Available online at http://bjas.bajas.edu.iq
https://doi.org/10.37077/25200860.2025.38.sp.35
College of Agriculture, University of Basrah

Basrah Journal of Agricultural Sciences

ISSN 1814 – 5868 **Basrah J. Agric. Sci., 38(Special Issue), 400-416,2025** **E-ISSN: 2520-0860**

Concentrations of Polycyclic Aromatic hydrocarbons in the muscles of *Planiliza klunzingeri* in the Shatt Al-Basrah Canal, southern Iraq

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Received 23rd October 2024; Accepted 29th April 2025; Available online 24th August 2025

Abstract: Oil pollutants are one of the most dangerous pollutants to the aquatic environment, which affects aquatic organisms. Total petroleum hydrocarbon (TPH) and polycyclic aromatic hydrocarbon (PAHs) levels were examined in the muscles of *Planiliza klunzingeri* at two stations on the Shatt Al-Basrah Canal seasonally. The results of the current study indicated that there is a variation in the levels of total petroleum hydrocarbons in the two study areas, which is ranged between 48.9 and 5.9 $\mu g.g^{-1}$dry weight during the summer and autumn seasons. On the other hand, the statistical analysis showed high statistically significant differences in the level of total hydrocarbons in the muscles of fish in winter and summer, but no significant differences were recorded in spring and autumn. The results of (PAHs) in *P. klunzingeri* ranged between 0.644 and 36.961 $ng.g^{-1}$dry weight in spring and winter, while lipid values ranged between 7.88% and 19.85% during spring and winter**,** Statistical analysis showed significant differences in muscle fat across seasons and for both stations during the seasons. The study also showed that the origin of (PAHs) from Pyrogenic sources for all seasons, as (PAHs) with high molecular weight (HMW-PAHs) were generally predominant and pollution in fish falls within low pollution.

Keywords: muscles, polycyclic aromatic hydrocarbons, *Planiliza klunzingeri*, Shatt Al-Basrah canal.

Introduction

Pollution of crude oil-based petroleum hydrocarbons is an important issue threatening the aquatic environment worldwide (Galo *et al*., 2022). It causes serious problems that have affected aquatic organisms, as due to the expansion Urban activities (Galo *et al*., 2023). In addition, the ongoing impacts of seawater and the decline in freshwater discharge lead to deteriorating water quality (Hammadi *et al*., 2023). As well as the use of fertilizers in agriculture and wastewater discharge inputs from pollutants and nutrients (Galo & Resen, 2024). Oil is a mixture of aromatic hydrocarbons and saturated hydrocarbons, natural gas (Mahjoubi *et al.*, 2018). This leads to a change in the natural characteristics of the environment (Badrzadeh *et al*., 2022). Habitats and organisms have been affected by the total petroleum hydrocarbons as a pollutant in their natural environment (Sayed *et al*., 2021). Awing to petroleum hydrocarbons are highly lipophilic to fats, Fish are able to absorb them (Rodrigues *et al.,* 2010). Therefore, fish can be used as bioindicators to assess pollution levels in the aquatic environment (Wang *et al*., 2021).

Over the past decades, the sources of these compounds have been experimental products, waste incineration, gas emissions, plastic waste ash and transportation, and polycyclic aromatic hydrocarbons, all of which are inherently hazardous due to their toxic and carcinogenic properties, environmental stability is crucial for assessing the environmental risks of contaminants. (Mofijur *et al*., 2024).

The International Agency for Research on Cancer (IARC) confirmed according to its classification the presence of eight compounds of aromatic hydrocarbons containing more than four integrated rings (high molecular weight) and therefore considered carcinogenic, for their ability to resist decomposition by microorganisms, Additionally, they accumulate in fish (Bakhtiari *et al*., 2009).

There are two types of polycyclic Aromatic hydrocarbons, the first containing 1 -3 ring merging rings with water solubility and volatile substances called (Low molecular weight PAH), so it is sensitive to decomposition processes, while the high molecule that contains more than four merging rings with less solubility and volatilization and more lipophilic than the low molecular (Al-Talal *et al*., 2019).

P. klunzingeri inhabit estuaries, temperate and tropical coastal waters (González-Castro & Ghasemzadeh, 2016). The Mugilidae family includes 26 genera and 79 edible species. It is considered of global commercial importance and is widely distributed in the Arabian Gulf, forming part of the Iraqi fish stock. (Mohamed & Abood, 2020). Organic and inorganic matter and fish eggs are the main component of food (Mohamed & Al-Hassani, 2023), so *P. klunzingeri* can be used as a biological indicator for environmental monitoring. (Minos *et al*., 1995).

The aim of the study was to determination level TPHs and lipid content to highlight the sources and concentrations of PAHs in the muscles of *P. klunzingeri* muscles and to compare it with other studies to assess contamination levels.

Materials & Methods

Study & sampling area

The Shatt Al-Basrah Canal is one of the waterways that connect Iraq to the Arabian Gulf and represents the lower southern part of the general estuary drain. It extends for a distance of approximately 38 km, It lies between latitudes 30°27´-30°28´N north and 47°50´- 47°49 east within the alluvial plain,. It transports floodwaters directly to the Arabian Gulf via Khor Abdullah (UNEP, 2001).

The samples were taken at two stations, the first station near the Shatt Al-Basrah gas power station located northwest of Basrah (N: 47°44´-42°5 E: 30°28´-28°1´) and the second station near the regulator of the Shatt Al-Basrah and is located in the southwestern part of the city of Basrah (E: 30°24´-40°1 N: 47°46´- 22°6). The first station is about 13 km away from the second station, the study area is affected by the presence of sewage pipes and the Basrah oil refinery, as well as the presence of neighboring residential communities and small boats used. On the other hand, the waters of the two stations are affected by the discharge of irrigated land and tidal phenomenon of the Shatt al-Basra Regulator, which connects to Khor Abdullah and ends in the Arabian Gulf. (Fig. 1).

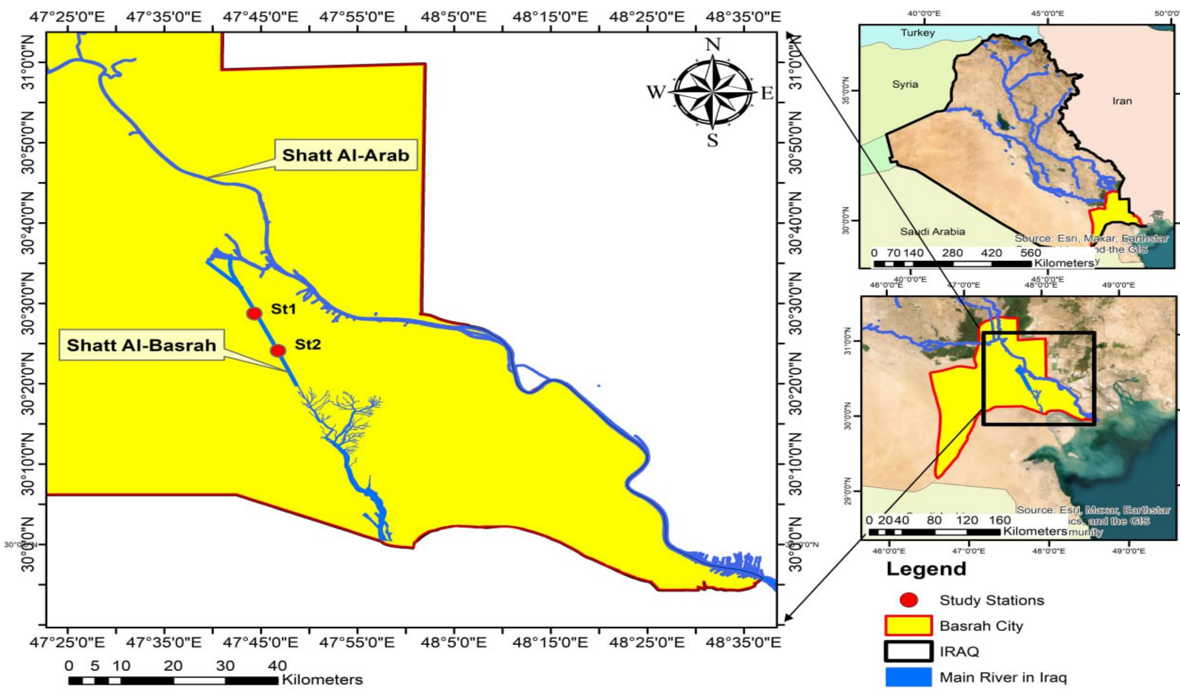

Fig. (1): Map of sampling sites in the Shatt Al-Basrah Canal.

Planiliza klunzingeri was collected using gill nets seasonally, at two stations on the Study area, and for a period of twelve months spread over four seasons starting from winter 2023 to autumn 2024 to estimate TPHs and aromatic compounds. The samples were placed in an ice-filled container and transported to the laboratory the morphological measurements were taken and stored at -4°C, the muscles were taken for analysis, to measure the levels of (TPHs) and (PAHs) in the fish muscles.

Total petroleum hydrocarbons extraction

According to the standards of (Goutx & Saliot, 1980). Three grams of dried fish were used in a Memmert B36 incubator, made in Germany, at a temperature not exceeding 50°C. The ground fish was sampled and Placed for 24 hours in 100 ml of extraction solvent mixture (methanol: benzene v/v 1:1). The extraction process was carried out using the Soxhlet Intermittent Extraction method. The contents were poured into a separating funnel and 15 ml of aqueous solution of 4N MeOH (KOH) was added at 40°C for 2 hours. 50 ml of n-hexane was added and then left to settle after shaking well. Formed in two layers. The upper layer containing hydrocarbons was taken; the extracted samples were transferred to a separation column and collected from it, allowed to dry, and dissolved in pure hexane for measurement of TPHs using a fluorescence spectroflurophotometer. The sixteen most toxic substances listed by the EPA (Yan *et al*., 2004) were evaluated. In fish using the Capillary Gas Chromatography (GC).

Calibration

A known weight of Basra crude oil was dissolved with a specified volume of n-hexane for titration by a spectroflurophotometer from Shimadzn, made in Japan, model RF-540.

Lipid Extraction

Muscles sections of the studied fish were dried and then dissolved in a mixture of n-hexane, for the purpose of determining the lipid concentrations in them (Egan *et al*., 1981).

Statistical analysis

The statistical analysis of the data was performed using SPSS 20 software (Statistical Package for Social Sciences). Also, Least Significant Differences Test LSD test was used to determine significance differences under the probability level of $P<0.05$ through the ANOVA test in the current study sites (Snedecor & Cochran, 1989).

Results & Discussion

The study showed variation in hydrocarbon concentrations at the studied stations, where the lowest concentrations of (TPHs) in P. klunzingeri (7.88 and 5.9) $\mu g.g^{-1}$.dry weight were achieved during the autumn for the first and second stations, respectively, while the highest concentrations of (TPHs) in *P. klunzingeri* (48.9 and 33.8) $\mu g.g^{-1}$dry weight were achieved during the summer for the first and second stations, respectively (Fig. 2).

The lowest concentration of PAHs (11.583 and 0.644) $ng.g^{-1}$dry weight was during winter for stations first and second, respectively, while the highest concentration (24.690 and 36.961) $ng.g^{-1}$. Dry weight was during summer and spring for stations first and second, respectively (Fig. 3), the most abundant compounds were Indeno (1, 2, 3, cd) pyrene + dibenzo at the first station (Fig. 4) while Benzo (g, h, i) perylene was the most abundant at the second station (Fig. 5).

No light molecules such as Naphthalene, Acenaphthylene and Acenaphthene, Fluorene and Phenanthrene were recorded at the two stations during the study except for Anthracene which was recorded at the spring at the first station where it recorded 0.372281 $ng.g^{-1}$dry weight.

Heavy molecular weight compounds such as Benzo (K) Fluoranthene and Benzo (A) Pyrene were detected in all seasons and at both stations, while Indeno (1, 2, 3, cd) pyrene + dibenzo was not recorded during the winter at both stations, and Benzo (g, h, i) perylene was not recorded during the winter only at the second station and was recorded in all seasons in the first station. Chrysene was also recorded in the second station only during the spring, recording 1.119225 $ng.g^{-1}$dry weight, and it was found that both Fluoranthene and Pyrene were not recorded during the winter only and at both stations.

The highest lipid content was recorded in the *P. klunzingeri* muscles during the spring (16.52% and 19.85%), while the lowest value were recorded during the winter 10.45% and 7.88% at the first and second stations respectively. (Fig. 6). The results of the statistical analysis showed that there were significant differences (P≤0.05, sig=0.0001)) in fish muscle lipid in the two stations and during the seasons of the year, but no significant differences were recorded (p>0.05, sig=0.101) between the two stations during the summer.

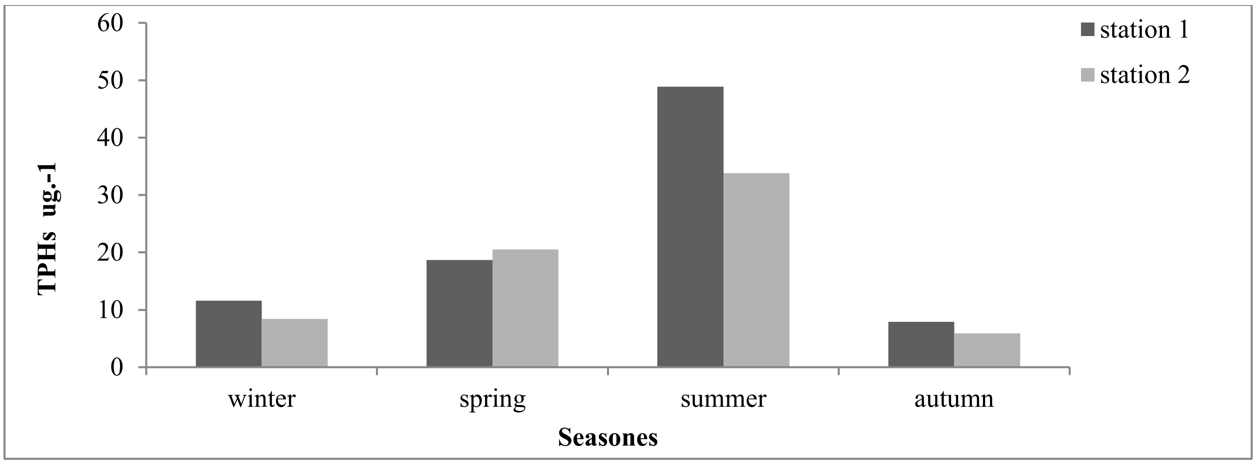

Fig. (2): TPHs in the *P. klunzingeri* muscles.

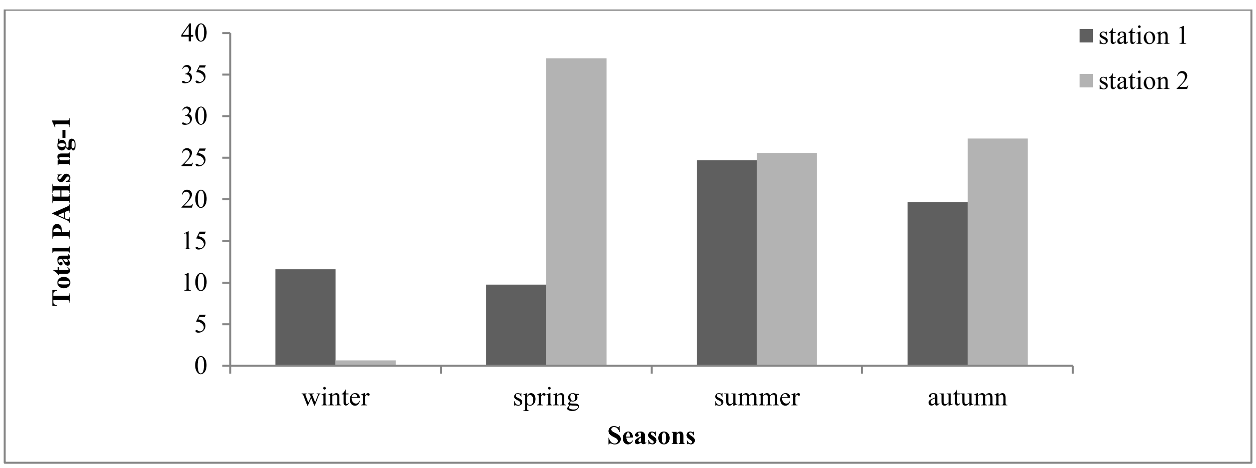

Fig. (3): Total PAHs in the *P. klunzingeri* muscles.

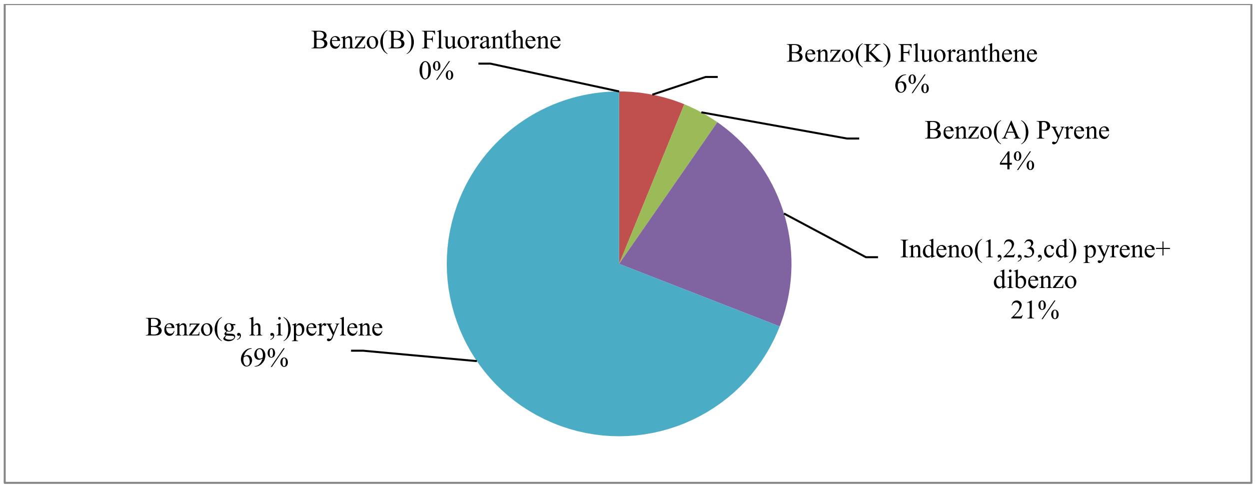

Fig. (4): Percentage of PAHs in fish muscles in the first station.

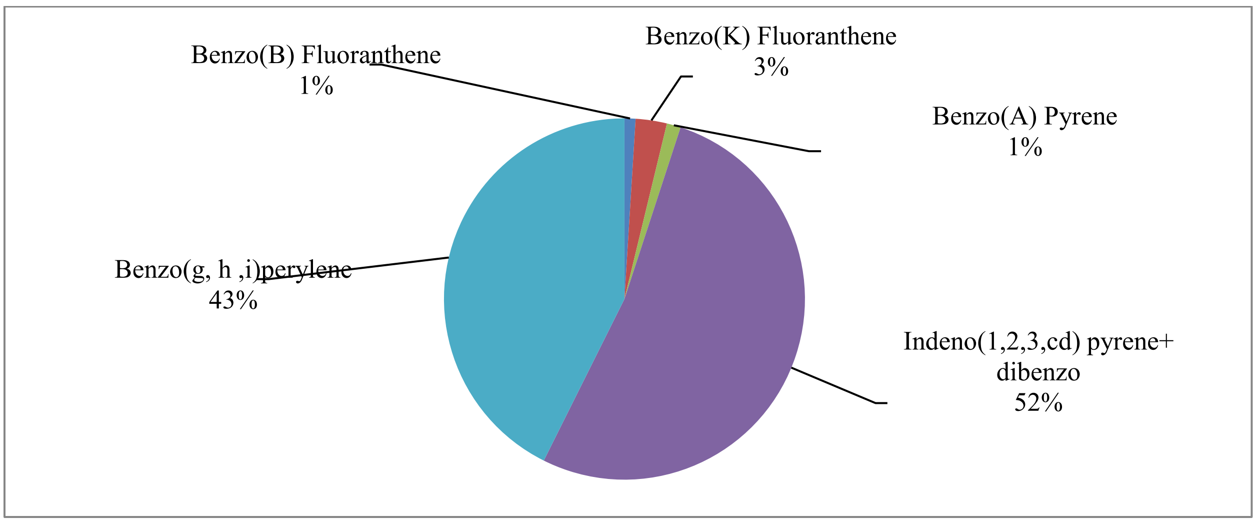

Fig. (5): Percentage of PAHs in fish muscles at the second station.

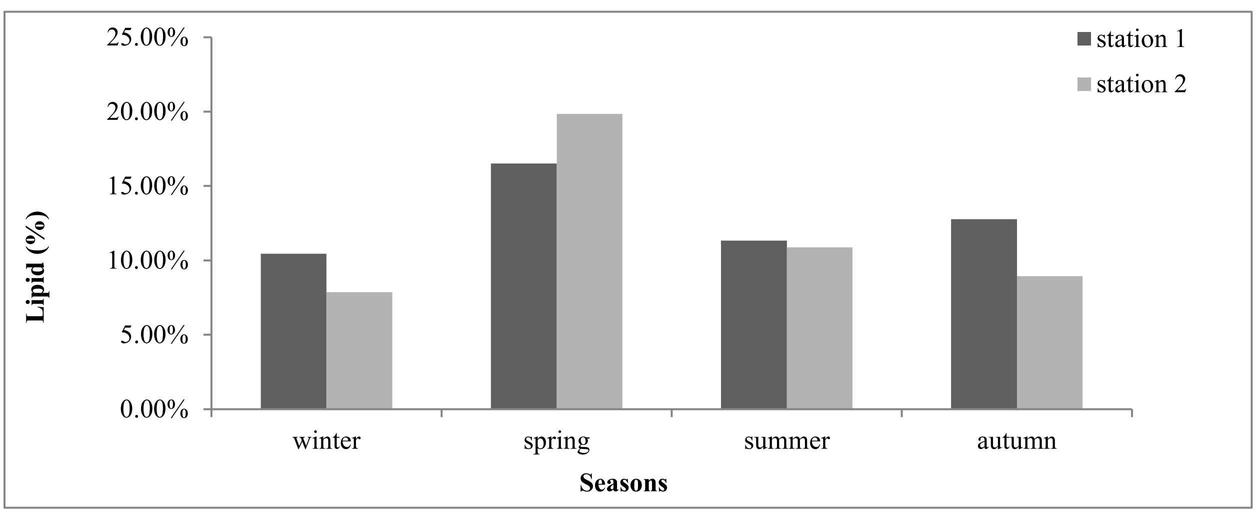

Fig. (6): Concentrations of lipids (%) in the muscles of *P. klunzingeri*

Discussion

Fishes are an important and main food source for people in Basrah Governorate, and the study area serves as a waterway connecting the Iraqi marshes to the northern part of the Arabian Gulf (Al-Aesawi *et al*., 2013). *P. klunzingeri* enter the canal for feeding and reproduction (Mohamed & Al-Hassani, 2023). The ability of fish to accumulate hydrocarbons in their bodies in concentrations higher than those in their aquatic environment (Zhou *et al*., 1997) shows their importance when they reach humans directly.

The current study showed variation in the rate of accumulation of TPH concentrations during the study seasons, with the highest concentration reaching 48.9 $\mu g.g^{-1}$dry weight in the summer at the first station, while the lowest concentration reached 5.9 $\mu g.g^{-1}$dry weight during the autumn at the second station. This study was compared with other studies in Iraq (Table 1). It was found that the concentrations recorded in the current study are higher than the fish standard (Ansari *et al*., 2012).

However, Galo *et al*., (2023) reported higher concentrations than the current study in the Shatt Al-Basrah, it is likely due to biological, anthropogenic and biochemical influences, in addition to the decomposition and transformation processes that occur to organic materials (Rushdi *et al*., 2018). Also, due to the increased fishing boats and untreated sewage and domestic wastewater. (Galo & Resen, 2024) i.e.; high hydrocarbon inputs resulting from pollution by discharges of petroleum products (Huguet *et al*., 2019). Also, the current study is less than what has been recorded in Saudi Arabia because the coasts of the Arabian Gulf are considered places of oil export, and on the other hand the release of ballast water quantities from supertankers, washing basins, loading docks in addition to exhaust oils, Fish feeding habitats are affected by high inputs from hydrocarbons (Al-Saad *et al.,* 2011). The pollution conditions for nutrition habitats, food sites and main sources are the causes of differences in hydrocarbon concentrations in fish tissues (Johnson-Restrep *et al*., 2008), which results largely from oil-related activities (Galo *et al*., 2022).

Except for spring, the highest concentrations was recorded in the first station, which may also be due to the presence of some industrial facilities that dump their waste in the Shatt al-Basrah, On the other hand, untreated wastewater (Al-Saad *et al*., 2017a).

The increase in second station concentration levels during the spring may be attributed to the abundance and diversity of food due to the flowering of plants and phytoplankton that are capable of accumulating hydrocarbons, Also, changes in the physical and chemical factors of the water body cause changes in the structure of the organisms within it. (Akaahan *et al.,* 2014).

The study demonstrated significant differences in fish fat ($P \leq 0.05$) at the study stations, but no significant differences were recorded between the two stations during the summer. The lowest values were recorded in the winter (10.45% and 7.88%), while the highest values were recorded in the spring

(16.52% and 19.85%), respectively, at the two stations.

The increase in fish lipid content during spring may be attributed to the abundance of phytoplankton that fish feed on, as they thrive in spring, As well as organic crumbs, algae and diatoms. (Mohamed & Al-Wan, 2020).

Both micro and macroalgae have also been cited as potential candidates for the provision of unsaturated fatty acids although their Lipid content is relatively low, they contain higher levels of unsaturated fatty acids (Kendel *et al*., 2013); which vary according to season, geographical region and environmental factors, as well as the arrival of some fish to sexual maturity that coincides with the spring season, as Lipids play an important role in the optimal use of dietary protein for growth and reproductive performance during reproductive period (Das & Biswas, 2019).

The low Lipid content during the winter may be due to the significant energy loss of fish species consumed in their search for food scattered throughout the river (Inhamuns & Franco, 2008). Also, due to the increased energy costs of metabolism in fish, the total lipid content in fish, it is affected by the nutritional status, life cycle, and fish species. (Das & Biswas, 2019), which also be taken into account when explaining the effects of environmental pollution on fish physiology, the accumulation of pollutants depends on the percentage of fat (Levesque *et al*., 2002).

The current study showed that the concentrations of TPHs in fish were ranged between 5.9 and 48.9 $\mu g.g^{-1}$dry weight. The variation in TPH concentrations muscles of fish during the seasons this is likely due to the type and availability of food and the feeding method (Nasir, 2007). The current study also showed there is a relationship between the values of petroleum hydrocarbons and the fat content of fish species, as studied (Sun *et al*., 2016), as the bioaccumulation factor increases with the increase in chemical hatred of organic pollutants to water due to the increased tendency of the chemical to reduce solubility in water and increase its affinity to fish lipid instead of remaining dissolved in aqueous solution (De Mora *et al*., 2004). It has been observed that tissues with fatty content of fish he percentage of organic pollutants in it is high. (Reinert, 1969). Differences in pollutants levels among fish species are also associated with average Lipid concentrations in these species (Reinert, 1970).

The PAHs values in muscles of *P. klunzingeri* collected at the study station were indicated in tables (3 and 4) The most abundant compounds were Indeno (1, 2, 3, cd) pyrene + dibenzo in the first station (Fig. 4) and Benzo (g, h, i) perylene in the second station (Fig. 5) and dominant heavy molecules such as Benzo(K) Fluoranthene and Benzo (A) Pyrene appeared in all seasons and at both stations. The presence of low molecular weight polycyclic aromatic hydrocarbons present in tissues may be attributed to metabolic transformations of high-molecular weight polycyclic aromatic hydrocarbons occurring in fish liver (Meador *et al*., 1995). He explained (Perugini *et al*., 2007). Fish have the ability to change the pattern and concentrations of PAHs in their tissues by converting an estimated 99% within 24 hours into metabolites of PAHs after absorption Also, none of the light molecules such as Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, and Phenanthrene were recorded at the two stations during the study, except for Anthracene, which was recorded in the spring at the first station, where it recorded 0.372281 $ng.g^{-1}$dry weight., This may be due to the fact that low molecular weight polycyclic hydrocarbons are water-soluble and volatile, so they are sensitive to decomposition processes (Al-Talal *et al*., 2019).

There are many non-specific factors that can play a role in the bioavailability of PAHs in *P. klunzingeri* as the abundance of dissolved oxygen, food type and stress affect levels of polycyclic aromatic hydrocarbons, fish living in an industrially contaminated environment or sewage may be exposed to higher levels of polycyclic aromatic hydrocarbons (Lemke & Kennedy, 1997). Based on the recommendation of the World Health Organization on Food Additives and FAO through the Joint Expert Committee using Benzo (A) Pyrene was recommended as a general indicator of total polycyclic aromatic hydrocarbon pollution. (Anyakora *et al*., 2005) at <10 $ug.kJ^{-1}$ dry weight.

Our current study in tables (3 and 4) indicated that the concentrations of Benzo (A) Pyrene in fish tissue at study stations and for all seasons are lower than those in the guideline, so the concentrations of PAHs in the muscle tissue of *P. klunzingeri* are low pollution.

The study indicated that the total concentrations of PAHs recorded in the muscle tissue of *P. klunzingeri* ranged between 0.644 and 36.961 $ng.g^{-1}$.dry weight. It is likely to the variation in total PAHs concentrations during the different seasons is due to the different type and regimen, food abundance, place of living, Lipid content and affecting environmental conditions (Frapiccini *et al.,* 2020).

It is known that fish can accumulate high concentrations of Pollutants within their tissues (Al-Obeidi & Al-Hamadawi, 2023), through water and food, as the accumulation occurs within fish tissues through food chains. To find out the source of PAHs within the muscle tissues of fish, the ratio of Flouranthene to Pyrene compound was calculated, which is greater than (1). Tables (3 and 4), indicating that its source for all seasons except spring is (Pyrogenic) (Zakaria *et al.,* 2002). When comparing total muscle concentrations of *P. klunzingeri* locally and globally, we find that they are within what has been recorded and contain contaminants (Table 2).

Table (1): Comparison of petroleum hydrocarbon concentrations in muscle of *P. klunzingeri* and other fishes from Iraq and other marine areas.

Region	TPHs ($\mu g\ g^{-1}$)	References
The Arabian Gulf	9.6-310	Fowler *et al*., 1993
Northwest Arabian Gulf	11.44-48.16	Nasir, 2007
Shatt Al-Arab River	2.47- 21.52	Al-Saad *et al*. 2017b
Nigeria	1.97 – 52.84	Ugwu & Achadu, 2021
Shatt Al-Basrah Canal	6.2-57.5	Galo *et al*. 2023
Shatt Al-Basrah Canal	5.9-48.9	The current study

Table (2): Comparison of the concentrations of polycyclic aromatic compounds in *P. klunzingeri* muscle with those of other fish species in Iraq and the world.

Fish species	Region	PAHs (ng g^{-1})	References
Arius thalassinus, Epinephelus tauvina, Epinephelus sp., *Lethrinus nebulosus*,	Oman	2.2 – 110	Fowler *et al*., 1993
Mugil lisa and *Micropogonias furniere*	Coanabara Bay, Brazil	11.44-48.16	Silva *et al*., 2007
Clarais gariepinnus, Liza dumerillii, Parachanna obscura, Pseudolithus elongatus,	Niger Delta / Africa	0.41 – 39.64	Anyakora & Coker, 2007
Cynoscion guatucupa	Argentina	11.27 – 52.80	Recabarren-Villalon *et al*., 2019
Mesopotamichthys sharpeyi	Huralazim wetland in Iran	9.52 - 43	Bostanzadeh *et al*., 2022
Coptodon zillii, Oreochromis aureus	Shatt Al-Arab river	23.55 – 55.81	Al-Salman *et al*., 2024
P. subviridis	Shatt Al-Basrah Canal	0.644 - 36.961	The current study

Table (3): Types and concentrations of PAHs in muscle tissue of *P. klunzingeri* at the station 1 during the seasons.

PAHs in *P. klunzingeri* (ng.g^{-1}dry weight) at Station 1.				
Aromatic compounds	**winter**	**Spring**	**summer**	**autumn**
Naphthalene	ND	ND	ND	ND
2-methyl naphthalene	ND	ND	ND	ND
1-methyl naphthalene	ND	ND	ND	ND
Acenaphthyene	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND
Anthracene	ND	0.372281	ND	ND
Fluoranthene	ND	0.392525	2.48256707	0.566493
Pyrene	ND	0.033413	0.036969568	0.126161
Chrysene	ND	ND	ND	ND
Benzo (A) anthracene	ND	0.958178	ND	ND
Benzo (B) Fluoranthene	ND	0.103427	0.109541196	ND
Benzo (K) Fluoranthene	0.154072	0.3013	0.37447482	1.171736
Benzo (A) Pyrene	0.859821	0.10459	0.096392117	0.661317
Indeno (1,2,3,cd) pyrene+ dibenzo		4.74333	10.17758926	4.034221
Benzo (g, h ,i) perylene	10.56961	2.755163	11.41257304	13.11365
Sum. of the PAHs	11.5835	9.764208	24.69010707	19.67358
Fluoranthene/Pyrene	ND	11.74767	67.151639	4.490239
Fluoranthene/Pyrene	ND	Pyrogenic	Pyrogenic	Pyrogenic

* ND= Not Detected.

Table (4): Types and concentrations of PAHs in muscle tissue of *P. klunzingeri* at Station 2 during the seasons.

PAHs in *P. klunzingeri* (ng.g^{-1} dry weight) at station 2				
Aromatic compounds	**winter**	**Spring**	**summer**	**autumn**
Naphthalene	ND	ND	ND	ND
2-methyl naphthalene	ND	ND	ND	ND
1-methyl naphthalene	ND	ND	ND	ND
Acenaphthyene	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND
Fluoranthene	ND	0.044698	4.355398	1.264387
Pyrene	ND	0.032923	0.631836	0.063047
Chrysene	ND	1.119225	ND	ND
Benzo (A) anthracene	ND	1.019258	ND	ND
Benzo (B) Fluoranthene	ND	0.343189	1.153406	ND
Benzo (K) Fluoranthene	0.133899	0.972333	0.130472	0.488064
Benzo(A) Pyrene	0.510404	0.433949	1.61718	0.590954
Indeno(1,2,3,cd) pyrene+ dibenzo	ND	18.18608	10.09751	4.284914
Benzo (g, h ,i) perylene	ND	14.80986	7.604116	20.62871
Sum. of the PAHs l	0.644303	36.96151	25.58992	27.32007
Fluoranthene/Pyrene	ND	1.357653	6.8932413	20.05467
Fluoranthene/Pyrene	ND	Pyrogenic	Pyrogenic	Pyrogenic

* ND= Not Detected.

Conclusions

Panelize klunzingeri is able to accumulate hydrocarbons in their muscles, as they recorded high concentrations of TPHs and total lipids, Most of the PAHs of high molecular weights and their source (Pyrogenic) and Benzo (A) Pyrene concentrations in study stations and for all seasons were <10 ug.kg^{-1}, so they fall within the range of globally recorded values for low-pollution areas, the recording of Benzo (A) pyrene concentrations in all seasons and Benzo (A) anthracene in spring is a risk indicator that we recommend taking into account due to their potential accumulation and the fact that they are serious carcinogens.

Acknowledgments

The authors would like to thank to Marine Science Centre and Fisheries and Marine Resources, College of Agriculture for their assistance and support in completing this research.

Contributions of authors

A.M.G.: Collected sample, conducted laboratory analysis, wrote the manuscript.

A.K.R.: Constructed the idea and hypothesis for research; planned the methodology, reviewed and revised the manuscript.

M.A.T.A.: Planned study design, advised on sample collection, analysed the data**.**

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Conflict of Interest

The authors declared that they have no conflict of interest.

Ethical approval

All ethical guidelines related to fish and their care issued by national and international organizations were implemented in this report.

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تركيزات الهيدروكربونات العطرية متعددة الحلقات في عضلات سمك *Planiliza klunzingeri* في قناة شط البصرة جنوب العراق

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المستخلص: من أبرز الاخطار البيئية شيوعاً في الوقت الحاضر هي تلوث المياه نتيجة لفرط النشاط الصناعي والزراعي وتعد الملوثات النفطية من اخطر الملوثات على البيئة المائية مما يؤثر على الكائنات المائية، تم فحص إجمالي مستويات الهيدروكربونات النفطية Total Petroleum Hydrocarbon (TPHs) والمركبات العطرية متعددة الحلقات (PAHs) Polycyclic Aromatic Hydrocarbon في عضلات اسماك *Planiliza klunzingeri* في محطتين على قناة شط البصرة موسمياً أشارت نتائج الدراسة الحالية إلى وجود تباين في مستويات إجمالي الهيدروكربونات النفطية في منطقتي الدراسة، إذ تراوحت معدلات الهيدروكربونات النفطية الكلية بين (5.9-48.9) ميكروغرام/ غرام بالوزن الجاف خلال فصلي الصيف والخريف من جهة اخرى أظهر التحليل الإحصائي فروق ذات دلالة إحصائية عالية في مستوى اجمالي الهيدروكربونات في عضلات الأسماك في الشتاء والصيف ولكن لم تسجل فروق معنوية في الربيع والخريف، كما تراوحت نتائج (PAHs) في *P. klunzingeri* بين (0.644-36.961) نانو غرام/ غرام بالوزن الجاف في الربيع والشتاء، بينما تراوحت قيم الدهون بين (7.88%-19.85%) خلال الربيع والشتاء كما أشارت نتائج التحليل الإحصائي إلى وجود فروق ذات دلالة إحصائية عالية في الدهون العضلية في المحطتين وخلال المواسم، كما بينت الدراسة ان اصل (PAHs) من المصادر Pyrogenic ولجميع المواسم، كما كانت (PAHs) ذات الوزن الجزيئي العالي (HMW-PAHs) هي السائدة عمومًا كما أن التلوث في الاسماك يقع ضمن التلوث المنخفض.

الكلمات المفتاحية: العضلات ، الهيدروكربونات العطرية متعددة الحلقات، *Planiliza klunzingeri*، قناة شط البصرة.