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The Effect of Water Discharge Rates on the Spread of Plastic Particles in the Shatt al-Arab River

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Abstract

From November 2021 to August 2022, water and fish samples were taken quarterly from four selected stations in the central part of the Shatt al-Arab River, several environmental parameters were collected. They include the temperature of water, water turbidity, dissolved oxygen, total suspended materials, and total dissolved solids. During the summer in Al-Baradiya, the highest water temperature was 31°C, water turbidity values ranged from 1-45 nephronic turbidity units, the highest total suspended solids value was 6 mg/l, and the highest total dissolved solids value was 22777 mg/l. During the winter, Al-Baradiya had the highest dissolved oxygen value of 6.5 mg/l. catch 377 Individuals of fish were caught, and they were dispersed among 15 species. At all study stations, the types of plastic extracted in the stomach of fish were divided into three types: fibers, fragments, and plastic films, with fibers being the dominant species at a percentage of 56% over the other types. The red color of the plastic predominated in the rest of the colors, the largest number of plastic waste was in the Dakir and Al-Ashar stations, at 43.40% of the total number of plastic. The effect of the lack of water reaching the Shatt al-Arab River during the year 2022 was detected in a clear increase in plastic particles in the river.

Keywords: plastic, fish, Shatt al-Arab, Ecological factors, Water drainage

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تأثير معدلات تصاريف المياه على انتشار الجسيمات البلاستيكية في شط العرب

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الخلاصة

جمعت عينات الماء والاسماك فصليا" من الجزء الأوسط من شط العرب من اربع محطات مختارة ومنها النجيبية والداكير والعشار والبراضعية خلال المدة من تشرين الثاني 2021 الى اب 2022 ، وقيست عدة عوامل بيئية منها درجة حرارة الماء وعكارة الماء وتركيز الاوكسجين المذاب والمواد العالقة الكلية والمواد الذائبة الكلية. اذ بلغت اعلى قيمة لدرجة حرارة الماء 31م ° بينما تراوحت قيم عكارة الماء ما بين 1 - 45 وحدة عكارة نفرونية وسجلت اعلى قيمة للمواد العالقة الكلية 6 ملغم/لتر ،وسجلت اعلى قيمة للمواد الصلبة الذائبة الكلية 22777 ملغم/لتر كلها اثناء الصيف في البراضعية. بينما كان اعلى قيمة للأوكسجين المذاب 6.5 ملغم/لتر اثناء الشتاء في البراضعية. صيد 377 فردا من الأسماك توزعت على 15 نوعا" في جميع محطات الدراسة، وزعت اشكال البلاستك المستخرج من القناة الهضمية للأسماك الى ثلاثة أنواع هي الالياف والشظايا والأفلام البلاستيكية اذ كانت الالياف هي النوع السائد بنسبة 56% عن الأنواع الأخرى .ساد اللون الأحمر من البلاستك على بقية الألوان ،بلغ اكبر عدد من النفايات البلاستيكية في محطتي الداكير والعشار بنسبة 43.40%من العدد الكلي للبلاستك. تم رصد تأثير نقص المياه الواصلة الى شط العرب خلال عام 2022 الى ازدياد الجسيمات البلاستيكية بشكل واضح في النهر.

الكلمات المفتاحية: البلاستك، الأسماك، شط العرب، عوامل بيئية ،تصاريف المياه.

1. Introduction

Plastic pollution can be found in every ocean and sea on Earth. It can damage coastal benthic habitats. By suffocating them when plastic sheets create a layer over the benthos. Additionally, changes in sediment permeability are caused by buried plastics (Eriksenetal.2014). Despite substantial employment and financial benefits to the nation, the ship-breaking business generates diverse wastes in the form of solids, liquids, and gasses. (Islam and Hossain, 1986). The influence of a contaminant on the base of the food web can affect trophic structure and ecosystem function. Throughout oceans globally, there is a need for more research into the growing threats of plastic pollution, particularly regarding the ingestion of anthropogenic debris by commonly eaten fish. Plastic is a significant concern for the oceans, threatening a diverse array of wildlife, from marine worms (Van Cauwenberghe *et al*. 2015) that the frequency of MPs and metals in fish from a heavily contaminated site is dictated not only by their bioavailability but also by the physiological features of the specific organism. (Tavera *et al*.2021). Food chain and pose serious threats to the biota. Microplastic exposure in fish frequently causes unfavorable physiological and behavioral effects, internal abrasions and obstructions, behavioral abnormalities, poor nutritional absorption, reproductive failure, and even mortality (Hamed *et al*., 2020). Aquatic environments play an essential role in the well-being of humans, and hence the deterioration in water quality imposed by humanity for various reasons has given special attention to water resources. (Tay 2021). Many developing countries, including Iraq, face major threats to their water security represented by a serious water shortage, with a clear deterioration in its quality due to the increase in demand to meet the population's needs for drinking water, irrigation, industry, or recreational purposes (Issa. *et al*,2014). In this study, we investigate the effects of microplastic exposure on young planktivorous fish (*Acanthochromis polyacanthus*). (Kay and Mia, 2018).

2. Material and Methods

From January 2022 to December 2022, quarterly expeditions were made to collect water and fish samples from four field sites in the middle section of the Shatt al-Arab River. As shown in Figure (1). The map was made using GIS V.10.1. Station one is named end

Al-Najebia with Cite E 047 45.930 N 30 34.766, Station two is called Al-Dakier for Cite E 047 50.223 N 30 32.105, station three is called Al-Ashar with coordinates E 047 50.830 N 30 30.923, and station four is called Al-Bradieyha with coordinates E 047 51.693 N 30 30.142. Fish samples were collected using two methods: a cast net with mesh sizes of 2x2 and 3x3. Cm, and Electrofishing The authors used a 1m.×m quadrate to measure the density of plastic debris on the riverbank four were classified by (Kuronuma, and Abe, 1986, and Fischer, and Bianchi, 1984 sites. Fish).

2.1. Water Parameters

The city collected data on five environmental indicators, including water temperature, air temperature, dissolved oxygen, turbidity, and total suspended sold.Water temperatures were measured using a basic mercury thermometer with a scale range of 0-50 Cº, and turbidity (NTU) with the HI-93703 HANNA. The American Health Association's Winkler method for measuring dissolved oxygen was followed. (APHA, 1999) The result is reported as (mg/l). The procedure described. In (AOAC, 1984). To quantify total suspended solids (TSS), a 100 ml sample was filtered in the laboratory using Whatman GF/C filter papers with 4.7 cm diameter and 0.45µ mesh diameter. The weight difference was determined after drying the paper and represented in mg/l.

2.2. Plastic Parts Examination and Measurements

Polyethylene Terephthalate (PET), Polyvinyl Chloride (PVC), Nylon, Polyethylene, Polypropylene, and Polystyrene make up 95% of worldwide plastic output. Microplastics have a harmful influence on ecosystems because they infiltrate the food web and act as a vector for transmitting various contaminants with an attraction for plastic surfaces. (Lagarde, *et al* .2016), and detection of microplastics. The samples were visually screened for microplastic using a binocular stereoscope (Stemi 2000 Zeiss with PI 10× 23 maximum magnification). Distilled water was used for clearing the stomach contents and to identify plastic particles. The samples were meticulously checked for the presence of plastic particles in the glass petri dish, particularly around the edge, where microplastic particles are commonly adhered. Plastic fragments or debris were collected from the banks of the stations by quadrature measuring 1 × 1 m2 to measure the plastic density on the shore The particles were counted and photographed. FTIR polymer identification (Fourier-Transform

Infrared Ray) spectroscopy is a fingerprinting technique that is used extensively for the characterization of plastic polymer particles. Carbon-based polymers can be described easily from different bond compositions by yielding a unique spectrum that discriminates plastic particles from other organic and inorganic particles (Löder, *et al* .2015) the apparatus was utilized in the Department of Chemistry, College of Science, University of Basra. The used plastic materials were investigated under a Projection microscope, projecting (CH-9435 Heerburg).

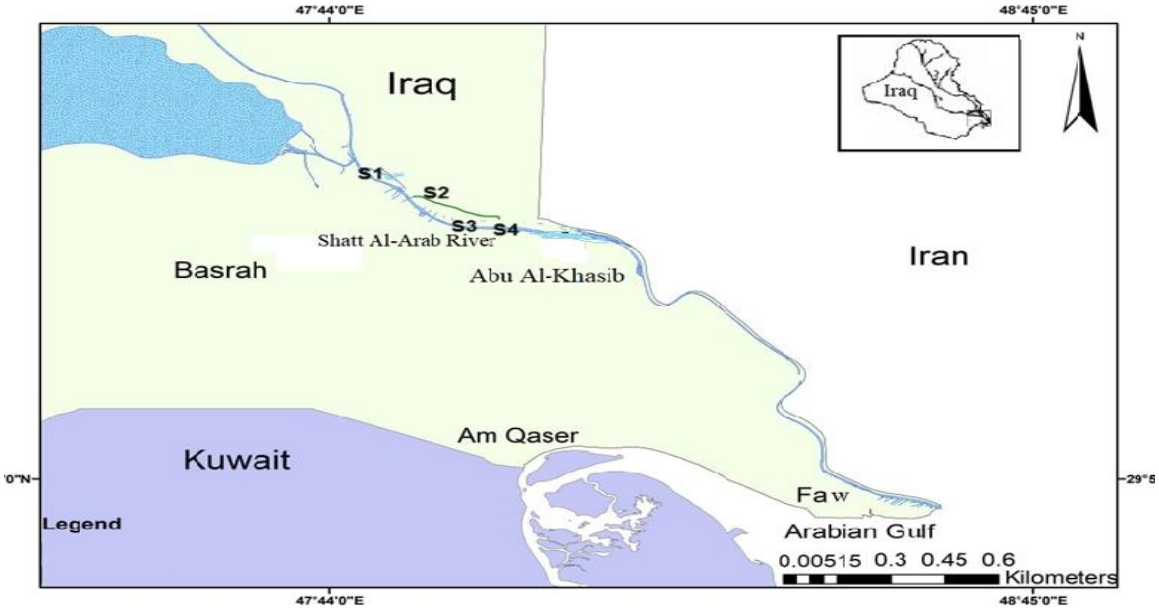

Figure (1): The locations of the four stations

3. Results and Discussion

The maximum temperature was 33°C in Al-Bradieyha in autumn, while the Minimum was 26°C in Al-Najebia in the spring. The Maximum summer air temperature was 44°C in Al-Bradieyha, while the minimum winter temperature was 20°C in Al-Najebia. The greatest dissolved oxygen was 6.6 mg/l in the summer in Al-Bradieyha, while the minimum value was 4 mg/l in autumn in Al-Najebia Figure (2).

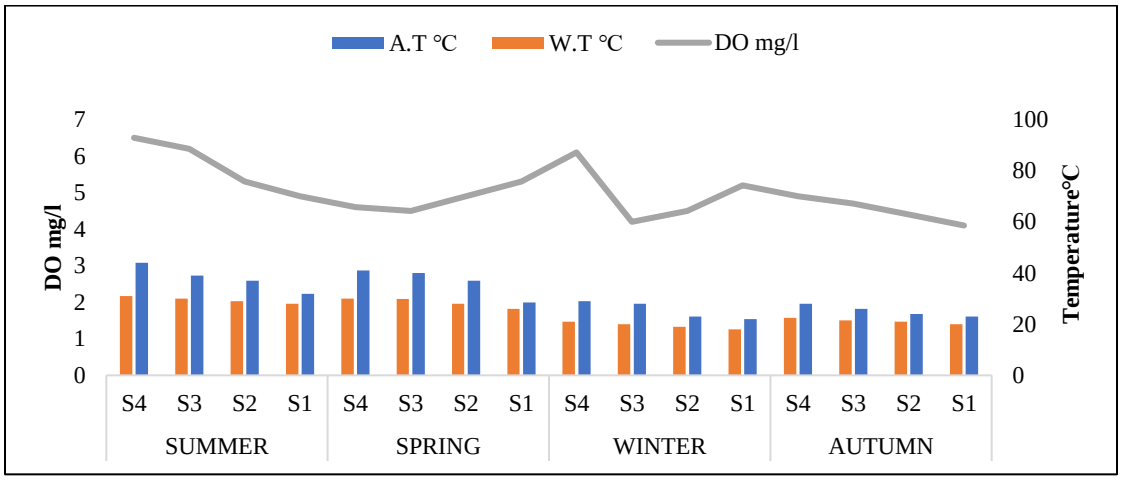

Figure (2): Seasonal variations in water and air temperature and dissolved oxygen at four study sites

Figure (3) depicts the seasonal changes at the research locations. The highest and lowest turbidity concentrations were reported in the Al-Ashar in winter and summer respectively, and achieved (45 NTU, 1 NTU). It is also stated that total suspended solids fluctuate seasonally, with a peak concentration of 0.0 0.6 mg/l in Al-Bradieyha and a minimum concentration of 0.0 0.1 mg/l during Al-Najebia.

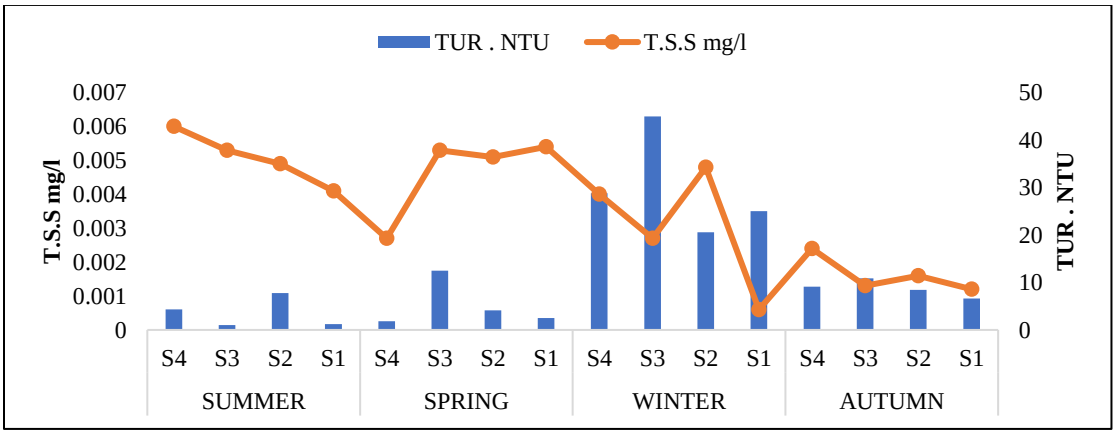

Figure (3): Turbidity and TSS change seasonally across the 4 study regions.

The lowest value was 1.99 millisiemens/cm during the spring in Al-Najibiya and the highest value was 25.3 millisiemens/cm during the summer in Al-Baradiya. High temperatures, high evaporation, and lack of rain (Al-Mohmood *et al*.2015) The electrical conductivity values correspond to a note by Moyle and Hussain (2015) In their study on

evaluating the quality of Shatt al-Arab water in southern Iraq, electrical conductivity values ranged from 3.90 to 18.45 millisiemens/cm. figure (4).

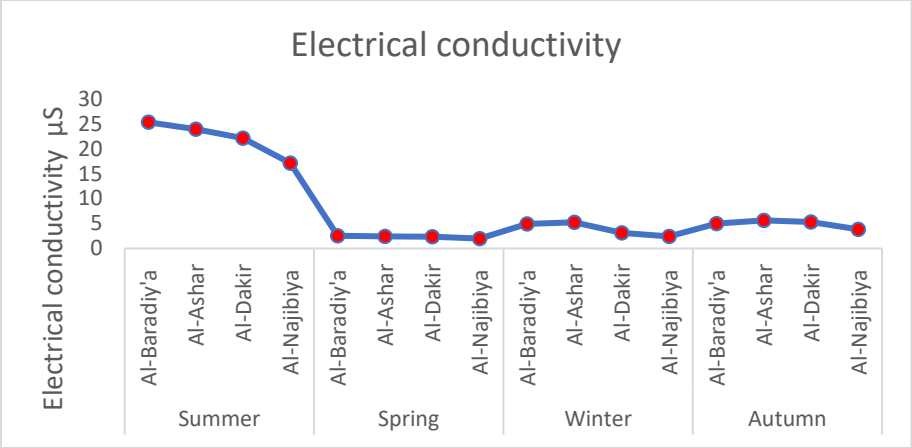

Figure (4): Seasonally changes of Electrical conductivity µs/cm in the four studied stations

Catch 377 individuals belonging to fifteen species of fish were caught during the study period, Including 12 genera, 10 families, and 6 orders. *Captodon zillii* was dominant at a ratio of 62.3% of the total number of fish, followed by *Cyprenus carpio* at a rate of 12%. 4%, and then *Oreochromis niloticus* at a percentage of 7.8%. This does not agree with what Mohamed and Hameed, (2019) mentioned during the period of their study on the effect of the advance of the salt tongue on the fish population in the central part of the Shatt al-Arab, where the percentage of *C. zillii* was 11%, as demonstrated in (Table. 1). Distribution of the types of fish caught during the study seasons, as the number of species reached 15 species. It is noted that *C.zillii* and *O.niloticus* are the only two species that were present during all the study seasons, and their numbers during the study period were 235 and 29 samples, respectively. This may be because The Tilapia fish species are tolerant to severe environmental changes, and a new species was recorded in the Shatt al-Arab during the present study period, *Acentrogobius dayi.*

Table (1): Scientific and local names of fish caught from the study stations during the period from November 2021 to August 2022

Local name	Scientific name	Habitat	Autumn %	Winter %	Spring %	Summer %	Total	%
Zillii tilapia	*Coptodon zillii*	Riverine	83	56	78	18	235	62.33
Common carb	*Cyprinus carpio*	Riverine	14	20	×	13	47	12.47
Nile tilapia	*Oreochromis niloticus*	Riverine	12	6	4	7	29	7.69
Khasini	*Planiliza abu*	Riverine	2	2	7	3	14	3.71
Karkafan	*Photopectoralis bind us*	Marine	×	×	×	10	10	2.6
Abu Shalambo	*Acentrogobius dayi*	Marine	×	×	×	9	9	2.39
Albiah Alakhdar	*Planiliza subviridus*	Marine	2	2	3	1	8	2.12
Wide semnan	*Acanthobrama marmid*	Riverine	3	3	×	×	6	1.59
Tall semnan	*Alburnus mossulensis*	Riverine	2	3	×	×	5	1.33
Shiga (blam)	*Thryssa whiteheadi*	Marine	×	×	×	5	5	1.33
Shiga (blam)	*Thryssa vitrirostris*	Marine	×	×	×	3	3	0.79
Double stripe shank	*Acanthopagrus bifasciatus*	Marine	×	×	2	×	2	0.53
Sabur	*Tenualosa ilisha*	Marine	×	×	×	2	2	0.53
Arabic shank	*Acanthopagrus arabicus*	Marine	×	×	×	1	1	0.22
Albiah	*Planiliza carinata*	Marine	×	×	×	1	1	0.22
			118	92	94	73	377	100%

The number of plastic was also measured using the quadrat method, as the station with the highest contamination with plastic waste was Al-Baradiya station, with 193 plastic pieces out of the total number of plastic pieces collected per square meter, and the most collected season of plastic pieces was spring, while the total number of plastic collected during the four seasons reached 638 plastic pieces (Al-Zwar *et al*.2023),(Table,2). These results are consistent with Cyork (2016) in her study on the classification of garbage Plastic, and contamination in the main branches of the Shatt Al-Arab, as the Khora River

was the most polluted branch river and contained 180 tons of plastic collected for an entire year. Perhaps the reason for this in the present study is due to its proximity to Local markets, The source of the plastic may be from clothes in all its forms, sewage and open water on the Shatt al-Arab, clothes washing solutions, and dyes in general through dyeing river lions near the river, in addition to throwing away plastic water bottles, which decompose after years, residential homes, and hospitals, and this was confirmed by the representative of the Basra Ports Directorate.

Table (2): percentages of plastic pieces/m^2 in the four stations

Seasons / Sites	Autumn %	Winter %	Spring %	Summer %	Total %	Average
Al-Najibiya%	(%22)32	(%22)34	(%17.1)32	(%28.4)43	(%22.1)141	35.25
Al-Dakir %	(%10.3)15	(%37)57	(%34.7)65	(%35.5)54	(%29.9)191	47.75
Al-Ashar %	(%31.7)46	(%7.7)12	(%16.2)30	(%16.4)25	(%17.7)113	28.25
Al-Baradiy'a %	(%36)52	(%33.3)51	(%32)60	(%19.7)30	(%30.3)193	48.25
Total	145	154	187	152	638	35.25

The results in Figure (5) showed that the majority of fish consuming plastic were of the type *C. zilli*, with a Percentage of 74%, amounting to 110 of the total number of fish consuming plastic, with some 149 samples, followed by the common carp, *C. carpio*, with a percentage of 13%. This shows that there were no significant differences in plastic consumption. Regarding fish, feeding pattern in terms of length, area, or species, as mentioned by Forrest and Hindell, (2018), in their study on the ingestion of plastic by fish intended for human consumption in remote South Pacific islands, this is observed through the consumption of plastic by tilapia fish of all types.

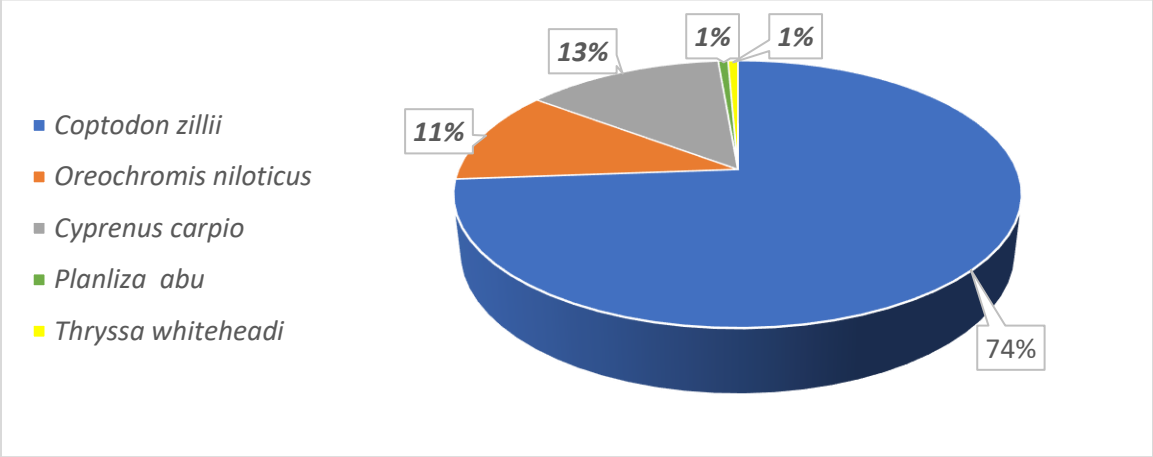

Figure (5): Plastic consumption by fish caught at the study stations during the period from November 2021 to August 2022

Plastic was also divided into forms extracted from the digestive tract of fish between seasons, and plastic fibers were prevalent during all seasons except autumn Figure (6) Perhaps the explanation is that the morphology of microplastics can resemble the natural prey of fish in the ecosystem. For example, the threads have a morphology similar to filamentous algae prevalent in the aquatic environment, which is considered a natural prey for fish.

The percentage of plastic fragments was higher in the fall, that is, during the rainy season. This is it does not match the note of Wicaksono *et al*. (2021) during their study, there was a higher percentage of particles in the sediments of the Talo River in Indonesia during the dry season, 5.63%, while in the rainy season, their percentage is only about 0.5% in the water. The sediments of the Talo River through the dry season contain a large percentage of fragments.

The highest percentage of plastic consumption out of the total number of fish in the study seasons during the fall, winter, spring, and summer which is found to be equal to 59.30%, 45.70%, 27.10%, and 16.40% respectively. The increase may be attributed to primary productivity in the fall and winter, as it was mentioned by Al-Essa ,(2004) in his study on the primary productivity of plankton within the northern part of the Shatt al-Arab in southern Iraq, where the maximum of primary productivity was in April and the lowest value in July, which led to the availability of nutrients in the environment and the availability of nutrients in large quantities during the fall and the flourishing of

phytoplankton, which led to the consumption for Plastic fish chapter and during subsequent chapters as shown in Figure(7).

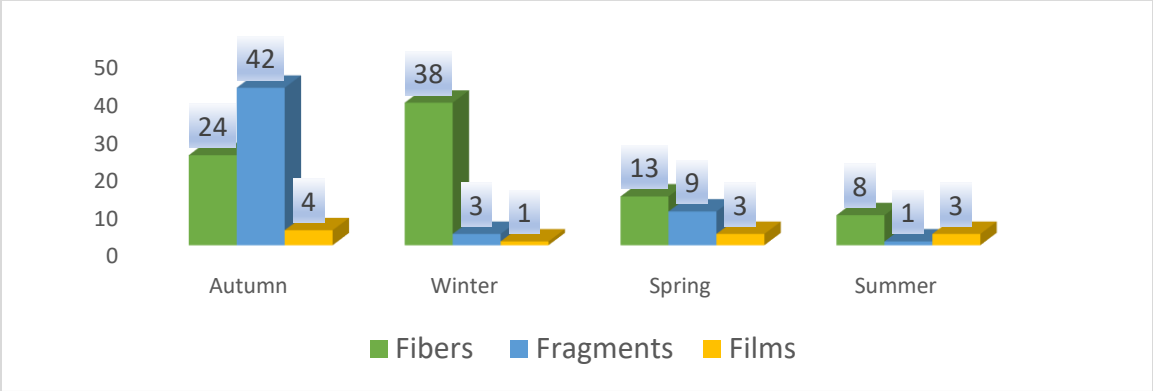

Figure (6): Distributing plastic shapes during different season

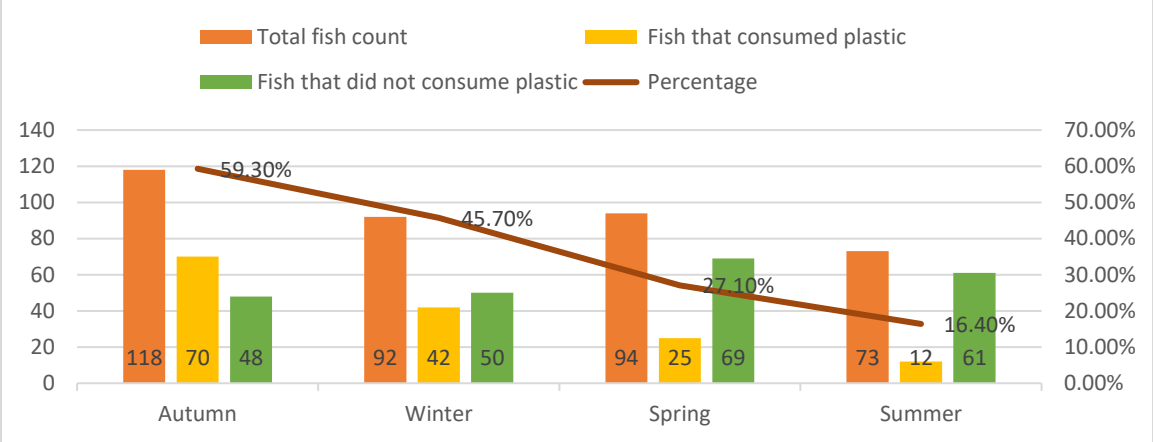

Figure (7): Percentages of plastic presence in the digestive tract of caught fish during the period from November 2021 to August 2022

Figure (8) shows the presence of the largest number of plastic waste residues in the Al-Dakir and Al-Ashar stations, at 40.43% of the total number of polymers. for both stations, followed by Al-Baradiya station, at a ratio of 90.37% of the total number of plastics, and then Al-Najibiya station, at a ratio of 60.30% of the total number of plastics, The water coming out of the station also has a direct or indirect effect on every function of plant and animal plankton. It affects natural processes such as diffusion, permeability, water absorption, and evaporation, in all chemical processes of food transformation, the rate of photosynthesis, carbon dioxide concentration, respiration, absorption, and

transpiration processes in plants. And also on zooplankton, their migration, lack of growth, density, and distribution in the environment this may confirm the contamination of the secondary rivers near the selected stations with plastic waste that is destined for the Shatt al-Arab River. This was confirmed by Cyrek, (2016) in her research that focused on the classification and management of waste contaminants in the main branches of the Shatt al-Arab river.

It is also noted that the most frequent color is red, accounting for 20.30% of the total percentage of plastic consumed during the period of the present study, as the number of samples reached 45 samples (Figure 9). This may be due to the frequent use of fishing nets and lines colored red, as all the pieces were red plastic is dry, and this is not consistent with what Martinez-Tavera *et al* (2021) mentioned In their study regarding microplastics and metal contamination in freshwater tilapia *O.niloticus* For a water reservoir in Central Mexico, the black color was dominant, accounting for 42% of the total number of plastics. They attributed the reason to the fish's preference to swallow it due to similarities with food or prey.

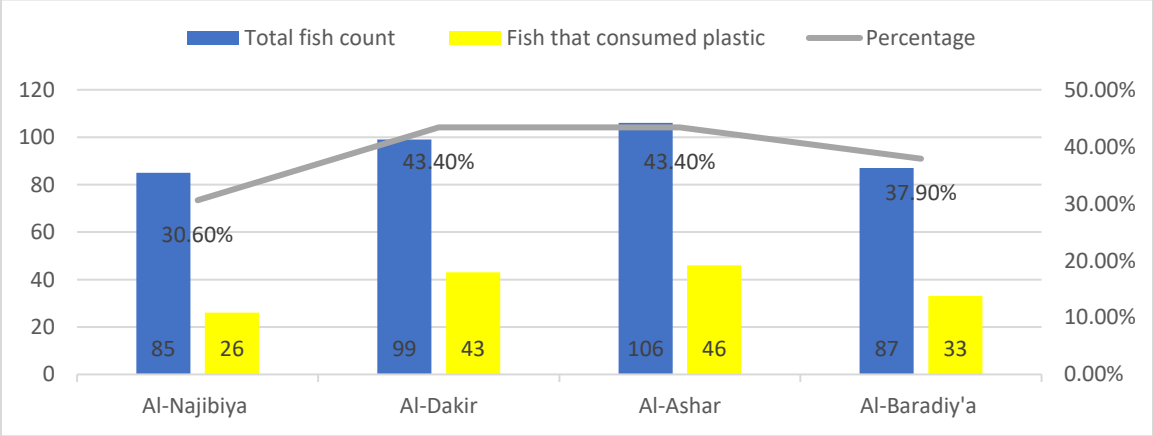

Figure (8): Number of fish and percentages of the presence of plastic in the digestive tract of fish caught at the stations of Al-Najibiya, Al-Dakir, Al-Ashar, and Al-Baradiya in the central part of the Shatt Al-Arab River

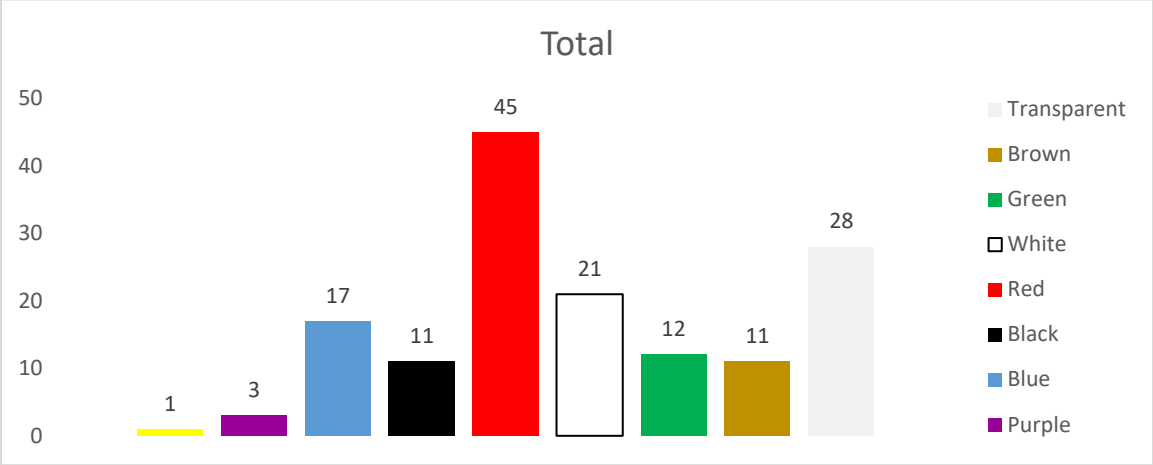

Figure (9): Plastic consumed by fish according to color during the period from November 2021 to August 2022

The plastic lengths were measured using a Projecting microscope, and they ranged from 0.04mm to 1.25mm, as seen in the figure (10) below. The following images indicate the quality of plastic residues figure (11).

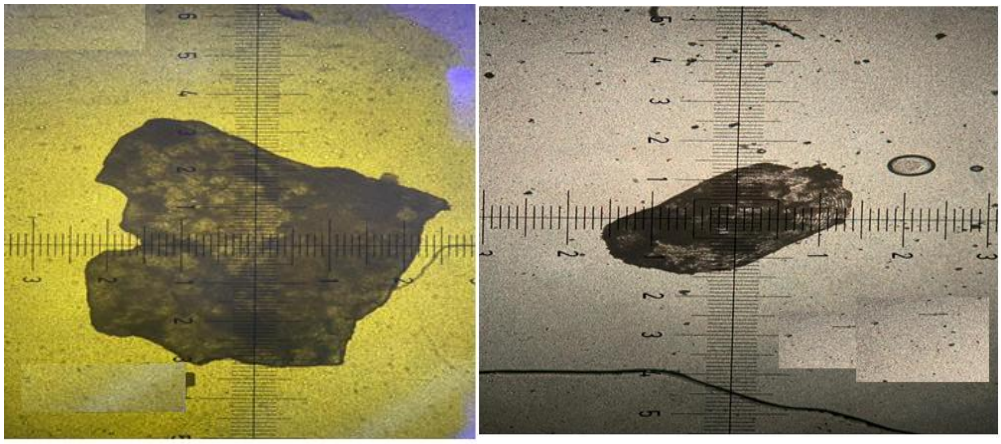

Figure (10): The Projectina microscope from the study station revealed the lengths of plastic particles in the stomachs of the captured fish.

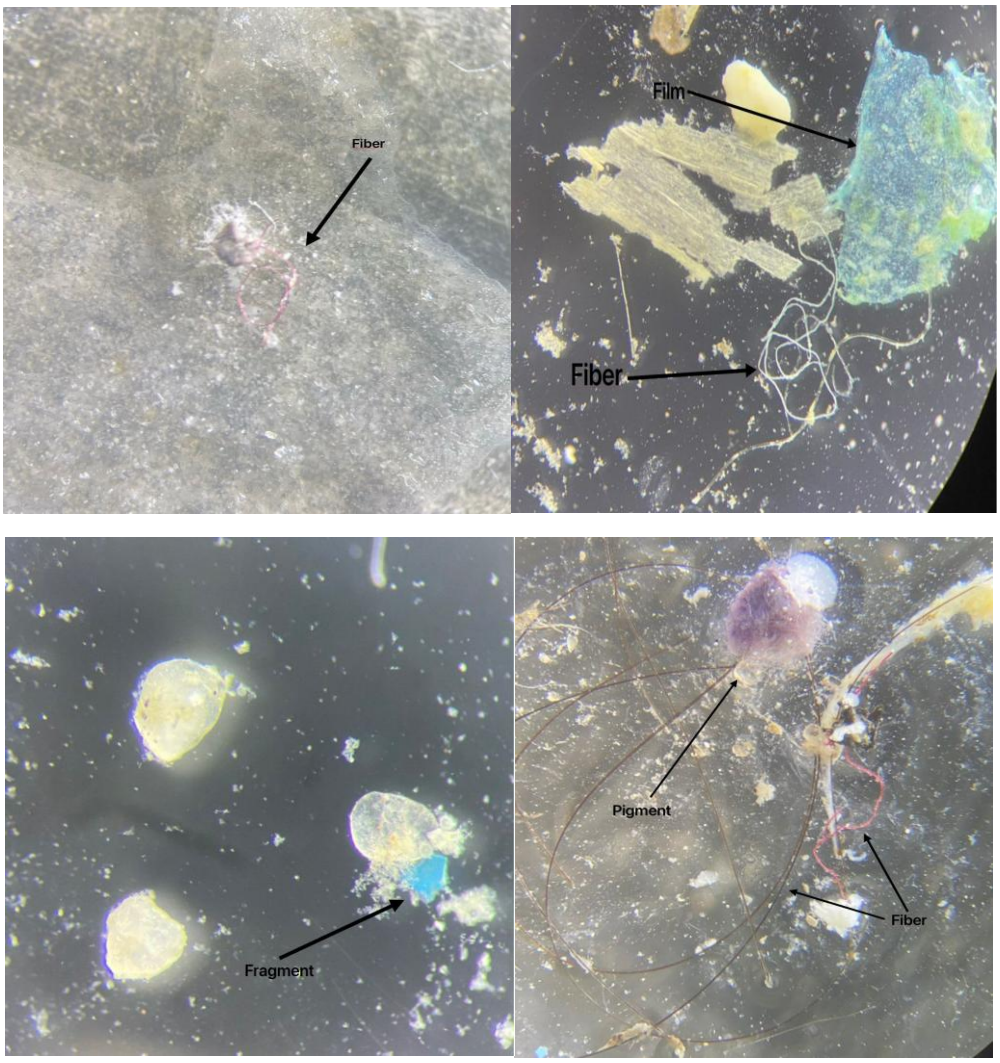

Figure (11): Plastic particles, including colors, films, Pigments, Fragments, and fibers, were detected in fish guts from four sites in the middle stretch of the Shatt Al Arab River.

Figure (12) shows water discharges from the Qalaat Saleh regulator during the years 2020, 2021, and 2022. The maximum value reached by water discharges during July was 103 m3/s during the year 2020, and the lowest value during March was 69.6 m3/s during the year 2022.

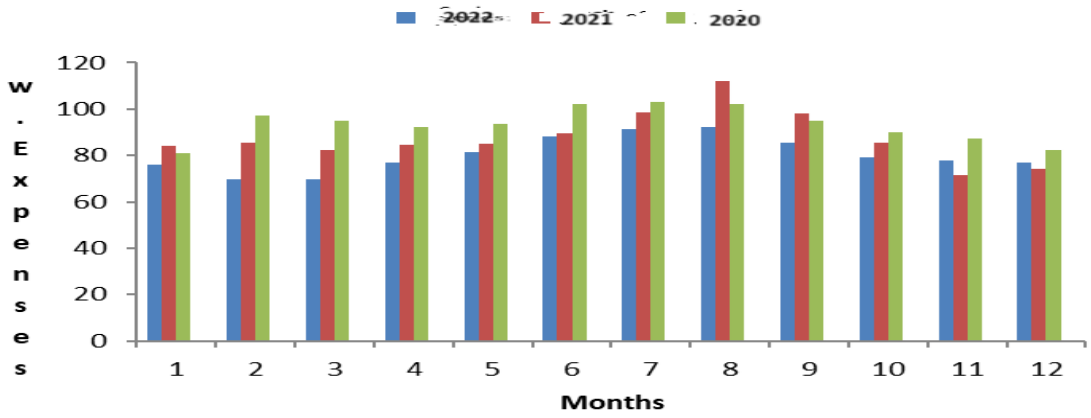

Figure (12): Water discharge levels over three years

This causes a problem when water drainage decreases, clear problems appear in the Shatt al-Arab, and the salt tongue coming from the sea rises, thus all kinds of pollution appear, including plastic pollution, the emergence of diseases and epidemics, lack of vegetation, and the deterioration of abiotic diversity. This is what Al-Zwar *et al* (2023) confirmed during their study of plastic Pollution in the Shatt al-Arab River. While plastic materials collect in the river this may be during the tidal process of transporting plastic materials, even microscopic ones, during their transport from the coasts of marine waters to the rivers. During the tidal process, the increase in plastic pollution in the rivers leads to the process of returning during the ebb and their deposition to the bottom of the river, and through the tidal process, these materials are transported to the rivers.

4. Conclusion

The results showed that the autumn season and the Dakir and Al-Ashar stations are the most polluted with plastic extracted from the digestive tract of fish, and *C. zillii* tilapia was the type that consumed the most plastic extracted from the stomach of fish, and The lack of water drainage and the increase in human waste has led to the spread of plastic materials in Shatt al-Arab River.

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