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Plastic pollution in fish (*O. niloticus* and *C. gariepinus*) in a Nile Canal, Delta of Egypt.

Elsayed Khallaf[1*], Alaa Alne-na-ei[1] and Muhammad Authman [2], Ranya Saqr [1]
1. Zoology Department, Faculty of Science, Minoufia University, Shebeen Alkoom, Egypt.
2. National Research center, Hydrobiology Department, Giza, Egypt.
[*]Corresponding Author: ekhallaf@yahoo.com.

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ABSTRACT

Plastic pollution is an international problem to the limit that World Environment Day, made its theme on the 5^{th} of June 2023: Beat plastic pollution. The Nile is suspected to be a source of such pollution that pour into the Mediterranean Sea. In this respect, the present work was carried out on 127 O. *niloticus*, as a surface feeder, and 32 C. *gariepinus* from Bahr Shebeen Nilotic Canal. The occurrence of microplastics varied with species and seasons. This did not exceed 10 particles per fish. The percentage occurrence was 33.9 for *O. niloticus* and 59.4 for C. *gariepinus.* Food and feeding and seasonal variations were examined and discussed, in the light of the shape and color of MPs with the length of fish. Colors of pink, red, and blue showed the highest occurrence in either species, while Fragments and fibers were found to be the highest. Identified polymers were shown to be polyamide, alkyd resins, polyethylene, polyethylene terephthalates and rayon. The highly occurring of those are polyamides and rayon in both species.

INTRODUCTION

Plastics are artificial organic polymers that have only been around for a little over a century **(Derraik, 2002)**. They are widely used by society because of their numerous advantages. They are preferred in all industrial applications because of their small size, low price, and high durability **(Yaranal *et al.*, 2021)**. According to **(Parker, 2019)**, plastics production was 2.5 million metric tons in 1950, but reached 448 m.m.t. in 2015. They constitute parts of automotive parts, electric devices, packaging, and fillers in complex materials. Trash from rivers reach the sea where they are carried and distributed around the world by water currents, Sun light, wind and waves transform plastics into small particles. They are responsible for disturbed reproduction in 100 spp. Some of them are endangered. In **Britanica, June 2023**, plastics produced in 2018 reached 359 million metric tons, of which, 5 to 14 million metric tons. are poured to the Ocean. According to the same source, plastics are nonbiodegradable materials. They are mistaken as food and thus affecting aquatic animals, and birds, causing starvation as their stomachs would be stuffed with that pollutant. The plastics production values between 600 to 800 Billion Dollars, which shows the difficulty to interfere by change or recycling **(Conolly, 2023)**.

After being dumped into the environment, plastic trash would break down into tiny plastic particles, eventually creating microplastics (MPs) with a particle size of less than 5 mm **(Zhou *et al.*, 2019)**. It is widely acknowledged that MPs fall into two categories: primary MPs and secondary MPs. Primary microplastics are defined as microplastics that are originally manufactured to be less than 5mm in size and are commonly found in textiles, medicines, and personal care products such as facial and body scrubs **(Cole *et al*., 2011; Browne, 2015)**. These primary microplastics can be transferred into freshwater and marine habitats via rivers, discharge from water treatment plants, wind, and surface run-off **(Gall and Thompson, 2015)**. Secondary MPs are produced as a result of continuous abrasion and weathering of plastic products **(Song *et al*., 2017;**.**Alimi *et al.*, 2018;).** Among the sources of secondary microplastics are household items, industrial resin pellets, fishing nets, and other discarded plastic waste **(Eerkes-Medrano *et al.*, 2015)**.

MPs are currently the most prevalent indeclinable pollutants on Earth **(Derraik, 2002; Galgani *et al*., 2013)**. The public is concerned about MPs because of their pervasive presence in the aquatic environment **(Li *et al.*, 2018)**. **McVeigh (2023),** in the Guardian, indicated that coral reefs are adversely polluted by plastics at a depth of 30 to 150 m., where more debris were noticed as depth goes deeper.

Freshwater can be sources of microplastics **(Klein *et al.*, 2018)**. Although several MPs can accumulate in freshwater, fewer researches have been conducted to monitor them than have been done for marine water **(Li *et al.*, 2018)**.

According to several studies, MPs can cause fish to exhibit ecotoxicological symptoms such as anemia, metabolic disturbances, and oxidative stress **(Lu *et al.*, 2016; Barboza *et al*., 2018; Choi *et al*., 2018; ; Qiao *et al.*, 2019; Wang *et al*., 2019; Hamed *et al*., 2019, 2020)**. MPs have the potential to cause neural dysfunction in goby (*Pomatoschistus microps*) **(Oliveira *et al*., 2013),** Acetylcholinesterase inhibition in red tilapia (*Oreochromis niloticus*) **(Ding *et al.*, 2018),** increased mortality of European sea bass *(Dicentrarchus labrax)* **(Mazurais *et al*., 2015),** Increased expression of the photoreceptor opsin gene (zfrho) in zebrafish **(Chen *et al*., 2017),** higher levels of antioxidant enzymes and hepatic steatosis in (*Danio rerio*) **(Lu *et al.*, 2016),** and exhausting immune system of fathead minnows (*Pimephales promelas*) (**Greven *et al*., 2016)**.

The WWF (World Wild Life Org.) report 2023, indicated that among 44 countries Egypt appear to be the biggest plastic pollution country among the Arab World where 250 000 m.t, pour to the Mediterranean.

Egypt is the biggest user of polymers in Africa, consuming around 2.1 million tons of them in 2017 **(Babayemi *et al*., 2019)**. Aquatic ecosystems are being negatively impacted by Egypt's excessive plastic usage, lack of waste disposal management, and unregulated plastic waste dumping **(Hamed *et al.*, 2019)**. Most water sources include MPs, which either directly or indirectly enter aquaculture systems before passing to aquatic animals' bodies and then food chin **(Zhou *et al.*, 2021)**. Nowadays, aquaculture is Egypt's primary source of fish, contributing to about 65% of the country's total fish production, with more than 99% coming from privately operated farms **(Sayed *et al.*, 2021)**.

Fish is a good source of high-quality protein and an important source of micronutrients such as vitamins, minerals, and polyunsaturated omega-3 fatty acids **(Michael, 2022)**.

Tilapias are regarded as the basis of fishing because they account for more than 70% of Egyptian fish landings. They are the main species found in Egypt's Nile River and irrigation canal network ***(*Khallaf *et al.*, 2020)**. Nile tilapia (*Oreochromis niloticus*) is the basis of many African countries' commercial fisheries in tropical and subtropical freshwater **(Mohammed and Uraguchi, 2013)**. It is a common cichlid fish with cycloid scales. It is silver in color with olive/black/grey body bars and frequently flushes red during breeding season **(Picker and Griffiths, 2011)**. Nile tilapia is a mouth-brooder, with the eggs incubated within the female's buccal cavity. The optimum temperature for spawning is 25-30 °C **(Huntingford *et al.*, 2012)**. It can reach weights of 5 kg and survive for more than 10 years **(Khallaf *et al.*, 2020)**. Tilapias consume a wide range of natural food items, including plankton, some aquatic macrophytes, planktonic and benthic aquatic invertebrates, larval fish, detritus, and decomposing organic materials. They are frequently referred to as filter feeders because of their ability to efficiently capture plankton from the water. However, they do not physically filter the water through their gill rakers as well as real filter feeders like gizzard shad and silver carp. Tilapia gills generate the mucus that captures plankton. After that, the plankton-rich mucus, or bolus, is swallowed **(Popma and Masser, 1999)**.

Clariid catfishes have emerged as one of the world's most important groups of farmed catfish. The African catfish, *Clarias gariepinus*, is found throughout Africa and has long been regarded as one of the best species for culture **(El Naggar *et al.*, 2006)**. This species is known for its high growth rate, resistance to handling and stress, relatively low water quality requirements, adaptability to high stocking densities, excellent meat quality, and consumer preference in many African countries **(Hecht and Verheust, 1996)**. *C. gariepinus* is found in practically all fresh water bodies, including rivers, lakes, flooded plains, and large and shallow streams **(Iheanacho and Odo, 2020)**. It is a bottom omnivorous feeder, eating practically anything it comes into contact with **(Ogueji *et al*., 2020)**. It has great potential in human nutrition as a protein and energy source, and its lipids are a good source of polyunsaturated fatty acids, particularly omega 3 fatty acids so it's considered as a main solution to the increasing demand for fish and fish products in many African countries as a result of rapid human population growth **(Sorour and Hamouda, 2019)**. In spite of the plastic pollution immanent threat in the world as well as in Egypt, no research article tackled this problem, but only one on the Nile. The latter was supported by SKY News International **(Khan *et al*., 2020),** where no Egyptian Research Organization or a researcher participated in that paper.

In this work, the problem of microplastics pollution in fish (*Oreochromis niloticus* and *Clarias gariepinus*) from Bahr Shebeen Canal is studied. To emphasize how much is the problem in polluting the fish. *O. niloticus* is chosen as the abundant surface or near surface fish, while *C. gariepinus* as mostly a bottom feeder.

MATERIALS AND METHODS

1. Study Area:

Bahr Shebeen Canal (BSC) as described in **Fig. 1** is a semi-independent water ecosystem passing by three governorates : Menoufia, Gharbia, and Dakahlia in the Egyptian Delta **(Khallaf and**

Authman, 1991). It arises from the Nile and connects to it near the Barrage via Alrayah Almenoufi **(Khallaf and Authman, 1992)** . It is approximately 80 kilometers long, 2-3 meters deep, and 30 meters wide **(Khallaf and Alne-na-ei, 1987)**.

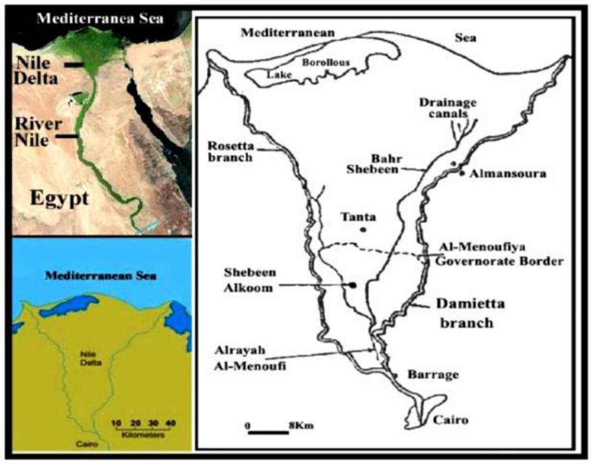

Fig.1: Bahr Shebeen Canal in the Egyptian Delta.

2. Collection of samples:

Two commercially important fish species (*O. niloticus and C. gariepinus*) were chosen for microplastic detection, the fact that the two species' niches and feeding areas differ, thus providing some insight into the MPs' fate in the canal environment. As a result, studying these fish species has ramifications for economics, ecology, and possibly human health.

A total of 118 Nile tilapia and 32 African catfish were collected for analysis from fish landing places through the day between 5 AM and 1 PM at different localities of Bahr Shebeen Canal during the sampling period between January 2021 to September 2021. Fish caught by trammel nets by local fishermen. These samples were obtained randomly.

The collected samples were immediately brought to the laboratory at Zoology Department Ecology laboratory, Faculty of Science, Menoufia University for later analysis.

3. Laboratory analysis:

The specimens were distributed on filter paper to remove excess water from their body surface and the following data were recorded: **-**

- Date of capture.
- Serial number of each sample.
- Morphometric parameters such as standard length (from the tip of the snout to the end of last vertebra) were then measured using a ruler to the nearest centimeter.
- Body weight was measured to the nearest gram.

4. Stomach extraction:

Stomach of each fish was taken out very carefully, weighed to the nearest gram and preserved in labeled vials containing 10% formalin for subsequent examination. About 10 grams of the dorsal muscles of each fish were also isolated, preserved in labeled vials containing 10% formalin and then used to assess their contamination by microplastics **(Barboza *et al*., 2020)**.

4.1. Stomach index (SI):

Stomach index was calculated as the following:

The weight of the full stomach was divided by the fish weight and multiplied by a hundred **(Khallaf and Alne-na-ei, 1987).**

4.2. Digestion and Filtration processes:

Samples were placed in adequately sized beakers for peroxide digestion of organic material. Hydrogen peroxide is a well-known and efficient oxidant for the elimination of organic material. When 30% Hydrogen peroxide is added to a sample, it digests organic debris with minimal influence on the plastic polymer within 7 days **(Tirkey and Upadhyay, 2021)**. Each sample's volume of 30% Hydrogen peroxide was determined by the size and weight of the stomach or dorsal muscle **(Lv *et al.*, 2019).** According to **(Jabeen *et al*., 2017),** no more than 50% of the total volume of the container is used for the digestion process. To prevent any atmospheric contamination of microplastic, each sample was wrapped in aluminum foil. Beakers containing samples were kept in a water bath with a controlled temperature of 60 ◦C for 24 hours, and the organic tissues were manually stirred every few hours until they were entirely digested. After digestion, the solution was vacuum filtered using nylon net filter paper with pore sizes of 20 μm. Excess beaker contents were rinsed into the filtration system using filter deionized (DI) water. Each filter paper was placed in a labelled, covered petri dish and kept in an incubator at 50 ◦C for 24 hours to ensure that the samples were dry before any further processing **(Gad and Midway, 2022).**

5. Identification and polymer characterization of MPs:

5.1 Visual identification:

The optical microscope (Optika B-193, Italy) equipped with a digital camera (Optika 4083.13E, Italy) was used to identify and counting of microplastics. Images with lenses of 4× and 10× were obtained. Microplastics were visually estimated in order to identify their shape and color, according to their physical properties **(Yaranal *et al.*, 2021)**. Microplastics were divided into fibers (elongated), films (thin, soft, and filmy), fragments (small angular pieces), and pellets (spherical or ovoid) based on their shapes. Furthermore, the colors of microplastics were recorded and classified **(Liu *et al*., 2018)**.

5.2 Polymer Type Identification:

The most popular technique for the detection of microplastics is Fourier transform Infrared (FTIR) Spectroscopy for many reasons, including directness, reliability, and non-destructive approach **(Ojeda *et al*., 2009),** additionally, it creates individual band patterns using particular infrared spectra , for different types **(Hidalgo-Ruz *et al.*, 2012)**. Metal tweezers were used to extract individual MP particles. Infrared spectra were recorded with a FT-IR-ALPHABRUKER-Platinum-ATR spectrometer, at the Central Laboratory, Faculty of Science, Menoufia University, Egypt and are expressed as cm^{-1} using the attenuated total reflection (ATR) method. The spectra were manually baseline corrected where necessary according to **(Espiritu *et al.*, 2019)**.

6. Data quality assurance and quality control:

Neoprene gloves and cotton lab coats were worn during the dissection, filtering, and microscope processes to avoid contamination. All glassware was washed and rinsed with distilled water.

7. Data analysis:

Statistical analyses were carried out by Microsoft Excel.

RESULTS

1. Morphometric Characteristics:

As shown in T**ables 1 to 4, and Figs. 2 and 3**. the predicted morphometric parameters are presented for *O. niloticus and C. gariepinus* respectively. It is not the concern of this work to make inferences about growth characteristics which generally need more sufficient data to consider.

Table 1: Relationship between standard length & observed weight of *O. niloticus*.

Standard length	No. of fishes	Average of standard length (cm) ± SD	Average of observed weight (g) ± SD
11.1-12	7	11.53±0.20	62.29±7.57
12.1-13	33	12.65±0.28	80.30±9.24
13.1-14	42	13.62±0.28	91.38±10.80
14.1-15	24	14.55±0.28	110.46±14.98
15.1-19.5	12	16.22 ±1.14	162.75±33.75

Table 2: Relationship between standard length & observed weight of *C. gariepinus*

Standard length	No. of fishes	Average of standard length (cm) ± SD	Average of observed weight (g) ± SD
15-22	2	17.75±3.18	56.5±21.92
22.1-24	3	23.43±0.51	123.67±18.77
24-26	-	-	-
26-28	7	27.16±0.51	184.14±31.28
29-31	7	30.04±0.96	296.86±108.80
31.1-34	6	32.75±.93	624.5±472.69
34-36	-	-	-
36-38	-	-	-
38-57	7	42.91±6.69	759.43±508.26

Table 3: Relationship between standard length & SI of *O. niloticus*.

Standard length	**No. of fishes**	**Average standard length (cm) ± SD**	**Average SI ± SD**
11.1-12	7	11.53±0.20	0.40±0.28
12.1-13	33	12.65±0.28	0.67±0.59
13.1-14	42	13.62±0.28	0.89±0.9
14.1-15	24	14.55±0.28	0.96±0.95
15.1-19.5	12	16.22 ±1.14	0.56±0.44

Table 4: Relationship between standard length & SI of *C. gariepinus*.

Standard length	**No. of fishes**	**Average standard length (cm) ± SD**	**Average SI ± SD**
15-22	2	17.75±3.18	0.96 ±0.37
22.1-24	3	23.43±0.51	0.61±0.12
24-26	-	-	-
26-28	7	27.16±0.51	0.71 ±0.19
29-31	7	30.04±0.96	0.74 ±0.60
31.1-34	6	32.75±.93	0.68±0.23
34-36	-	-	-
36-38	-	-	-
38-57	7	42.91±6.69	0.67±0.30

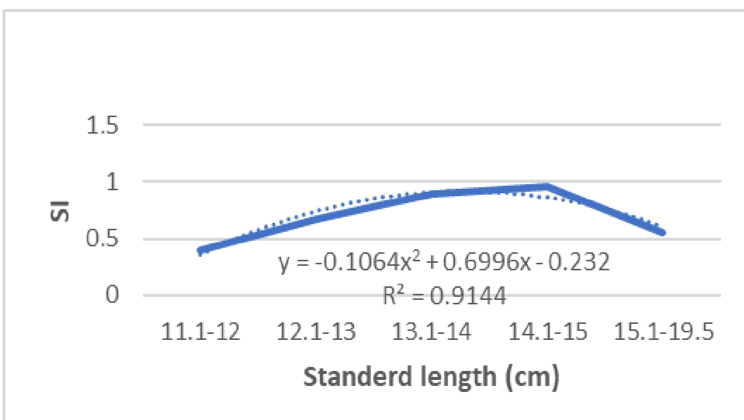

Fig.2: Stomach index variation with standard length of *O. niloticus*

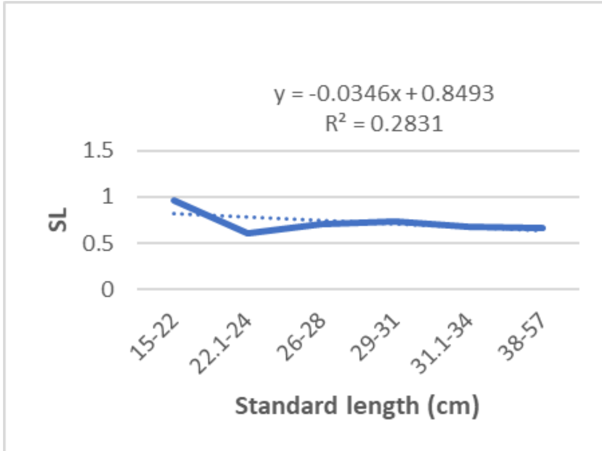

Fig. 3: Relationship between standard length (cm) & SI of *C. gariepinus*

2. Microplastics:

2.1 General abundance of Microplastics Ingested by Fish:

118 Nile tilapia and 32 African catfish were collected form Bahr Shebeen Canal to test the presence of MPs in their stomachs and dorsal muscles. It's found that a total of 269 MP particles were counted from the stomach of 44 fish sampled, with an average abundance of 6.11±3.77 particles/fish and about 51 MP particles counted from the dorsal muscles of 15 fish sampled, with an average abundance of 3.4±.63 particles/fish.

2.1.1. For *O. niloticus*:

In Winter, MPs were found in the stomach of 7 of the 60 fish tested (11.7%) with an average abundance of 6.7 ± 4.3 particles per individual fish and in the dorsal muscles of 2 of the 60 fish tested (3.3%) with an average abundance of 4.5 ± .5 particles per individual fish.

In Summer, MPs were found inside the stomach of 22 individuals (37.9% of total 58 fish samples) with an average abundance of 6.7±4.4 particles/fish and inside the dorsal muscles of 9 individuals (15.5% of total 58 fish samples) with an average abundance of 3.2 ±.44 particles/fish as stated in T**able 5**.

2.1.2 For *C. gariepinus*:

In Winter, MPs were found in 37.5% and 18.8% for stomach and dorsal muscles respectively with an average abundance of 5.5±2.5 and 3.3±.58 particles per individual fish for stomach and dorsal muscles respectively.

In Summer, MPs were observed in the dorsal muscles of 1 of the 16 fish sampled (6.3%) and in the stomach of 9 individuals (56.3%) with an average abundance of 4.6±1.5 particles per individual fish as shown in T**able 5**.

For the studied fish, percentage occurrence of microplastics in each species in the two seasons ranged between 13.44-55.31% with the highest in O. niloticus in the Summer As shown inT**able 5.**

Table 5: Microplastic (MP) abundance in fishes.

Fish species	Season	number of fish	Organ	No. of fish contain microplastic	percentage of organisms positive to ingestion	Microplastic (items/individual) (Mean±SD)
Oreochromis niloticus	Summer Winter	58 60	Stomach Muscles	22 9	37.9 15.5	6.7±4.4 3.2±.44
			Stomach Muscles	7 2	11.7 3.3	6.7±4.3 4.5±.5
Clarias gariepinus	Summer	16		9	56.3	4.6±1.5
			Muscles	1	6.3	-
	Winter	16	Stomach	6	37.5	5.5±2.5
			Muscles	3	18.8	3.3±.58

2.2 MPs and length of fish (Figs 4 and 5):

MPs increased with length significantly (r^2=0.82) for *O. niloticus*, while the that relationship was irregular for *C. gareipinus*.

MPs did not show a significant correlation with length of fish (r^2 = 0.25) in winter for *O. niloticus*. However, in summer MPs increased significantly with length of fish above 12 cm (r^2 =0.82) **(Fig. 4)**.

When *C. gareipinus* is considered, a significant correlation (r^2=0.94) in winter but not in summer where r^2 = 0.21**(Fig. 5)**.

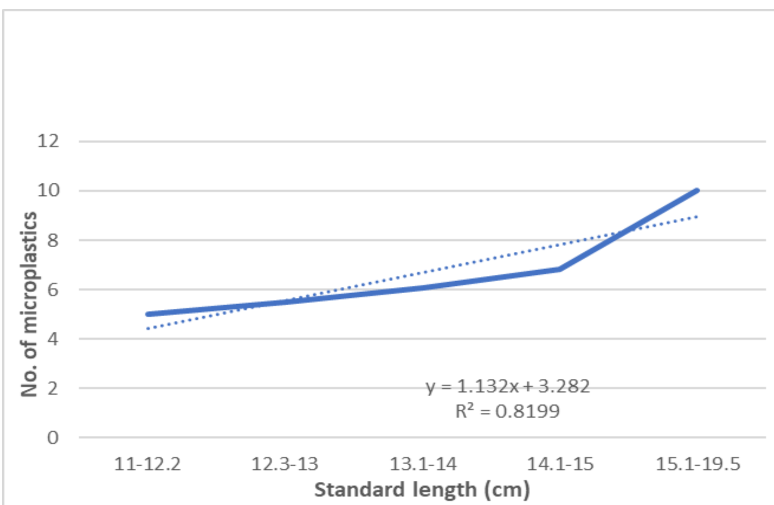

Fig. 4: Plastic variation in summer with standard length (cm) of *O. niloticus*

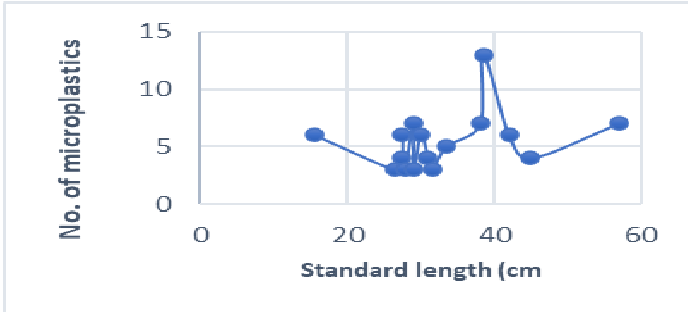

Fig. 5: Plastic variation with standard length of *C. gariepinus*

2.3 MPs and Stomach index:

2.3.1. *O. niloticus*: this relationship followed a polynomial significantly where r^2 was 0.91.

2.3.2. *C. gariepinus*: this did not correlate well where r^2 =0.28.

2.4 Physical characteristics of MPs detected:

MPs were classified based on their physical characteristics (shape and color) identified through visual observation under the optical microscope equipped with a camera as follows.

2.4.1 Shapes of MPs detected (Fig. 6, Table 6):

MPs recovered from the stomach and the muscles of the studied fish were classified into the following shapes: fragments, fibers, films and pellets **(Fig.6)**. Identifying the morphologies of MPs' characteristics is crucial for the future establishment of plastic waste management, because the MPs found are a direct sign of virgin macro-plastics.

- **For *O. niloticus*:**

In Winter, the most commonly observed microplastics were fragments, which accounted for 11.67% of all fish, followed by fibers and pellets, which accounted for 8.33% and 3.33% respectively, and then films which accounted for 1.67% of all fish.

As in Winter, fragments were the most common MP type in Summer, accounting for 48.28% followed by fibers, films and pellets which accounted for 24.14%, 12.07% and 3.45% respectively.

- **For *C. gariepinus*:**

In Winter, Fragment and fiber MPs were recorded as the most dominant shapes in the same percentage of (37.5%) where film and pellet MPs were the least dominant shapes in the same percentage too (12.5%).

In Summer, fragments were the most common MP type, accounting for 50%. The second most abundant type of MPs was fiber which accounted for 37.5%. The third abundant MPs particle was recorded as film type (18.75%). As compared with fragment, fiber and film MPs, pellets were the least proportion of 6.25% in Summer.

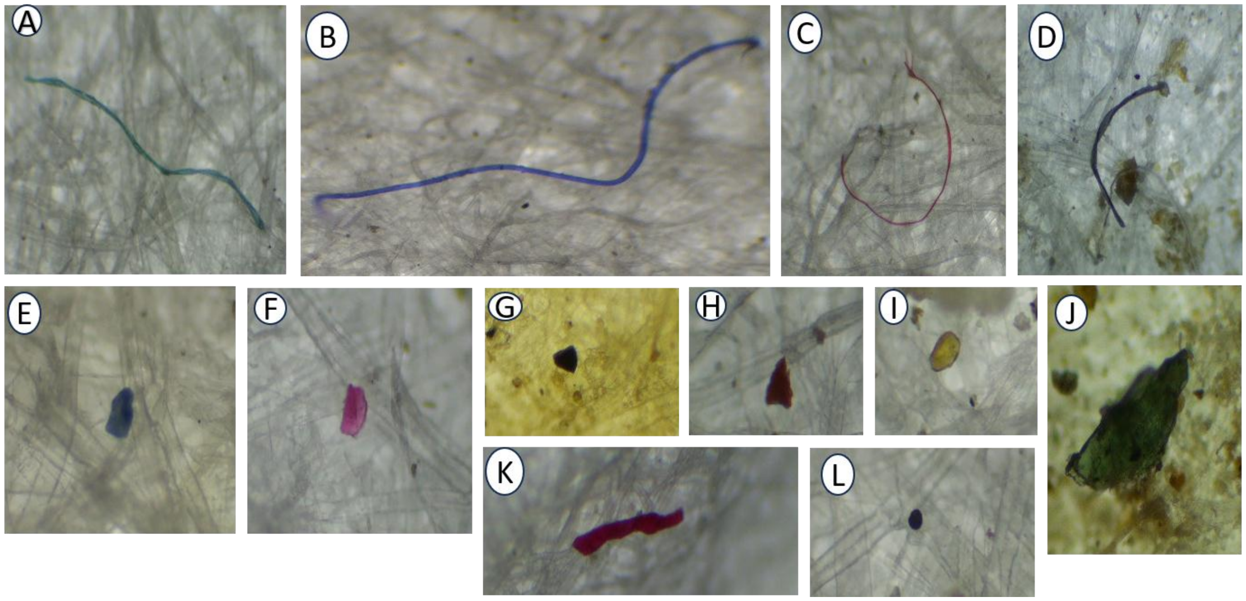

Fig. 6: Microscope images show different shapes and colors of microplastics present in the stomach and muscles of *O. niloticus* and *C. gariepinus* (Images A, B, C and D correspond to fibers; E, F, G, H and I to fragment; J and K to film and L to pellet.).

Table 6: Number. and percentage of fish containing different types of polymers.

Fish species	season	Polymer type Number (and percentage) of fish containing different types of polymers					
		Polyamide 6	Alkyd resin	Poly propylene	Polyethylene terephthalate	Rayon	Polyethylene
O. niloticus	Summer	28 (48.28)	3 (5.17)	3 (5.17)	6 (10.34)	12 (20.69)	4 (6.90)
C. gariepinus	Summer	9 (56.25)	-	-	1 (6.25)	3 (18.75)	-
O. niloticus	winter	8 (13.33)	1 (1.67)	2 (3.33)	2 (3.33)	5 (8.33)	-
C. gariepinus	winter	7 (43.75)	-	3 (18.75)	2 (12.5)	3 (18.75)	2 (12.5)

2.4.2 Color of MPs detected:

Various colors were recorded across all samples in the two seasons as shown in T**able 7**.

Table7: No. & percentage of fish containing different shapes of MPs.

Fish species	season	Shapes of MPs (No. & percentage of fish containing different shapes of MPs)			
		Fragments	**Fibers**	**Films**	**Pellets**
O. niloticus	Summer	28 (48.28%)	14 (24.14%)	7 (12.07%)	2 (3.45%)
C. gariepinus		8 (50%)	6 (37.5%)	3 (18.75%)	1 (6.25%)
O. niloticus	Winter	7 (11.67%)	5 (8.33%)	1 (1.67%)	2 (3.33%)
C. gariepinus		6 (37.5%)	6 (37.5%)	2 (12.5%)	2 (12.5%)

- **For *O. niloticus*:**

Nine colors of microplastics were found in fish stomach and muscles in Winter as pink, blue, green, brown, red, black, grey, purple and transparent. The most common color was pink (10%), followed by red (6.67%), then brown, blue, black and grey in the same percentage (5%). The remaining three hues accounted for less than 7% of all MPs.

In Summer, a total of ten colors of microplastics were found: pink, blue, green, brown, red, black, grey, purple, yellow and transparent. Pink and red MPs were the most abundant in fish stomach and muscles (18.97%), while purple MPs were the least abundant (1.72%).

- **For *C. gariepinus*:**

Among eight colors that were observed in Winter, pink MPs were the most dominant color (37.5%), while green, brown, grey and yellow were the least dominant colors (6.25%).

A great variety of colors were found in Summer, being pink (37.5%) the most common, followed by blue and black (25%) then, red and brown (18.75%). The remaining four colors accounted for less than 32% of all MPs.

2.5 Polymer composition of identified MPs:

FTIR analysis was used to determine MP composition of all samples, showing the FTIR spectrum of six categories: polyamide 6 (Nylon 6), alkyd resin, polypropylene, polyethylene terephthalate, rayon and polyethylene **(Fig. 7)**.

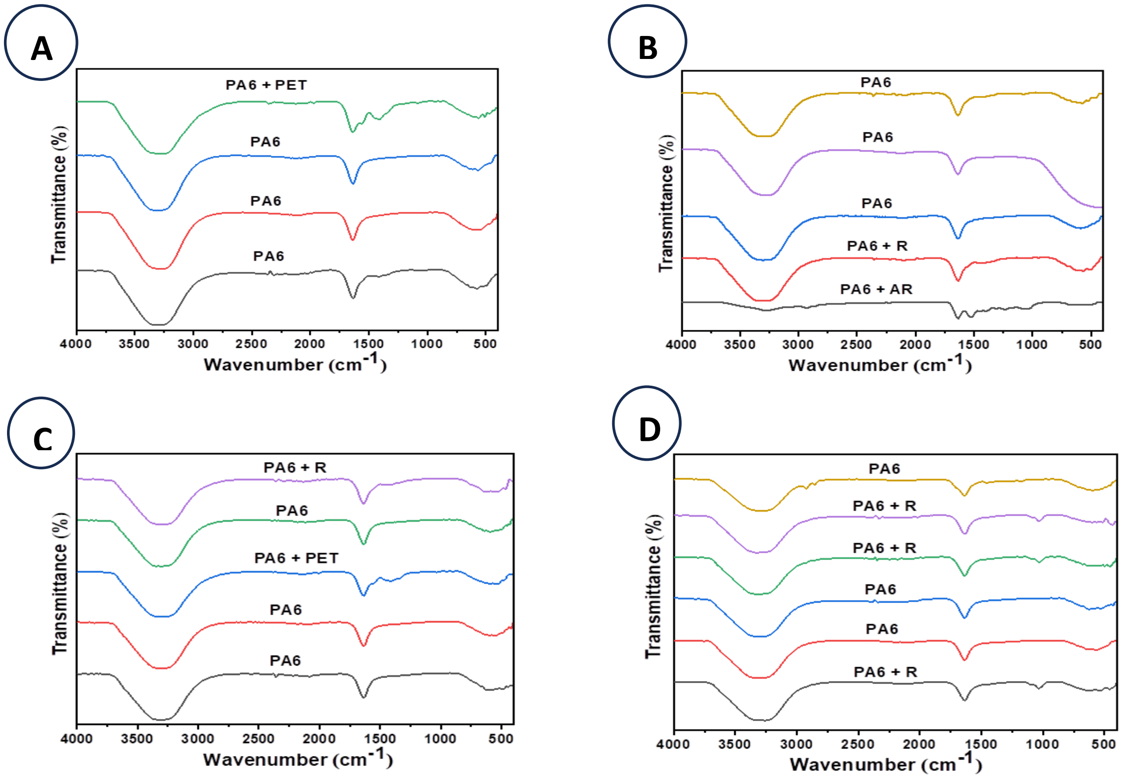

Fig. 7: Fourier transform infrared (FTIR) spectroscopic polymer type identification of MPs for selected No. of fishes collected in Winter: (A), *Clarias gariepinus*, (B), *Oreochromis niloticus*, and in Summer: (C), *Clarias gariepinus*, (D), *Oreochromis niloticus.* While PA6 = Polyamide 6 (Nylon 6), R = Rayon, AR = Alkyd resin, PET = Polyethylene terephthalate.

2.5.1 For *O. niloticus*:

The order of abundance of different microplastic composition in Winter was Polyamide (13.33%) > Rayon (8.33%) > Polypropylene and Polyethylene terephthalate (3.33%) > Alkyd resin (1.67%), while in Summer was Polyamide (48.28%) > Rayon (20.69%) > Polyethylene terephthalate (10.34%) > Polyethylene (6.90%) > Polypropylene and Alkyd resin (5.17%) as shown in **(Table 8)**.

Table 8: No. & percentage of fish containing different colors of MPs.

Fish name	season	Colors of MPs (No. & percentage of fish containing different colors of MPs)									
		Pink	**Blue**	**Red**	**Green**	**Brown**	**Black**	**Purple**	**Yellow**	**Grey**	**Transparent**
O. niloticus	Summer	11 (18.97%)	9 (15.52%)	11 (18.97%)	9 (15.52%)	6 (10.34%)	6 (10.34%)	1 (1.72%)	4 (6.9%)	4 (6.9%)	4 (6.9%)
C. gariepinus		6 (37.5%)	4 (25%)	3 (18.75%)	1 (6.25%)	3 (18.75%)	4 (25%)	-	1 (6.25%)	2 (12.5%)	1 (6.25%)
O. niloticus	Winter	6 (10%)	3 (5%)	4 (6.67%)	2 (3.33%)	3 (5%)	3 (5%)	1 (1.67%)	-	3 (5%)	1 (1.67%)
C. gariepinus		6 (37.5%)	5 (31.25%)	2 (12.5%)	1 (6.25%)	1 (6.25%)	3 (18.75%)	-	1 (6.25%)	1 (6.25%)	-

2.5.2 For *C. gariepinus*:

Polyamide (43.75%), Rayon and Polypropylene (18.75%), Polyethylene terephthalate and Polyethylene (12.5%) were detected in fish samples of winter, while Polyamide was the most dominant type of polymers (56.25%) in Summer, followed by rayon (18.75%) and Polyethylene terephthalate (6.25%) as shown in **(Table 9)**.

Table 9 : No. & percentage of fish containing different types of polymers.

Fish species	season	Polymer type (No. & percentage of fish containing different types of polymers)					
		Polyamide 6	**Alkyd resin**	**Poly propylene**	**Polyethylene terephthalate**	**Rayon**	**Polyethylene**
O. niloticus	Summer	28 (48.28%)	3 (5.17%)	3 (5.17%)	6 (10.34%)	12 (20.69%)	4 (6.90%)
C. gariepinus		9 (56.25%)	-	-	1 (6.25%)	3 (18.75%)	-
O. niloticus	winter	8 (13.33%)	1 (1.67%)	2 (3.33%)	2 (3.33%)	5 (8.33%)	-
C. gariepinus		7 (43.75%)	-	3 (18.75%)	2 (12.5%)	3 (18.75%)	2 (12.5%)

DISCUSSION

The UN made the 5th of June "World Environment Day" every year. In this year, 2023, the Theme was "Beat plastic pollution", with a message: Say no to plastics, with a hope to reduce their production by 80 % in the year 2040. That is a promise hard to achieve. According to the Earth.Org. every year plastics production is 242 million tons, difficult to degrade or recycle, this might amount to about 800 billion Dollars. Their danger on aquatic marine and freshwaters were enumerated **(McVeigh, 2023; Nava *et al.*, 2023)**.

As a trial to investigate the size of plastics pollution in a Nile Canal, which is expected to reach destination in the Mediterranean Sea, this work was carried out. The occurrence of plastics in fish varied with the species as well as with seasons. Their values did not exceed 10 particles per fish, while the percentage occurrence in fish was 33.9 for *O. niloticus* and 59.4 for *C. gariepinus*. This is in contrast to the reported occurrence in *O. niloticus* (75.9 %) **(Khan *et al.*, 2020)**. *B. bayad*, by the same author, is not comparable to *C. gariepinus*, since the latter is a benthic feeder while the first is not.

The tendency to include plastics in food increased with length significantly (r^2=0.84) in *O. niloticus* in summer, and in both seasons (r^2= 0.94 and 0.21) for *C. gariepinus*. This may be due to the feeding nature of either species or interference of reproductive activity of *O. niloticus*.

As a further analysis, Stomach Index variation with length **(Figs. 2 and 3)** showed how much the process of feeding is complex. Various factors gather to produce effects in feeding, e.g., water temperature, availability of food, and reproductive activities. That is why the coefficient of determination followed a polynomial for SI variation with length.

Another interference with food and feeding tendencies are shapes and colors of the objects in the aquatic environment. As shown in T**able 6 and Fig. 6**, different shapes included: fragments, fibers, films and pellets, as they occur respectively in either species in the two seasons. However, **(Khan *et al.,* 2020)** reported only fibers (65.3%) and films (25.6) as the highest occurrence in *O. niloticus*.

When color of the MPs is considered **(Table 7)**, pink, red, and blue acquire the highest occurrence in both species in the two seasons. According to (**Loew, 2018)** the fish retina has three color detectors and may be four. Those are red, green, blue and may be ultraviolet cones to detect objects in the surrounded habitat. Earlier**, Levin and MacNichols (1982)** indicated that depth or distance, and suspended matter interfere with identification and feeding on objects in the aquatic habitat.

The MPs identification showed a number of types **(Fig. 7)**. Those were: polyamide, alkyd resin, polypropylene, polyethylene terephthalate, rayon, and polyethylene. **(Khan *et al.,* 2020)** reported only three types: polyethylene, polyethylene terephthalate and polypropylene. In this work polyamide showed the highest occurrence in fish. Thus, in either species, polyamide occurrence was the highest followed by rayon **(Table 8)**.

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الملخص العربى

التلوث بالبلاستيك فى الأسماك *O. niloticus and C. gariepinus* في قناة نيلية، دلتا مصر.

السيد خلاف [1]، علاءالدين النعناعى [1]، محمد عثمان [2]، ورانيا صقر [1].

1، قسم علم الحيوان- كلية العلوم- جامعة المنوفيه
2. فسم الاحياء المائية- المركز القومى للبحوث

يمثل التلوث بالبلاستيك مشكلة عالمية، مما دعى الأمم المتحده في يوم البيئه العالمى في 2023 ان تجعل شعارها لنهزم البلاستيك. ويظن ان النيل يشكل احد مصادر التلوث بالبلاستيك ليصب في البحر المتوسط. في هذا السياق تم اجراء هذا العمل على 127 سمكة بلطى نيلى، و 32 سمكة قرموط. الأول لان تغذيته سطحيه والثانى تغذيته قاعيه. وقد تبين ان البلاستيك لم يتجاوز 10 قطع من هذا الملوث، ويتواجد في 33.9 % في البلطى، 59.4 % في القرموط. ونوقشت عمليات التغذية والغذاء في ضوء اشكال والوان البلاستيك وتغيراتها الموسميه مع اطوال الأسماك في النوعين المدروسين. واظهرت الدراسه ان الشظايا والالياف قى الميكروبلاسنيك، وكذلك ذوات اللون البمبى والاحمر والازرق هي الأكثر تواجدا في كلا النوعين المدروسين. وتم تعريف أنواع البوليمرات التي تشكل الميكرو بلاستيك فوجد انها: بولى امايد، الكايدرزنز، بولى اثيلين، بولى اثيلين ترايفثالات ثم الرايون. ووجد ان البولى امايدز والرايون هي الأكثر تواجدا في كلا النوعين من الأسماك.