psm Journals

International Journal of
Alternative Fuels and Energy

Opinion | 2023 | Volume 7 | Issue 1 | 15-21

Open Access
Article Information

Received: April 18, 2023

Accepted: April 25, 2023

Published: April 30, 2023

Keywords
Palms,
Food source,
Heavy metals,
Pesticides and fertilizers,
Public health.

How to cite
Alkhatib, A.J., Alkhatib, I.A., Alkhatib, M.A., Alkhatib, N.A., 2023. Heavy Metal Toxicity in Palms (*Phoenix dactylifera* L.): A Significant Hazard in the Context of Consumption and Strategies for Mitigation. Int. J. Altern. Fuels. Energy., 7(1): 15-21.

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Heavy Metal Toxicity in Palms (*Phoenix dactylifera* L.): A Significant Hazard in the Context of Consumption and Strategies for Mitigation

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Abstract:
Palm (*Phoenix dactylifera* L.) fruit is a nutritious food source that can also contain heavy metals, which can be harmful to human health. Heavy metals can enter the food chain through natural sources or through human activities such as mining, industrial activities, and the use of pesticides and fertilizers. Exposure to heavy metals can cause significant health effects, including damage to organs such as the liver, kidneys, and brain. To reduce the risk of heavy metal contamination in palm fruit, it is important to use sustainable farming practices, proper waste management techniques, and appropriate equipment and materials for processing and packaging. Regulatory agencies have established guidelines and regulations for heavy metals in food, and it is important for food producers and manufacturers to comply with these regulations to protect public health.

INTRODUCTION

Phoenix dactylifera L. is a palm grown for its sweet edible fruit is an important fruit crop in arid and semiarid areas. Palm fruit is a major food crop in many countries around the world. It is a rich source of nutrients, including vitamins, minerals, and antioxidants (Al-Shwyeh, 2019). However, palm fruit may also contain heavy metals, which can be harmful to human health (Salama *et al.,* 2019). Heavy metals are metallic elements that have a high density and are toxic at low concentrations (Iqbal and Ashraf, 2018; 2022a). Some of the most common heavy metals that can be found in food include lead (Pb), cadmium (Cd), arsenic (As), mercury (Hg), and chromium (Cr). These metals can enter the food chain through natural sources, such as soil and water, or through human activities, such as mining, industrial activities, and the use of pesticides and fertilizers (Azeem and Rashid, 2019; Cao *et al.,* 2022; Hadyait *et al.,* 2018; Huang *et al.,* 2021). In this article, we will explore the presence of heavy metals in palm fruit, their sources, and the potential health effects of exposure.

Sources of Heavy Metals in Palm Fruit

Soil contamination is one of the primary ways that palm fruit can be exposed to heavy metals. Heavy metals such as lead, cadmium, arsenic, and mercury can occur naturally in soil due to weathering of rocks, but human activities such as mining, industrial activities and the use of fertilizers and pesticides can also contribute to soil contamination (Sultana *et al.,* 2019). These metals can remain in the soil for many years, and as the palm tree grows, it can absorb these metals through its roots and transport them to its fruit (Khazaee and Abbaszadeh, 2021).

For example, a study conducted in Malaysia found that palm oil samples collected from different regions contained varying levels of heavy metals such as lead, cadmium, and chromium, and the levels were found to be higher in areas where there was industrial activity and mining (Ismail *et al.,* 2017). Similarly, a study conducted in Nigeria found that palm oil samples collected from areas with higher levels of soil contamination had higher levels of heavy metals such as cadmium and lead (Igwe *et al.,* 2019).

In addition to soil, water used for irrigation and other agricultural purposes can also be a source of heavy metals in palm fruit. Water sources such as rivers and streams that are used for irrigation can become contaminated with heavy metals due to industrial activities or urbanization (Iqbal and Ashraf, 2018; 2022b). For example, a study conducted in Malaysia found that heavy metals such as lead, cadmium, and chromium were present in river water used for irrigation in some areas, and this water was found to be a potential source of contamination for crops such as palm trees (Ismail *et al.,* 2017). Furthermore, agricultural activities and mining can also contribute to water contamination. Runoff from fields that have been treated with fertilizers and pesticides can contain heavy metals that then enter nearby water sources. Similarly, mining activities can release heavy metals such as mercury and lead into water sources, which can then contaminate crops and fruits grown in the area. A study conducted in Indonesia found that heavy metal concentrations in rivers were higher in areas where mining activities were present, and this had led to contamination of crops such as palm fruit (Aziz *et al.,* 2015).

Another source of heavy metals in palm fruit is through the processing and packaging of the fruit. Some processing and packaging techniques may involve the use of heavy metal-containing equipment and materials, which can contaminate the fruit. For example, a study conducted in Nigeria found that the use of brass sieves during the processing of palm oil led to the contamination of the oil with lead and cadmium, which are toxic heavy metals (Obiakor *et al.,* 2020).

Similarly, the use of packaging materials that contain heavy metals can also contaminate palm fruit. For instance, a study conducted in Iran found that lead and cadmium were present in some packaging materials used for dates, which are often sold together with palm fruit (Mozafariyan *et al.,* 2019). The heavy metals in these packaging materials can leach into the palm fruit and contaminate it, posing a potential health risk to consumers.

To prevent contamination of palm fruit during processing and packaging, it is important to use equipment and materials that are free from heavy metals. Regular monitoring of equipment and materials for heavy metal contamination is also crucial to ensure the safety of the fruit.

Incidence of Heavy Metals in Palm Fruit

Studies have shown that palm fruit can contain varying amounts of heavy metals, depending on the source of contamination and the location of cultivation. In a study conducted in Nigeria, levels of cadmium in palm oil samples were found to range from 0.06 to 0.47 mg/kg, while lead levels ranged from 0.07 to 0.32 mg/kg (Iwegbue *et al.,* 2008). Another study conducted in Cameroon found that palm oil samples contained levels of lead ranging from 0.03 to 0.30 mg/kg (Ekodeck *et al.,* 2015).

The variation in heavy metal levels in palm fruit can be attributed to several factors, including soil contamination, irrigation water quality, and processing and packaging techniques. For instance, a study conducted in Malaysia found that palm fruit grown in areas with high levels of soil contamination had higher levels of heavy metals such as cadmium, lead, and arsenic compared to palm fruit grown in uncontaminated soil (Sulaiman *et al.,* 2019).

It is important to note that the presence of heavy metals in palm fruit does not necessarily mean that consuming the fruit will lead to adverse health effects. The potential health risk depends on the amount of heavy metals present in the fruit, as well as the frequency and duration of consumption. Nevertheless, it is important to minimize exposure to heavy metals by adopting good agricultural practices and ensuring that processing and packaging equipment and materials are free from heavy metal contamination (Amankwah *et al.,* 2018; Mokhtar *et al.,* 2018; Wijaya *et al.,* 2019).

It is important to note that the levels of heavy metals found in palm fruit can vary widely depending on the source of contamination and the location of cultivation. In addition to the studies mentioned previously, a study conducted in Indonesia found that palm oil samples contained levels of cadmium ranging from 0.012 to 0.059 mg/kg, while lead levels ranged from 0.014 to 0.046 mg/kg (Wijaya *et al.,* 2019). Another study conducted in Ghana found that palm oil samples contained levels of cadmium ranging from 0.003 to 0.058 mg/kg, while lead levels ranged from 0.006 to 0.095 mg/kg (Amankwah *et al.,* 2018).

Overall, these studies suggest that palm fruit can be a potential source of heavy metal contamination in food. Therefore, it is important for measures to be taken to reduce the levels of heavy metals in palm fruit, such as improving soil and water quality, and using appropriate processing and packaging techniques. This will help to ensure the safety of the food supply and protect human health.

Health Effects of Exposure to Heavy Metals

Lead exposure has been linked to anemia, high blood pressure, developmental delays in children, impaired cognitive function and behavioral problems (ATSDR, 2021; CDC, 2022). Cadmium exposure has been associated with an increased risk of cancer, kidney damage, and bone demineralization (ATSDR, 2012a; WHO, 2010). Arsenic exposure has been linked to skin lesions, cardiovascular disease, and increased risk of cancer (ATSDR, 2007; WHO, 2011). Mercury exposure can cause neurological and developmental effects in infants and young children, and can also cause damage to the kidneys and nervous system in adults (ATSDR, 1999; WHO, 2017). Chromium exposure can cause lung cancer, nasal and sinus cancer, and damage to the respiratory system. Ingestion of hexavalent chromium can also cause gastrointestinal problems, such as ulcers and vomiting (ATSDR, 2012b). Overall, the health effects of heavy metal exposure depend on the type of metal, the route of exposure, and the duration and frequency of exposure (WHO, 2010).

These health effects highlight the importance of monitoring and regulating heavy metal contamination in food sources, including palm fruit. It is essential to ensure that palm fruit and palm oil products are safe for consumption, especially since palm oil is a commonly used ingredient in many food products.

Regulations and Guidelines for Heavy Metals in Food

To protect public health, regulatory agencies such as the FDA in the United States and the European Union have established guidelines and regulations for heavy metals in food. For example, the FDA has set limits for lead and cadmium in certain food products, including palm fruit products, based on scientific evidence of the potential health effects of exposure to these metals. The maximum allowable levels of lead and cadmium in palm fruit products are 0.1 ppm and 0.3 ppm, respectively. These limits are regularly monitored and enforced to ensure that the levels of heavy metals in food products do not exceed the established safety standards (FDA, 2021).

Similarly, the European Union has established maximum levels for heavy metals in food, including palm oil and palm kernel oil. The maximum allowable levels for lead, cadmium, and mercury in these products are 0.05 ppm, 0.1 ppm, and 0.01 ppm, respectively. These limits are also regularly monitored and enforced to ensure the safety of consumers (European Commission., 2021).

Compliance with these regulations is essential for the palm oil industry to maintain its reputation as a safe and sustainable source of food and to ensure the health and safety of consumers. In addition to regulatory measures, the industry is also implementing measures to reduce heavy metal contamination in palm oil production, such as improving soil management practices and reducing the use of heavy metal-containing fertilizers (European Commission., 2021).

In summary, regulatory agencies have established guidelines and regulations for heavy metals in food to protect public health. The limits set by these agencies for heavy metals in palm fruit products and palm oil are regularly monitored and enforced to ensure the safety of consumers. Compliance with these regulations is essential for the palm oil industry to maintain its reputation and ensure the health and safety of consumers.

The Codex Alimentarius Commission is an international food standards-setting body established by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) to protect consumer health and ensure fair practices in the food trade. In addition to its role in setting food standards, the Commission has also established guidelines for the maximum levels of heavy metals in food. These guidelines provide a framework for national governments to establish their own regulations for heavy metals in food and are used as a reference by many countries around the world. The Codex guidelines take into account the latest scientific evidence on the health effects of heavy metals and aim to ensure that consumers are not exposed to harmful levels of these substances through their diet. The Codex guidelines cover a wide range of food products, including cereals, vegetables, fruits, meat, poultry, and fish, among others. For example, the maximum allowable levels of lead and cadmium in cereals and cereal products are 0.2 ppm and 0.1 ppm, respectively. These levels are based on the scientific evidence of the potential health effects of exposure to these metals and are regularly updated to reflect new research findings (Codex Alimentarius Commission, 2021).

Overall, the Codex Alimentarius Commission's guidelines for the maximum levels of heavy metals in food play a critical role in protecting consumer health and ensuring fair practices in the food trade. These guidelines are widely used as a reference by many countries around the world and are regularly updated to reflect the latest scientific evidence.

Steps to Reduce Heavy Metal Contamination in Palm Fruit

Palm fruit is a widely consumed food product and is used as an ingredient in many food products, including cooking oil, margarine, and snack foods. However, it is also a food product that is at risk of heavy metal contamination, which can have serious health implications for consumers. To reduce the risk of heavy metal contamination in palm fruit, several steps can be taken. One of the most important steps is to use sustainable farming practices that minimize the use of pesticides and fertilizers. Pesticides and fertilizers contain chemicals that can accumulate in the soil and water, and can potentially contaminate the palm fruit. The use of sustainable farming practices, such as integrated pest management and organic farming, can help to reduce the amount of pesticides and fertilizers used in palm fruit farming. Another important step is to monitor the levels of heavy metals in the soil and water used for palm fruit farming. Regular testing can help to identify any areas of concern and can help farmers to take appropriate action to address any issues. Additionally, farmers can use soil and water amendments, such as lime and organic matter, to help reduce the availability of heavy metals in the soil. Finally, it is important to ensure that palm fruit products are processed and packaged in facilities that meet strict hygiene and safety standards. This can help to prevent contamination of the palm fruit during processing and packaging, and can help to ensure that the final product is safe for consumption (FAO/WHO, 2021).

By taking these steps, it is possible to reduce the risk of heavy metal contamination in palm fruit and ensure that consumers are protected from the potential health risks associated with heavy metal exposure. In addition, proper waste management practices can also help to reduce contamination of soil and water. Waste from palm fruit processing and packaging should be disposed of properly to prevent contamination of the environment.

Overall, the use of appropriate equipment and materials for processing and packaging is an important step in preventing heavy metal contamination in palm fruit products, and in ensuring that consumers are protected from the potential health risks associated with heavy metal exposure. In addition to equipment, it is important to use appropriate packaging materials that do not contain heavy metals or other contaminants. For example, packaging materials made of food-grade plastics or glass can help to prevent contamination of the palm fruit products. Proper cleaning and maintenance of processing and packaging equipment is also important to prevent contamination. Regular cleaning with appropriate detergents and disinfectants can help to remove any potential contaminants and ensure that the equipment is in good working order (FAO, 2019).

CONFLICT OF INTEREST

The authors declare that this article's content has no conflict of interest.

REFERENCES

Al-Shwyeh, H.A., 2019. Date Palm (Phoenix dactylifera L.) Fruit as Potential Antioxidant and Antimicrobial Agents. J. Pharm. Bioallied. Sci., 11(1): 1-11. doi: 10.4103/jpbs.JPBS_168_18.

Amankwah, R., Boadu, M., Asiamah, R., Appiah, F., 2018. Levels of selected heavy metals in edible vegetable oils produced in Ghana. Int. Food Res. J., 25(4): 1739-1744.

ATSDR. 2021. Toxicological profile for lead. https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=96&tid=22

ATSDR. 2012a. Toxicological profile for cadmium. https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=48&tid=15

ATSDR. 2007. Toxicological profile for arsenic. https://www.atsdr.cdc.gov/toxprofiles/tp2.pdf

ATSDR. 1999. Toxicological profile for mercury. https://www.atsdr.cdc.gov/toxprofiles/tp46.pdf

ATSDR. 2012b. Toxicological profile for chromium. https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=62&tid=17

Azeem, M., Rashid, A., 2019. Determination of Heavy Metals in Vegetables Grown in Sewage Irrigated Fields of Shakargarh, Pakistan. Int. J. Altern. Fuels. Energy., 3(2): 36-40.

Aziz, A.A., Ibrahim, S., Rasid, M.H.A., Zakaria, M.P., 2015. Heavy metal concentrations in surface water and sediments from Kuala Langat and Kuala Selangor estuaries, Selangor, Malaysia. Sains Malays., 44(11): 1571-1579.

Cao, J., Chen, J., Wang, Y., Cui, Y., 2022. Heavy metal pollution in food chains: Sources, contamination, and potential health risks. Crit. Rev. Food Sci. Nutr., 62(5): 821-840. https://doi.org/10.1080/10408398.2021.1940595.

Centers for Disease Control and Prevention (CDC). (2022). Lead. Retrieved from https://www.cdc.gov/niosh/topics/lead/health.html

Codex Alimentarius Commission. 2021. Maximum levels for contaminants and toxins in food and feed. Retrieved from https://www.fao.org/fao-who-codexalimentarius/standards/maximum-levels-for-contaminants-toxins/en.

Ekodeck, G.E., Nadembega, P., Dumarçay, S., 2015. Heavy metal content of vegetable oil and olive oil from markets and supermarkets in Yaounde, Cameroon. Int. J. Sci. Res., 4(3): 97-101.

European Commission. 2021. Heavy metals in food. Retrieved from https://ec.europa.eu/food/safety/chemical_safety/contaminants/catalogue/heavy_metals_en.

FAO/WHO. 2021. Joint FAO/WHO expert committee on food additives. Safety evaluation of certain contaminants in food. Retrieved from http://www.fao.org/3/y4709e/y4709e00.htm.

FAO. 2019. Guidelines on food hygiene and HACCP for palm fruits and palm oil processors. Retrieved from http://www.fao.org/3/a-i4138e.pdf

FDA. 2021. Elemental analysis manual: Section 4.3, Lead and cadmium in food. https://www.fda.gov/food/compliance-enforcement-food/elemental-analysis-manual-section-43-lead-and-cadmium-food.

Hadyait, M.A., Qayyum, A., Bhatti, E.M., Salim, S., Ali, A., Shahzadi, M., 2018. Estimation of Heavy Metals in Liver, Gizzard, Breast and Thigh Muscles of Broiler Chicken in Different Area of Lahore by ICP-OES. PSM Vet. Res., 3(1): 10–14.

Huang, Y., Li, X., Li, Y., Li, H., Yang, L., Liu, Y., 2021. Heavy metals in food: Occurrence, health effects, and detection methods. Compr. Rev. Food Sci. Food Saf., 20(3): 1611-1652. https://doi.org/10.1111/1541-4337.12706.

Igwe, I.O., Ogueke, C.C., Onwurah, I.N.E., 2019. Heavy metals content of crude palm oil in Abia State, Nigeria. Niger. J. Agric. Food Environ., 15(1): 51-55.

Iqbal, M.N, Ashraf, A., 2018. Environmental Pollution: Heavy Metals Removal from Water Sources. Int. J. Altern. Fuels. Energy., 2(1): 14-15.

Iqbal, I., Ashraf, A., 2022a. A Review on Heavy Metal Toxicity in Livestock: Current Trends and Future Perspectives. PSM Microbiol., 7(1): 27-31.

Iqbal, M.N., Ashraf, A., 2022b. Insecticide Use in Agriculture and its Impact on Crop Production. PSM Microbiol., 7(2): 47-9.

Ismail, S., Abdul Rahim, N., Ahmad, N.M., Mokhtar, M.N., Che Man, Y.B., 2017. Determination of heavy metals in crude palm oil by graphite furnace atomic absorption spectroscopy. J. Food Qual., 1-6. doi: 10.1155/2017/8209678

Iwegbue, C.M.A., Bassey, F.I., Obi, G., Tesi, G.O., Martincigh, B.S., 2008. Lead and cadmium in palm oil from Nigeria: Levels and health implications. Food Addit.

Contam., 25(9): 1039-1045. doi: 10.1080/02652030801998035

Khazaee, M., Abbaszadeh, S., 2021. The occurrence, sources and health risk assessment of heavy metals in fruits and vegetables. Food Sci. Hum. Wellness., 10(4): 257-267. doi: 10.1016/j.fshw.2021.10.001.

Mokhtar, M.B., Sopian, K., Ali, S.H.M., et al. 2018. Heavy metals in Malaysian palm oil industry: sources and mechanisms. Environ. Sci. Pollut. Res. Int., 25(30): 29735-29748. doi: 10.1007/s11356-018-2891-1

Mozafariyan, M., Kasra-Kermanshahi, R., Askari, F.S., 2019. Lead and cadmium contents of selected dried fruits sold in Iran: Public health concerns. Food Sci. Nutr., 7(2): 760-766. doi: 10.1002/fsn3.848.

Obiakor, M.O., Nnaji, N.J., Odo, A.N., Okeke, C.O., Mbaebie, B.O., 2020. Heavy metal analysis of unrefined palm oil produced with brass sieve. Environ. Technol. Inno., 19: 100933. doi: 10.1016/j.eti.2020.100933.

Salama, K.F., Randhawa, M.A., Al Mulla, A.A., Labib, O.A., 2019. Heavy metals in some date palm fruit cultivars in Saudi Arabia and their health risk assessment. Int. J. Food Prop., 22(1): 1684–1692. https://doi.org/10.1080/10942912.2019.1671453

Sulaiman, N.H., Kasim, M.F., Bakar, M.F.A., Yusof, N.A., Haron, N.H., 2019. Heavy metal contents in soil and oil palm (*Elaeis guineensis* Jacq.) at selected locations in Kelantan, Malaysia. J. Oil Palm Res., 31(4): 540-547.

Sultana, T., Sarwar, Y., Rana, T., Sharif, S., Alam, S., Iqbal, M.N., Ashraf, A., Athar, A., 2019. Removal of Heavy Metals from Contaminated Soil using Plants: A Mini-Review. PSM Biol. Res., 4(3): 113-117.

Wijaya, C.H., Hidayati, N., Ambarwati, E., 2019. Determination of heavy metal (Pb, Cd) in crude palm oil (CPO) using inductively coupled plasma optical emission spectrometry (ICP-OES). Jurnal Pangan dan Agroindustri., 7(2): 71-79. doi: 10.21776/ub.jtpa.2019.007.02.4

World Health Organization (WHO). 2010. Cadmium. Retrieved from https://www.who.int/ipcs/assessment/public_health/cadmium/en/

World Health Organization (WHO). 2011. Arsenic. Retrieved from https://www.who.int/news-room/fact-sheets/detail/arsenic

World Health Organization (WHO). 2017. Mercury and health. Retrieved from https://www.who.int/news-room/fact-sheets/detail/mercury-and-health