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A study of Microplastic contamination in fishes of the river Godavari, Maharashtra (India)

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ABSTRACT
Plastic is used in a variety of applications ranging from a general-purpose application to essential components in industries, households, agriculture, commercial, etc. The increasing demand and production of plastic products are increasing the presence of plastic in the environment rapidly. The waste debris, including plastic wastes, pollutes the freshwater bodies too. This study was aimed to observe the presence of the microplastics in the gastrointestinal tracts (GIs) of the fishes in the river Godavari. Considering the sources of pollution, two sites, the upstream and the downstream, were selected in the river Godavari. The observations suggested that the microplastic contamination was present in the gastrointestinal tracts of the fishes at both the sites, but was comparatively higher in the downstream fishes. The microplastics were observed in the form of tiny plastic particles, pallets, beads, filaments, fibers, etc. Due to the bioaccumulation of microplastics they may reach to higher-order consumers through food chain and may adversely affect the freshwater fauna of the river Godavari. However, further studies are essential to check the plastic pollution and the presence of microplastics in fishes of the river Godavari. It is recommended to generate awareness about adverse impacts of plastic pollution.
Key Words: *Microplastics, Gastrointestinal Tract, Fish, Freshwater, River Godavari, Pollution.*

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INTRODUCTION

The production and consumption of plastic is exhibiting the increasing trends. In the modern world, it is widely used across sectors, including residential, industrial, commercial, agricultural, etc. Plastic is a durable product and eventually registers its presence in the environment for a more extended period. Plastics, in most cases, are thrown away after use in the natural habitats as a waste. Due to the use and throw policy and mismanagement of the waste, the plastics in the waste debris continue to contaminate the natural resources [1, 8, 9].

The freshwater environments are experiencing threat from the microplastics. They ultimately pollute the terrestrial and marine ecosystems as well. Possible sources include sewage or drainage runoffs from urban and rural areas, thickly populated residential and industrial sectors, Water Treatment Plants (WWTPs), unmanaged wastes, agricultural runoffs, etc. to the freshwater ecosystems [4, 6, 11]. These contaminants may include inorganic, organic, biological and toxic pollutants. The quality, hygiene, biota, the food web, etc., of the freshwater ecosystems are at stake due to the microplastic contamination.

In the recent past, few researchers had reported the presence of microplastics with high concentrations in various rivers [1, 10, 19]. Considering the literature paucity about microplastics in fishes of freshwater bodies of India, it was decided to study the microplastic contamination in fishes of the river Godavari. The river Godavari is one of the major rivers of Maharashtra, India. It originates from Nashik, Maharashtra, and has a significant religious preference and flows from various important cities and industrial towns. Its water sourced to multiple sectors like domestic, industrial, and agricultural fields etc.

It has been observed that, like other major rivers, the river Godavari, is also polluted. The rural, urban, industrial areas located in the vicinity, discharge their wastes into the river Godavari. The river Godavari possesses a variety of aquatic fauna across its spread and provides livelihood to the community by fishing [3, 12]. For this study two sites, Nandur Madhmeshwar Dam (upstream) and Kokamthan (downstream)

located just after the industrial town, Kopargaon, Maharashtra, were selected in the river Godavari. The upstream site, Nandur Madhmeshwar dam, is a prominent reservoir. The downstream site, Kokamthan, is situated just after the industrial town Kopargaon. The distance between these two locations covers a stretch of about 60 km. Considering the visual pollution in the Kopargaon town, into the river water, the site of Kokamthan was selected. The regular fishing activities were observed at both the sites.
The fishes are among the most liked foods that provide excellent nutritional value and livelihood to the local community. The fishes A) *Puntius sarana sarana*, B) *Channa gachua,* and C) *Heteropneustes fossilis*, are easily available, voracious feeders, hardy in nature and also provide excellent nutritional value. Therefore, it was decided to consider the above three fishes for the investigation of the presence of microplastic contamination in the gastrointestinal tracts. Further, the study may help to compare the presence and the concentration of microplastics in the fishes at the respective sites.

MATERIALS AND METHOD

The target fishes A) *Puntius sarana sarana,* B), *Channa gachua,* and C) *Heteropneustes fossilis*, were collected from the catch of the local fishermen at the two selected sites. Initially, the identification of fishes was done by the local name, and then they were identified up to the species level by standard keys [**18**]. The five samples of each of the three fish species were collected, keeping their length and weight almost equal. The fishermen sell these fishes in the local market and even cut the fishes while selling.
The weight and length of the fishes were recorded. The fisherman was requested to cut the fishes with tools rinsed in distilled water in a clean environment. The gastrointestinal (GI) tracts of each fish was obtained and preserved in beakers with 70% ethanol. Labeling was done indicating the site name; fish name, length, weight, etc., and covered with aluminum foil for transportation to the laboratory in an icebox at about -4^0 C, and further processed to observe the presence of microplastic contaminants in the GI tracts of the fishes.

QUANTIFICATION OF MICROPLASTICS IN FISH GASTROINTESTINAL TRACTS

With few modifications the popular method [**5, 17**], was opted for the quantification of microplastics (MPs) in the GIs of the fishes. The beakers containing samples of fish GIs were opened in the laboratory. The ethanol from the beakers were removed and brought to the room temperature. Then these glass beakers were heated on a hot plate at 60°C, for 15 minutes. After that, these samples in the beakers were placed in an incubator and shacked for 30 minutes at 300 rpm at around 25^{o}C [5, 9, 17]. The wet peroxide oxidation (WPO) was carried out on these dried samples by adding 30% H_2O_2 in increments of 5 mL. It was followed by the wet sieving process with 1 mm and 300 µm steel mesh. In these sieved samples, 20 mL of aqueous ferrous (II) sulfate was added. These beakers were then placed in a shaking incubator at around 300 rpm at 60°C for about 15 minutes. Further, these were dried in an oven at 60°C for about 24 to 48 hours. These samples were then vacuum filtered (Whatman Grade GF/C) after adding distilled water.
Each filtrate with the filter paper was placed on a Petri dish, and further dried in the oven for about one hour at 50°C. A dissecting microscope (10 – 40 x magnification) was used to examine the microplastics. The microplastics were separated and counted and were recorded for further analysis. Further, the microplastics were confirmed with a heated needle [14].

STATISTICAL ANALYSIS

The two-way ANOVA method was used to calculate the differences in microplastic concentrations in various species.

RESULTS AND DISCUSSION

The microplastics were observed in the GI tracts of all the tested fishes. The types of microplastics were different in these fishes. The microplastics in the targeted fishes, found in the GI tracts, were in the form of tiny particles, fibers, pallets, beads of different sizes and colours. Fishes from the upstream did not have any beads. They had only tiny particles, pallets, and fibers. It may be due to the sources of pollution at either site [10]. The results indicated the comparatively higher contamination of microplastics in the downstream fishes. The microplastics presence in the GI tracts of the fishes was as per the previous studies [14, 15].
The quantities and types of microplastics ingested by the fishes at upstream and the downstream differ. The upstream fishes had lower concentration of microplastics than the downstream fishes. It was found that the upstream fish A had an average proportion of 16.4% of microplastics in their GI tract. However, fish B had 20.2%, and fish C had 27% of average microplastics concentration in their GI tracts. However, the fishes from the downstream indicated a comparatively higher percentage of concentration of

microplastics. The average proportion of microplastics, in fish A, was about 23%; fish B had 26.8%, and fish C had 37.5% in their GIs tracts.

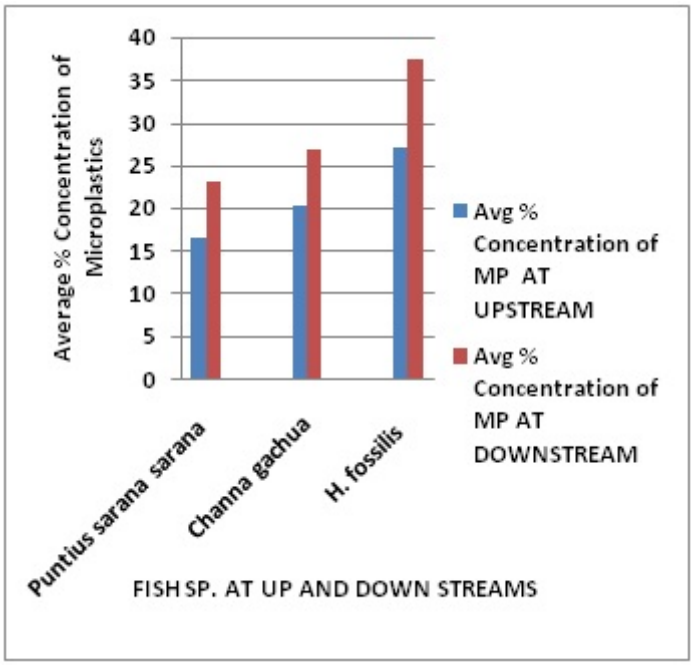

FIG. 1.0 Average % concentration in fish species at up and down streams

The quantitative differences of microplastics observed in fish GIs may be due to the polluting sources in the vicinity, the concentration of microplastics in the water body and exposure time of the pollutants, etc. The feeding habits of the targeted fishes might have also played a significant role in the findings. However, the presence of microplastics in freshwater fishes at different sites differs with the present investigation [13].

The examination of the GIs of the sample fishes included fibers or filaments, fragments, pellets, and beads, which may have come from various pollution sources near the respective sites [2, 7, 8**]**. The possible causes of filaments or fibers might be the fishing accessories, i.e., nylon nets, lines, cloths, etc. Other microplastics like geometric or irregular shaped particles, disk-shaped pellets, tiny beads, etc., may be from different plastic products, tools, etc. A close observation exhibited that the plastics were eroded, degraded, irregularly shaped plastic particles. It has been already documented that the microplastics were generated after degradation or fragmentation of macro plastics [2].

Previous few documents also showed the presence of microplastics in the GI tracts of freshwater fishes. The *Gudgeons* (Gobio gobio) fish exhibited to the tune of 12%, from French rivers [15], freshwater catfish species *Hoplosternum littorale,* showed accumulation of 83%, microplastics in South America [16]. But, it is difficult to assess the findings with other studies because of the sources of pollutants, geography, environmental conditions, feeding habits of the fishes, etc. But, the present research positively indicated the presence of microplastics in the GI tracts of the freshwater fishes. The bioaccumulation and magnification of microplastics may drag the freshwater fauna in dangerous situations and may reach to the higher-order consumers [5].

CONCLUSIONS

The results revealed that the microplastics were present in the GI tracts of the targeted fishes. The microplastic concentration was comparatively higher in the downstream fishes than the upstream. The observed differences may be due to the sources of pollution in the vicinity, concentration of these pollutants in the water body, feeding habits of fishes, etc.

The bioaccumulation and magnification of microplastics in fishes may lead to the ill metabolism and in turn degrade the fish flash quality for top consumers of the food chain. Further studies are required to observe the concentrations of the microplastics, particularly in the freshwater food fishes. Further, it is highly essential to check all the possible sources of pollution with priorities to prevent the entry of plastics in the freshwater bodies.

However, further studies are essentially to be conducted with more variables and parameters. It is also essential to generate awareness and provide appropriate solutions to restrict hazardous impacts of plastic pollution and their presence in the freshwater fishes.

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