples were collected from six local markets. The samples were collected in sterile plastic bags as follows: 144 samples of vegetables (tomatoes, eggplants, potatoes, cucumbers, peppers, onions, lettuce, carrots), and 54 samples of fruits (oranges, apples, bananas). All samples were washed, stored in fresh plastic bags and brought to the laboratory for analysis.

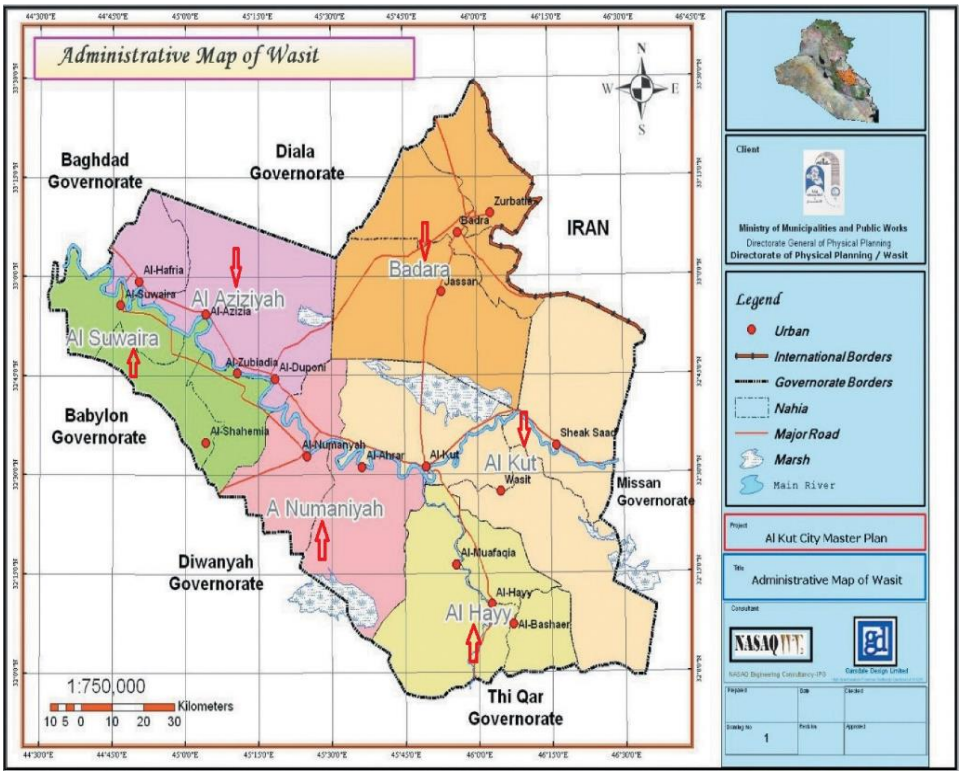

Figure (1): Sampling site of the study, Wasit province, Iraq prepared by GIS software

2.2. Laboratory Procedures

All the collected vegetable and fruit samples were prepared according to [9]. All the glass equipment used for the analysis as well as the study samples were cleaned with deionized water.

All the samples were then oven dried at 105°C to remove all moisture and ground with the help of mortar. 10 g of the sample was weighed into a digestion flask and 20 mL of concentrated nitric acid was added and the flask was left for a quarter of an hour. It was then placed on a hot plate until its contents became 3–5 mL. 20 mL of nitric acid, 10 mL of H_2SO_4, and 8 mL of $HClO_4$ were added, and the contents of the flask were evaporated to about 5 mL. When the solution became colorless, it was cooled to room temperature and 5 mL of HNO_3 and 2 mL of $HClO_4$ were added and heated until white fumes rose. If the solution was colored, the steps were repeated from the beginning until the color disappeared. Then 10 mL of deionized water was added to the cooled flask and heated for 10 minutes until white vapors rise. The mixture was then cooled to room temperature, and the clear solution was filtered using filter paper and the volume was completed to 25 mL with deionized water.

The heavy metal determination was carried out using a Model Phoenix-986 AAS atomic absorption spectrometer [10].

3. Results and discussion

The analytical results of the present study indicate the presence of lead and cadmium in the selected fruits and vegetables collected from production and marketing sites in Wasit province, Iraq. The observed Pb and Cd concentrations in fruits and vegetables were compared to the recommended limit as set by FAO/WHO in 2007 to assess food contamination levels. The mean concentration and permissible limit of heavy metals (Pb and Cd) found in vegetables and fruit sampled from the local markets, are summarized as shown in Table (1) and Table (2).

Table (1): Pb Concentration in fruit and vegetables (µg/g)

Vegetables	Pb
Tomatoes	1.52
Potatoes	0.33
Cucumber	0.96
Eggplant	0.45
Pepper	0.78
Carrots	0.21
Onions	0.93
Lettuce	1.29
Fruits	
Orange	0.32
Apple	0.39
Banana	0.25
WHO/FAO limits	0.3

Table (2): Cd Concentration in fruit and vegetables (µg/g)

Vegetables	Cd
Tomatoes	0.182
Potatoes	0.09
Cucumber	0.11
Eggplant	0.087
Pepper	0.073
Carrots	0.052
Onions	0.095
Lettuce	0.17
Fruits	
Orange	0.065
Apple	0.133
Banana	0.082
WHO/FAO limits	0.1

Lead (Pb): It is one of the most dangerous elements that may be present in the environment and has a significant impact on humans [11]. The Pb may enter from erosion and leaching from the soil and the release of industrial and domestic waste and as a result of lead dust in the atmosphere and the combustion of coal products in addition to pesticides that are applied during agriculture and the use of contaminated water in irrigation [12, 13]. The contamination of the environment with lead is reflected in food contamination, whether in vegetables or fruits, which affects the health and

safety of consumers, especially children, as lead is characterized by its ability to cross the placenta, causing low birth weight and irreversible damage to the fetal brain [14].

As shown in Table (1) and Figure (2), the concentration of lead in fruits was lower than in vegetables, with values reaching 0.25 µg/g, 0.32 µg/g, and 0.39 µg/g for bananas, oranges, and apples, respectively. While the highest concentration was recorded in tomatoes (1.52 µg/g), lettuce (1.29 µg/g), cucumber (0.96 µg/g), and onions (0.93 µg/g), the lowest concentrations were in carrots, potatoes, eggplant, and peppers, with values of 0.21 µg/g, 0.33 µg/g, 0.45 µg/g, and 0.78 µg/g, respectively.

The main reason for the increase in lead concentration in vegetables and fruits is due to the pollution of the surrounding and densely populated area, as well as car exhaust and waste near residential areas, which play a role in increasing concentrations of pollutants. Moreover, the high concentration of lead, especially in tomatoes, is likely related to its larger surface area, since there is a direct proportion between the size/surface area of the fruit and the degree of surface contamination [15].

On the other hand, leafy vegetables are more susceptible to heavy metal accumulation, reflecting the ability of leafy plants to absorb and store heavy elements, particularly lead, in their leaves [16].

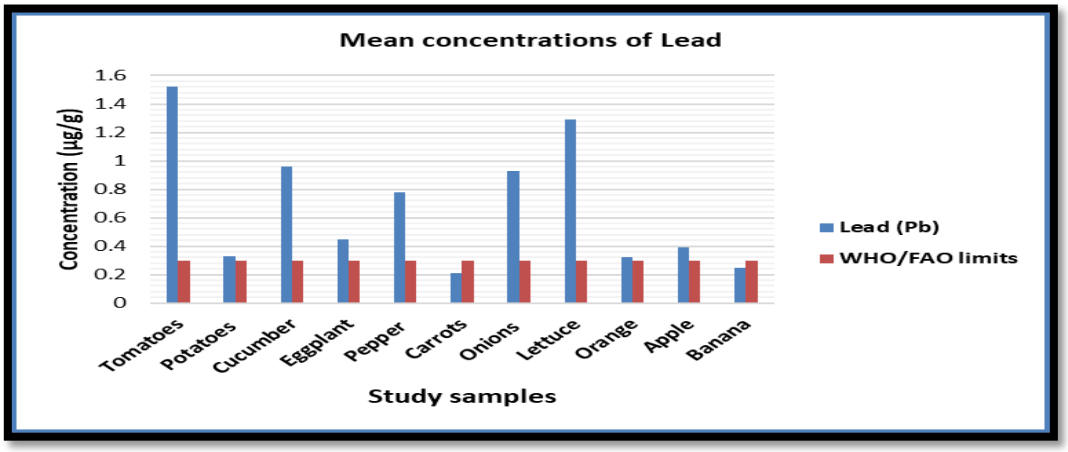

Figure (2): Concentration of Pb in vegetables and fruits

Cadmium (Cd): It is one of the most dangerous heavy elements for human health and cadmium reaches the atmosphere as a by-product of coal burning operations in power plants, moving with dust resulting from the transfer of coal to surrounding areas and settling in the bodies of living organisms, soil, or water sources. It enters the body mainly through inhalation of airborne dust and affects the work of the kidneys as it may cause cancer and in the case of inhalation in high concentrations, it leads to severe pain in the lungs and heart disorders, and may also lead to high blood pressure, liver disease, and anemia [17, 18].

The mean concentrations of cadmium found in vegetables and fruits sampled from the local markets are summarized in Table (2) and shown in Figure (3). The results showed that the levels of Cd in the fruit content were close to the vegetable content, where the content was 0.065 µg/g, 0.082 µg/g, and 0.133 µg/g for oranges, bananas, and

apples respectively. While tomatoes were 0.182 µg/g, lettuce 0.17 µg/g, and cucumbers 0.11 µg/g, the lowest concentrations were found in carrots, peppers, eggplant, potatoes, and onions, with values of 0.052 µg/g, 0.073 µg/g, 0.087 µg/g, 0.09 µg/g, and 0.095 µg/g, respectively.

The different concentrations of cadmium in vegetables and fruits are due to the different sites contaminated with heavy metals. On the other hand, the danger of cadmium comes as one of the heavy elements with a negative impact on human health, as it moves from the soil to the plant and the plant bears high levels of it, but even low concentrations of it affect human and animal health; it is highly toxic and causes kidney failure, and it affects the bones, causing fragility, as it replaces calcium in bone tissue [19, 20].

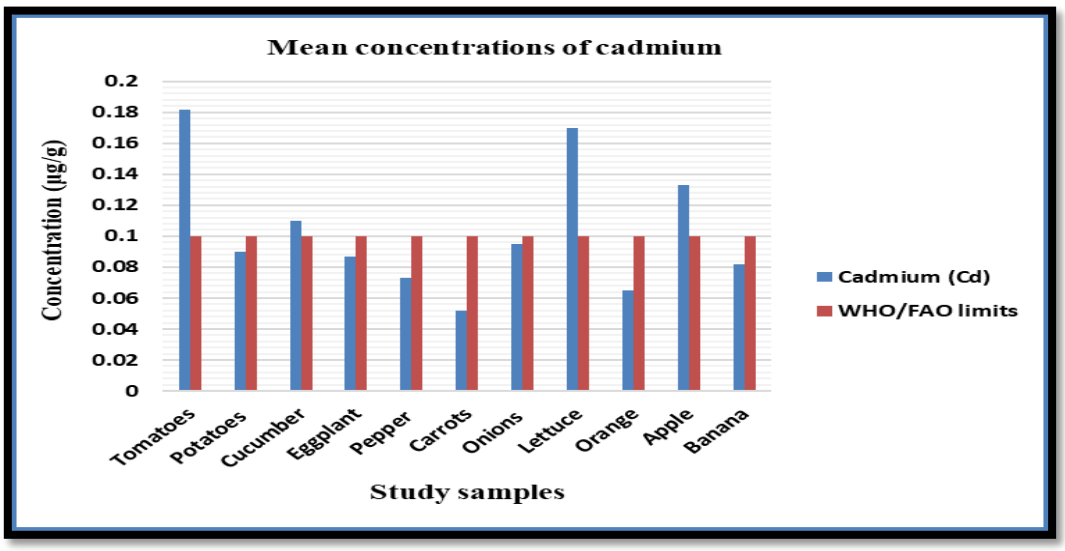

Figure (3): Concentration of Cd in vegetables and fruits

Conclusion and Recommendation

The present study revealed that an excess of lead and cadmium was present in most of the samples studied, and this leads to long-term effects that directly affect human health. This study showed that the effects of car waste, irrigation operations, and excessive use of pesticides were major reasons for the increase in heavy metal concentration in vegetables and fruits. Therefore, vegetables and fruits must be covered in markets, especially near intersections and crowded areas with cars. Also, fruits and vegetables should be washed effectively before eating to remove accumulated mineral dust. Moreover, modern pest control methods, such as organic pesticides, should be used instead of hazardous chemical pesticides. The cultivation of fruits and vegetables along roadsides, main streets, and near factories and large cities should be avoided to prevent contamination with heavy metals and other hazardous compounds.

References

[1] Mishra, S. et al.. Heavy metal contamination: an alarming threat to environment and human health. Environmental biotechnology: For sustainable future, 103–125 (2019).

[2] Al-Mayah, Wisam Thamer. Estimation of health risks of lead and cadmium in infant formula and their food for consumption in Wasit Governorate, Iraq.

[3] British Journal of Global Ecology and Sustainable Development. Volume-06, July, 2022. ISSN (E): 2754-9291.

[4] Chowdhury, A.I., Shill, L.C., Raihan, M.M. et al. Human health risk assessment of heavy metals in vegetables of Bangladesh. 2024, Sci Rep 14, 15616. https://doi.org/10.1038/s41598-024-65734-6

[5] Elbagermi, M. A.; H. G. M. Edwards, and A. I. Alajtal. Monitoring of Heavy Metal Content in Fruits and Vegetables Collected from Production andMarket Sites in theMisurata Area of Libya. International Scholarly Research Network. ISRN Analytical Chemistry. 2012, Article ID 827645, 5 p.

[6] Oves, M.; Khan, M.S.; Zaidi, A.; Ahmad, E. Soil contamination, nutritive value, and human health risk assessment of heavy metals: An overview. In Heavy Metals in Plants. Physiological to Molecular Approach; Kumar, J., Gaur, S., Srivastava, P.K., Mishra, R.K., Prasad, S.M., Chaudan, D.K., Eds.; CRC Press Publishing: Boca Raton, FL, USA, 2022.

[7] Younas, Saba , Syeda Anjum Tahira, Muhammad Umer Farooq. Assessment of heavy metal contamination in vegetables collected from selected localities of Okara, Pakistan. Adv. life sci., 2023, vol. 10, no. 2, pp. 167-173.

[8] Nisa, Un. K., Samiullah, S., Khan, N., Kakar, A. R. Detection of Heavy metals in Fruits and Vegetables Available in the Market of Quetta City. Al-Nahrain J. of Science, 2020, vol. 23, no. 1, pp. 47-56.

[9] Liang G, Gong W, Li B, Zuo J, Pan L, Liu X. Analysis of heavy metals in foodstuffs and an assessment of the health risks to the general public via consumption in Beijing, China. Int J Environ Res Public Health. 2019;16:909.

[10] Akinyele, I. & Shokunbi, O. Comparative analysis of dry ashing and wet digestion methods for the determination of trace and heavy metals in food samples. Food Chem. 2015, 173, 682–684

[11] Welz, B. and Sperling, M. Atomic Absorption Spectrometry. 3rd Edition, Wiley-VCH, Weinheim, New York. 2008

[12] WHO/FAO. Joint FAO/WHO. Food Standards Programme Codex Alimentarius Commission Twenty-Seventh Session Report of the Thirty-Sixth Session of the Codex Committee on Food Hygiene. Food & Agriculture Org.; 2007.

[13] Chen T, Liu X, Li X, et al. Heavy metal sources identification and sampling uncertainty analysis in a field-scale vegetable soil of Hangzhou, China. Environ Pollut. 2009;157:1003-1010.

[14] World Health Organization (WHO). Food safety and foodborne diseases. Geneva, Switzerland: WHO; c2020.

[15] Antoine JMR, Fung LAH, Grant CN. Assessment of the potential health risks associated with the aluminium, arsenic, cadmium and lead content in selected fruits and vegetables grown in Jamaica. Toxicol Rep. 2017;4:181-187.

[16] Tabassam, Q.; Ahmad, M.S.A.; Alvi, A.K.; Awais, M.; Kaushik, P.; El-Sheikh, M.A. Accumulation of Different Metals in Tomato (Lycopersicon esculentum L.) Fruits Irrigated with Wastewater. Appl. Sci. 2023, 13, 9711. https://doi.org/10.3390/app13179711

[17] Ahmad, M.S.A.; Ashraf, M.; Tabassam, Q.; Hussain, M.; Firdous, H. Lead (Pb)-induced regulation of growth, photosynthesis, and mineral nutrition in maize (Zea mays L.)

plants at early growth stages. Biol. Trace Elem. Res. 2011, 144, 1229–1239.

[18] Baldantoni, D.; Morra, L.; Zaccardelli, M.; Alfani, A. Cadmium accumulation in leaves of leafy vegetables. Ecotoxicol. Environ. Saf. 2016, 123, 89–94.

[19] Ali, H.; Khan, E.; Ilahi, I. Environmental chemistry and ecotoxicology of hazardous heavy metals: Environmental persistence, toxicity, and bioaccumulation. J. Chem. 2019, 2019, 6730305.

[20] Feseha, A., Chaubey, A. K., and Abraha, A. Heavy metal concentration in vegetables and their potential risk for human health. Health Risk Analysis, 2021, 1(1), 68–81. https://doi.org/10.21668/health.risk/2021.1.07.eng.

[21] Pan, X.-D.; Han, J.-L. Distribution of Cadmium in Fresh Vegetables Marketed in Southeast China and Its Dietary Exposure Assessment. Foods 2023, 12, 1204. https://doi.org/10.3390/ foods12061204.