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Polycyclic Aromatic Hydrocarbon (PAH) Content and Microbiological Investigation of Dried Fig Fruits in Tikrit City

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Abstract: Human, industrial or agricultural activities or microorganisms from dried fruits generate a variety of pollutants such as polycyclic aromatic hydrocarbons (PAHs) in food products, particularly in dried fruits sold in local markets. This study sought to quantify the amount of polycyclic aromatic hydrocarbons in dried fruits as well as isolate and identify the microorganisms (bacteria).

The study outcomes revealed that most dried fruits contain PAHs, which are a result of vehicle exhaust, old processing techniques and the remains of oil refineries and power plants. Moreover, the present study revealed that *Escherichia coli* was the predominant amongst the types of bacteria present in dried figs followed by *Staphylococcus* and *Pseudomonas aeruginosa*.

Keywords: Figs, dried fruits, polycyclic aromatic hydrocarbon, microbial contamination

Introduction

Due to their widespread presence in the marine environment and their harmful effects on aquatic life as well as human health, scientists have studied polycyclic aromatic hydrocarbons (PAH) in a great deal of detail [1]. Carbon and hydrogen make up polycyclic aromatic hydrocarbons (PAH), which are xenobiotic substances. They belong to a class of hydrophobic, nonpolar contaminants that have low vapor pressure, high melting and boiling temperatures, and low water solubility [2]. Usually, incomplete combustion of organic materials like wood and fossil fuels produces PAH. Industrial processes, waste disposal, and natural occurrences like wildfires and volcanic eruptions can all introduce them into the environment [8]. Car emissions, catalytic cracking facilities, and associated petroleum refinery operations are further sources of PAHs [3]. Additionally, biological processes can emit PAHs into the environment. Because of this, PAHs are pervasive environmental pollutants that are frequently discovered in the air, soil, and water [4].

When PAHs are deposited on seeds, fruits, or vegetables that are subsequently consumed, food contamination can also happen during times of air pollution [5]. Some of these substances can cause a

variety of health impacts, including systemic effects (hepatic, hematological, and immunological effects, as well as the development of arteriosclerosis), genotoxic effects, and carcinogenic effects, according to experimental findings pertaining to PAHs in animals [6]. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) and the Scientific Committee for Food (SCF) are two international organizations that have shown particular interest in researching the toxicity of PAHs.

These days, a range of drying methods are used to preserve food characteristics; the drying process helps prevent fruits from browning and inhibits the growth of these bacteria [7]. Pathogens like *Staphylococcus aureus* can survive in dried goods for a long time and grow throughout storage and transit until they are sold, according to Alp and Bulantekin [8]. Dried fruits can become contaminated by chemicals, particularly polycyclic aromatic hydrocarbons (PAHs). When coal, wood, petroleum, and their derivatives burn incompletely, aromatic compounds are created. More than a hundred hazardous PAHs can affect human health when consumed through food (vegetables and fruits), animal products, drinking water, or breathing in air contaminated with PAHs. PAHs are currently considered one of the most significant and hazardous chemical pollutants because of their negative effects on the body and the fact that they can enter the body through skin contact. Fatty tissues absorb these chemicals, which are then mostly deposited in the kidneys, liver, spleen, adrenal glands, and ovaries, where they might result in abnormalities and malignancies [9], [10].

Aim of Study

Polycyclic aromatic hydrocarbon levels in the dried fig fruits under investigation were determined. Microorganisms (bacteria) from dried figs are isolated and identified.

Materials and Method

Polycyclic Aromatic Hydrocarbons Extraction and Purification from Dried Fruit Samples

Before being extracted and purified using the QuEChERS technique, the chopped dried figs were taken out of the refrigerator and thawed at 4°C. Polycyclic aromatic hydrocarbons (PAHs) in dried fig samples can be quickly, accurately, and successfully identified using the QuEChERS purification process.

Analysis and Measurement of PAHs Using HPLC

The most popular approach for isolating and evaluating PAHs in various environmental contamination domains is chromatographic techniques. Chromatography is a physical analysis and separation technique that uses two phases: the stationary phase, which has a relatively large surface area, and the mobile phase, which passes through the stationary phase and usually contains the samples to be studied.

Sample Collection

Samples of dried figs from various sources (Turkish, Syrian, Iraqi, and Iranian) and another set of dried fruits from Kirkuk's local marketplaces were collected in August 2025. Every 80-gram sample was placed in sterile, properly labeled, and sealed bags. They were then taken to the laboratory so that the dried fruits could be examined for microbiological and chemical contamination.

Isolation, Identification, and Purification of Microorganisms from the Collected Samples

The Microbiology Laboratory at the Department of Life Sciences, College of Sciences, University of Tikrit received the collected samples (dry fruits) and processed them by grinding each sample in 225 milliliters of peptone water. Then, each 10-fold dilution was prepared in a series under sterile circumstances. After removing one milliliter from the tubes and preparing the dilution series, one milliliter of each dilution was added to the plates, which were subsequently filled with the media. Bacteria were allowed to grow on the plates for a full day at 30°C. Colonies emerged after incubation, and subculturing was used to purify them.

Statistical analysis

The Statistical Package for the Social Sciences software version 16 (SPSS) was used to analyze the data. Frequencies and percentages were employed in the descriptive data to characterize the participant attributes.

Result and Discussion

PAHs in Dried Figs

The average concentration of phenanthrene in dried figs was 11.34 $\mu\text{g}/\text{kg}$, according to Table 1, Iraqi figs had the highest concentration of naphthalene (0.06 $\mu\text{g}/\text{kg}$), whereas Syrian figs had the lowest concentration (0.02 $\mu\text{g}/\text{kg}$). Additionally, in the local Syrian samples, phenanthrene had the highest value (10.5 $\mu\text{g}/\text{kg}$) and the lowest value (0.0 $\mu\text{g}/\text{kg}$), respectively. The Thai sample had the highest concentration of benzo[b]fluoranthene (12.12 $\mu\text{g}/\text{kg}$), whereas the Iranian sample had the lowest concentration (0.0 $\mu\text{g}/\text{kg}$). In the Turkish sample, benzo[ghi]perylene had the highest concentration (0.40 $\mu\text{g}/\text{kg}$) and the lowest value (0.31 $\mu\text{g}/\text{kg}$). The Turkish sample Chr had the greatest and lowest quantities of chrysene (15.36 $\mu\text{g}/\text{kg}$ and 12.25 $\mu\text{g}/\text{kg}$, respectively).

Table 1. PAHs in Dried Figs

Sample	Places	NAP	PHE	B[b]F	B[ghi]P	Chr	Total PAHs ($\mu\text{g}/\text{kg}$)
Dried Figs	Turkish	0.00	0.00	0.00	0.47	15.36	15.79
	Turkish	0.00	0.00	0.00	0.31	13.15	13.46
	Iranian	0.04	0.00	9.31	0.00	0.00	9.34
	Iranian	0.00	0.00	0.00	0.40	12.25	12.65
	Iraqi	0.06	0.00	10.01	0.00	0.00	10.07
	Thai	0.05	0.00	12.12	0.00	0.00	12.17
	Syrian	0.02	10.5	0.00	0.00	0.00	10.25
	Mean	0.02	11.34	10.65	0.40	13.66	12.19
	Min	0.01	10.5	9.31	0.31	12.25	9.44
	Max	0.06	13.41	12.12	0.47	15.36	15.78

Isolation and Identification of Microbial Isolates:

The microbiological contamination of a variety of dried figs (Iraqi, Syrian, Iranian, Turkish, and Thai) was assessed after they were gathered from Tikrit marketplaces. Following inoculation onto different media and diagnostic testing, the current study's findings showed a broad range of bacterial growth in the dried fruits. According to Table 2, the highest percentage of bacterial contamination was *Escherichia coli* (33%), followed by *Staphylococcus* (28%), *Pseudomonas aeruginosa* (22%), *Staphylococcus epidermis* (13%), and *Enterococcus fecalis* (4%).

Table 2. Microbial Isolates

Microbial Isolates	%	NO.
<i>Escherichia coli</i>	33%	20
<i>Staphylococcus aureus</i>	28%	17
<i>Pseudomonas aeruginosa</i>	22%	13
<i>Staphylococcus epidermis</i>	13%	8
<i>Enterococcus fecalis</i>	4%	2
<i>Total</i>	100%	60

The difference in PAH concentrations depending on their origins and locations is caused by the nature of human activity and emissions from companies close to dried fruit producing sites, which emit different amounts of PAHs into the air that subsequently settle in water or soil [11]. In a study conducted in Saudi Arabia, Al-Farhan et al. discovered that the content of PAHs in figs was 11.61 $\mu\text{g}/\text{kg}$ [12]. Another study by Khalili et al. [13] on a group of Iranian fruits revealed that the content of PAHs in figs was 10.55 $\mu\text{g}/\text{kg}$.

In another study conducted in India by Kumar et al. [14], 56 fruit samples were collected from various locations and markets in order to detect PAHs in fruits consumed in India and assess possible health risks. The results of the investigation showed that all fruit samples had detectable amounts of PAHs, with banana and apple samples having the highest concentrations.

PAHs were examined at five locations in the city of Erbil by Mohammed et al. [15]. Plants were collected to monitor 16 PAHs that the U.S. Environmental Protection Agency (USEPA) has identified as priority pollutants. The results of the investigation showed that the plants had the highest and lowest concentrations of naphthalene and pyrene.

In a study on vegetables in the Baghdad Governorate, AbdulRada et al. [16] found that the increased amounts of PAHs in some samples may have been caused by the vegetables' exposure to vehicle exhaust on public highways or by their cultivation near power plants or fuel processing facilities.

The results of the current study showed that *E. coli* was the most prevalent bacterium, present in most of the dried fruit samples and particularly in the dried fig sample.

A previous study conducted in the Dohuk Governorate of Iraq found varying fungal isolation rates from dried figs. With 12 species, Ascomycetes has the most species diversity of any recorded genus. *Penicillium* ranked second with five species [17]. A study found that *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus* species were also isolated from dried figs [18].

104 bacterial isolates from dried apricot samples were revealed to be *Pseudomonas* spp. in a study [19]. Harvesting, drying, storing, transporting, and handling dried items can all result in microbial contamination [20].

The results of the current investigation revealed that *Escherichia coli* was the most often isolated bacterium from dried fruits, which is consistent with a previous study that shown Shiga toxin-producing *Escherichia coli* (STEC) could survive on dried apricots for three months when maintained at room temperature [21].

Conclusion

The amount of PAHs in the different dried fig samples varies; this difference can be attributed to both environmental conditions and fluctuations as well as the type of sample sources. The most prevalent species of bacteria in dried figs was *Escherichia coli*, which was followed by *Pseudomonas aeruginosa* and *Staphylococcus*.

REFERENCES

- [1] Edokpayi JN, Odiyo JO, Durowoju OS. Impact of wastewater on surface water quality in developing countries: a case study of South Africa. *Water quality*. 2017 Jan 18; 10:66561.
- [2] Fehlinger, L., Misteli, B., Morant, D., Juvigny-Khenafou, N., Cunillera-Montcusí, D., Chaguaceda, F., ... & Rimcheska, B. The ecological role of permanent ponds in Europe: a review of dietary linkages to terrestrial ecosystems via emerging insects. *Inland Waters*, (just accepted), 2022. 1-47.
- [3] Harrison S, Kargel JS, Huggel C, Reynolds J, Shugar DH, Betts RA, Emmer A, Glasser N, Haritashya UK, Klimeš J, Reinhardt L. Climate change and the global pattern of moraine-dammed glacial Lake outburst floods. *The Cryosphere*. 2018 Apr 9;12(4):1195-209.
- [4] Hector, A.,. *The new statistics with R: an introduction for biologists*. Oxford University Press. 2021
- [5] Ezugwu, Arinze Longinus, et al. "Mechanism, formation and transport of polycyclic aromatic hydrocarbons (PAHs) in fruits, vegetables and fresh fish species in Africa: a systematic review of its health risk." *Chemistry Africa* 7.5 (2024): 2321-2344..
- [6] Manda, Pierre, et al. "Evaluation of polycyclic aromatic hydrocarbons (PAHs) content in foods sold in Abobo market, Abidjan, Côte d'Ivoire." *Journal of Toxicology and Environmental Health Sciences* 4.6 .2012: 99-105.
- [7] Jayaraman, K. S., & Gupta, D. D. Drying of fruits and vegetables. In *Handbook of andustrial drying* (pp. 643-690). CRC Press. 2020.

- [8] Alp, D., & Bulantekin, Ö. The microbiological quality of various foods dried by applying different drying methods: a review. *European Food Research and Technology*, 247(6), 1333-1343. 2021.
- [9] Bukowska, B., Mokra, K., & Michałowicz, J. Benzo[a]pyrene-Environmental Occurrence, Human Exposure, and Mechanisms of Toxicity. *International journal of molecular sciences*, 23(11), 6348. 2022.
- [10] Davis, J.I. Species concept and phylogenetic analysis Introduction . *Syst. Bot.*,20: 555 -559. (1995).
- [11] Barbosa Jr, Fernando, et al. "Polycyclic aromatic hydrocarbons (PAHs): updated aspects of their determination, kinetics in the human body, and toxicity." *Journal of Toxicology and Environmental Health, Part B* 26.1 (2023): 28-65.
- [12] Al-Farhan Badriah S. , Tarek O. Said , Sara A. El-Ghamdi , Ali Y. Al-Alamie . Distribution and health risk assessment on dietary exposure of PAHs in vegetables and fruits of Asir, Saudi Arabia. Pages 94-102. 2023.
- [13] Khalili F , Nabi Sh, Mohammad Hadi Dehghani, Kamyar Yaghmaeian, Ramin Nabizadeh Nodeh, Mehdi Yaseri. The Analysis and Probabilistic Health Risk Assessment of Polycyclic Aromatic Hydrocarbons Contamination in Vegetables and Fruits Samples Marketed Tehran With Chemometric Approach. 2022. DOI: <https://doi.org/10.21203/rs.3.rs-130120/v1>
- [14] Kumar V, Balomajumder C, Roy P. Polycyclic aromatic hydrocarbons (PAHs) in fruits: a study from the northwestern Indo-Gangetic Plain, India. *Food Addit Contam: B.* ;8(1). 2015:51–58.
- [15] Mohammed, A. B. Biomonitoring of atmospheric PAHs by *Eucalyptus* sp. And *Pinus* sp. in Erbil, Iraq. *Journal of Babylon University/Pure and Applied Sciences*, 20(3), 2012.1061.
- [16] AbdulRada J. Nawar , Khalil I. Hussain, AbdulJabbar A. Ali, Separation and Determination of Poly Aromatic Hydrocarbons in Vegetables Samples in Baghdad City Using HPLC Technique. (1) 27. 2014.
- [17] Saadullah, A. A. M., & Abdullah, S. K. Contamination of dried figs with fungi and aflatoxigenic potential of some isolates of *Aspergillus* section *Flavi*. *Journal of Biology, Agriculture and Healthcare*, 5(2), 2015.76-80.
- [18] Abid, L., Smiri, M., Federici, E., Lievens, B., Manai, M., Yan, Y., & Sadfi-Zouaoui, N. Diversity of rhizospheric and endophytic bacteria isolated from dried fruit of *Ficus carica*. *Saudi journal of biological sciences*, 29(9), 2022.103398.
- [19] Gormez, A., Sahin, F., Gulluce, M., & Aslan, I. Identification and characterization of *Pseudomonas syringae* isolated from apricot trees in the Erzurum province of Turkey and evaluation of cultivar reaction . *Journal of Plant Pathology*, 95(3), 2013.525–532.
- [20] Ntuli, M., & Akinsomi, O. An overview of the initial performance of the South African REIT market. *Journal of Real Estate Literature*, 25(2), 2017. 365-388.
- [21] Liu, Z., Liao, C., Golson, K., Phillips, S., & Wang, L. Survival of common foodborne pathogens on dried apricots made with and without sulfur dioxide treatment. *Food Control*, 121, 107569. 2021.