

Microplastics As Contaminants In Water And Wastewater Streams Under Different Climate Condition

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Abstract

Industrial developments in recent years benefit the prosperity of human lives, whereas there are also their downsides. One of these downsides is the non-degradable pollutants that have started to exist and posing risks to the environment. Microplastics (MPs) being one of these pollutants, have become a worldwide environmental fear because of their global presence. Microplastics are delivered into the environment directly from daily uses of plastic substances, degradation of plastics, industries, and wastewater treatment plants. This study focused on the presence of the Microplastics in freshwater bodies and drain streams. During the study, the analytical methods was tested to ensure the quality of the research, and afterwards applied to study the presence of Microplastics in water and wastewater streams throughout different times of the year at variable locations along the streams to understand the seasonal effects, flow conditions, and ambient aquatic environment on the presence of the Microplastics. It was found that the presence of Microplastics can be affected by the climate conditions as one of the streams has shown a significant change in the results by the change in the season when the samples were collected.

Keywords Microplastics, Water quality, Water pollution, Water contamination, wastewater streams contamination

Introduction

Plastics play a huge role in our lives and our day-to-day activities it had a great impact on our lives. Its ability to be shaped and molded beside its light weight made it an adequate option for many industries, starting from microbeads in cosmetics [1], to the bodies of the modern aircrafts [2]. Many tools and items have been replaced by plastics recently to make life easier, or to avoid health problems, like plastic single use syringes instead of metallic syringes, and the plastic water distribution pipes instead of the asbestos pipes. In

Europe during the year 2020, the plastic industry employed around 1.5 million employees, working in around 52,000 companies, with turnover of 330 billion dollars, making it the 8th biggest industry in Europe. [3] The whole world has produced around 369 million tons of plastics in the year 2020. [3].

The main problem with plastics is that they have a high resistance to degradation. Which makes it a big concern when it comes to its impact on the environment. [4] Although the plastics are not easily degraded, still the large plastic parts can

break down to smaller particles sometimes can't be seen by naked eye, known as Microplastics, these particles resulting from the breakdown are widely known as Secondary Microplastics. [5] On the other hand there is a different type of Micro-plastics which is referred to as primary Microplastics. These particles were produced as microscopic size plastics, and they are usually used in cosmetics. [6]. It is widely used that by analyzing 7704 personal care products and cosmetics of the four biggest cosmetics producers in Europe. Micro-plastics were found in 90% of them. [7]

In the last decade Microplastics have started to appear in freshwater in researches conducted in different places, including but not limited to, Dutch river delta and Amsterdam canals [8] lake Winnipeg, Canada [9], Los Angeles river, United States of America [10], Taihu lake, China [11], Goiana river estuary, Brazil [12]. It has also appeared in samples taken from the effluent of 17 municipal wastewater treatment plants in the United States of America [13], and in 12 wastewater treatment plants in lower Saxony, Germany [14]. The presence of Microplastics was not limited to surface and wastewater effluents, it has also been detected in samples from 11 bottled water brands from 12 different countries, regardless the country [15] it was found in random bottled water samples in different studies [16] [15]. It was also present in tap water from groundwater sources [17] and surface water sources [18].

It's a complicated mission to track the sources of Microplastics in the environment [19]. Since there are not enough methods to do the tracking [20]. However, some studies focused their efforts on estimating the reasons of Microplastics occurrence, which gives an overview on understanding this phenomenon. Surface runoff of the roads is estimated to be one of the sources, as the paints used on the roads break down by time, and the tyres wear down as well [21]. Also

agriculture runoff is a source, especially when sludge fertilizers are used or when plastic tools are used [22]. Microbeads are also a huge source that releases Microplastics into the environment, each year around 3800 tonnes of Microplastics enter the environment through the use of care products and cosmetics in Europe only [23]. The use of Plastics in the water industry makes it one of the sources of Microplastics, some of the water distribution networks and transmission lines are made of different types of plastics, the same goes for some of the tools used in water treatment plants and it can release plastics through its degradation and corrosion [24] and the use of plastics bottles in bottled water as well [15] [16].

The impact of Microplastics on the environment is still being studied, although some studies have suggested that the invertebrates and fish living in freshwater that have ingested Microplastics have shown signs of tumor formation [25] [26]. Some plastics contain harmful materials like PCBs that are added to them during their manufacturing process. [27] PCBs are known to be carcinogenic and mutagenic [28]. One of the main concerns from the Microplastics in the freshwater is that biofilms were found in some of them [29]. This is extremely dangerous as it means they can transport pathogens [19]. When it comes to the effect of Microplastics on the human beings, there are no studies to confirm there is a health risk, which makes the presence of Microplastics in water not a huge health concern. [19]

With all these efforts made and studies available on Microplastics it still can be considered in a primary stage of research, as there are even no standard methods for sampling, analyzing or detection of Microplastics. The effect on human beings is also a critical matter that should be thoroughly studied. Some researchers should focus more on understanding the behavior of Microplastics in natural conditions in the environment, that should make understanding the occurrence of these pollutants easier, and give an

insight on how to prevent or remove them in the future.

Study area description

The area studied is an area that has both freshwater stream and drain stream close to each other, it also has agriculture, residential areas, and factories along the streams. It's in the Northeastern part of Egypt. (Figure 1) The fresh water was sampled from the Suez channel, one of the two branches that Ismailia channel is branched to. It flows around 90 km starting from Ismailia channel, down to the Suez gulf. The drain was sampled from El- Ganaien drain, which is an agricultural drain located in Suez governorate and is parallel to the Suez channel at the area of study. During the study, 3 points were sampled from on the channel, 3 points were sampled from on the drain.



Figure 1: Location of the study area in Egypt
By author. A photo taken from google earth.

This area was selected because it has many possible sources of Microplastics, and to have a better understanding of these sources, a quick scan for the area has been made, and the surroundings are as follows:

The points 1 water and 1 drain are in the middle of the study area, with the points 2 and 3 for both the channel and drain are around 5 km away from both sides upstream and downstream. (Figure 2) Point 1 water is surrounded by agricultural lands from one side, and desert plus highway from the other side, and point 1 drain is surrounded by agricultural and residential areas. Point 2 is surrounded by agricultural areas for both the water and drain streams. Point 3 water is surrounded by residential areas on both sides, while point 3 drain is surrounded by residential areas and agricultural areas. In the area of study, between the mentioned points, there is a chocolate factory, water treatment plant, and electricity power plant. Also both the channel and drain are parallel to the Suez Canal in this zone, with perpendicular distance between 1 to km for the Suez channel, and 0.3 to 2.5 km for El-Ganaien drain.



Figure 2: Location of the points along the streams
By author. A photo taken from google earth.

Experimental

The samples were collected in 3 batches during 3 different times of the year. The first batch was taken from the point #1 in both the water and drain streams. It was collected during May, when the weather is average between 25 to 30 degrees celsius. The second batch was from point number 1 in both the water and drain streams. It was collected during June, when the weather is average between 30 to 35 degrees celsius. The third batch was taken from the three points 1,2, and 3 from both the water and the drain streams. It was collected during August, when the weather is average between 35 to 40 degrees celsius.

Samples were taken using glass bottles that were covered by metallic covers and were kept away from exposure to any plastics materials. The samples were kept away from the sun and kept at room temperature until it was analyzed. Analysis took place in the central lab of AinShams University, using the method introduced by [30]

through FTIR spectrophotometer analysis using ATR imaging mode.

The results were compared to the results of a research that made spectra for the 8 most common plastics [30], after checking the results and finding out which kind of plastics is present, it was compared to the spectrum from a different research that focused on the analysis of the detected plastic.

Results and Discussion

By analyzing the samples, the following was found. In the samples from the first batch, the results were compared to the decision method introduced by the first reference research [30], the results showed a potential presence of polystyrene. The results were then compared to other research focused on the polystyrene [31], and the results showed significant similarity. (Figures 3, and 4) Which is an indication of the presence of polystyrene.

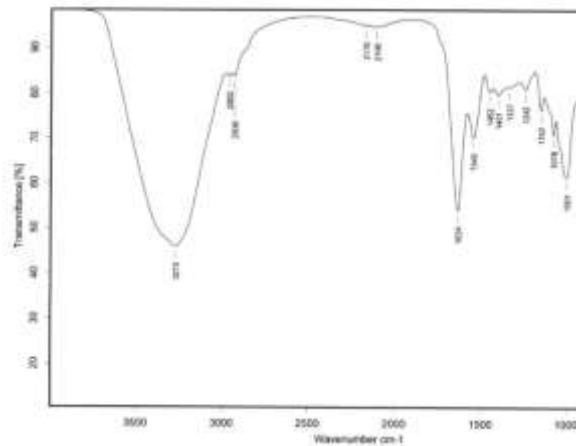


Figure 3: The results from the samples

By author. Analysis made by central lab of Ainshams University
 Umamaheswari, et al, 2016) . [31]

As shown in the figures (Figures 3, and 4), the peaks from the analysis made on the samples are almost similar to the peaks that were introduced as polystyrene in the reference research. [31] Which means that the material that was analyzed in the sample is polystyrene.

In the samples from the second batch, the results showed almost the same peaks as the first batch, they were compared to the decision method introduced by the first reference research [30] ,

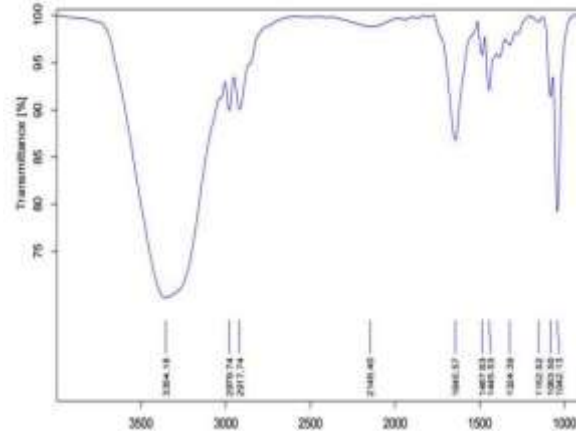


Figure 4: The results from the research

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then the results were compared to other research focused on polystyrene [31] , and the results showed the presence of polystyrene.

In the samples from the third batch, the results from the drain showed almost the same results, which is interpreted as polystyrene. On the other hand, the 3 samples from the water channel didn't show almost any peaks. Which means there were no plastics in them. (Figure 5)

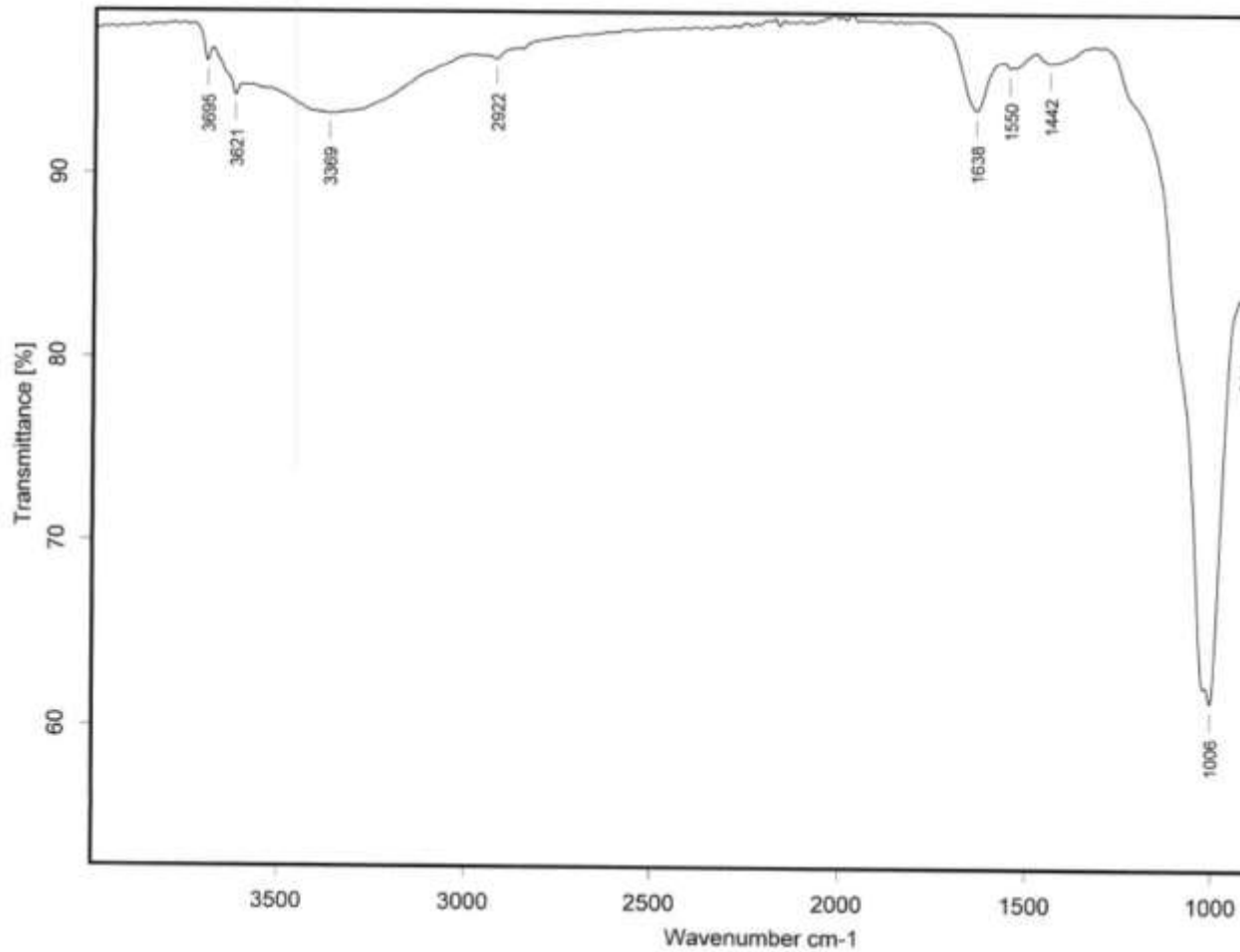


Figure 5: The results from the freshwater stream during August
By author. Analysis made by central lab of Ainsams university

As shown in (Figure 5), and unlike the results in (figure 3), these samples' results showed almost no peaks. Which means that there are no Microplastics in them.

Conclusion

The Results show that microplastics were found in the drain stream during different times of the year while it wasn't found in the freshwater stream when it was extremely hot, which means that the high temperature has reduced the Microplastics in the stream. Also it is noticed that the presence of the Microplastics in the freshwater stream was affected by the climate

change but not the drain stream, this has probably happened because the concentration of the Microplastics in the freshwater stream was small and/or the source was limited, while in the drain it was not affected because unlike the freshwater, the drain had more concentration and/or a more consistent source of Microplastics.

It is clear that there are Microplastics in both the freshwater and the drain streams, at least at some times of the year, and the presence of these Microplastics has been affected in the freshwater stream by the change in the climate conditions.

The presence of the Microplastics in both the Drain and the channel has probably happened

because of some plastics littering along the streams such as plastics cups, plates, and utensils, also it could have happened because of the presence of some factories close to stream that may have illegally thrown their plastics waste on the drain. Also, the surface runoff from the agricultural lands along the streams should be one of the main sources of the Microplastics. But still further studies on the presence of Microplastic should be conducted in Egypt in the water and wastewater systems. It is obvious that climate change influenced the presence of the microplastics in the freshwater stream, but more research should be made using more advanced tools and taking into consideration the concentration of the Microplastics, to understand better what exactly happens to the Microplastics in the streams.

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