Face Masks: New Source of Microplastic Release in the Environment

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Abstract COVID-19 has resulted in the increased use of personal protective equipment (PPEs) all around the globe. These face masks are made from polypropylene and polyurethane material. Now these face masks are becoming the new emerging source of microplastic pollution in the ecosystem. In this study, we have analyzed the release of microplastic particles from different face masks in the aqua medium over a span of time. It has been observed that the surgical face mask releases (3659 particles/ piece) the highest amount of microplastics in the water as compared to other face masks (2300 particles/ piece by KN95, 2908 particles/ piece by branded cloth mask, 3332 particles/ piece by N95) which clearly indicates that it has the highest degradation rate.

Keywords Face mask · COVID-19 · Microplastic · Environmental pollution

1 Introduction

Since the start of the COVID-19 (SARS-CoV-2) pandemic, generation of plastic medical waste has increased upto 410%, which also includes the generated waste due to the rise in demand of packaging plastic [1]. Since the WHO has entrusted that the use of facemasks and maintaining hand hygiene is one of the most effective non-pharmaceutical measures [2] for reducing the contamination of COVID-19, Continuous use of facemasks is expected in the coming days even after the implementation of effective vaccination programs. It has been observed that these used facemasks are not disposed with proper bioremediation, and are being disposed in public places along with municipal waste and in open spaces. This has resulted in the release of plastic particles in soil subgrades and freshwater environment, and finally, to the

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marine environment. It has been recently observed by Torre and Aragaw [3, 4]that these disposable facemasks are made of polypropylene and the same was confirmed by their Fourier transformation spectrometric analysis. They also suggested that due to the mechanical stress from freshwater and marine environment, these plastic polypropylene particles are being released in the ecosystem. Tareq and coworkers [5] stated that the solution to solid waste associated with single use disposable mask is 3D-printing. Since the 3D printed facemasks are made from thermoplastic polymers which are recyclable. However, these 3D printed facemasks might still pose a threat to the environment after continuous recycling and improper disposal, which will eventually lead to solid waste generation releasing the microplastic into the ecosystem. Microplastic fibers and particles can easily infiltrate into our food chains from any point of contact and may accommodate the development of microorganisms on their surface area [6–8]. Therefore, it is high time to quantify the release of microplastics from disposable face masks and its associated risks so that the relevant authorities may initiate a counterplan to avert any possible disaster before it is too late to respond. In this regard, Saliu and coworkers [9] stated that there is a significant effect of weathering on disposable face masks which is resulting in the release of microplastics in the marine environment. They reported that there is a significant amount of fiber released in saline water (around 135,000 particles). In this study, they processed surgical facemasks by inducing artificial weathering. However, they did not study the variation in the release of quantum of particles due to different types of face masks which also includes the different filtering standards.

In this study, four types of disposable masks are taken, which are N95 masks with five layers, KN95 masks with five layers, surgical masks with three layers and branded Cloth masks with three layers. We have quantified the release of MPs from every one of them with reference to time. In this study, the masks are left undisturbed in the water with no other external forces upon them.

2 Materials and Methods

All the masks (N95, KN95, Surgical and Branded Cloth of a single type of manufacturer) were purchased from the local market in the Bhopal city of India. It was made sure that all the masks purchased were of implementing standards for face masks in India. All the masks were fresh and unbroken.

All the types of masks were processed with the conditions as per Table 1 to quantify the release of microplastics from these masks if left in isolated water bodies like lakes, ponds etc. For every condition, the masks were put in 300 ML of tap water in a conical flask and the same were sealed with paraffin foil. After the required duration the masks were removed from the water and the supernatant was vacuum filtered on a 0.50 µm cellulose filter membrane. After the vacuum filtration, the filter membrane was kept in a petri dish and sealed with paraffin foil for further analysis.

Table 1 Different conditions for MPs release

S. no	Water type	Mask type	Duration (in days)	Nomenclature
1	Tap water	Branded cloth	1	B_{1DR}
			7	B_{7DR}
			30	B_{30DR}
			90	B_{90DR}
			180	B_{180DR}
2	Tap water	KN95	1	KN_{1DR}
			7	KN_{7DR}
			30	KN_{30DR}
			90	KN_{90DR2}
			180	KN_{180DR}
3	Tap water	N-95	1	N_{1TR}
			7	N_{7TR}
			30	N_{30TR}
			90	S_{90DR}
			180	S_{180DR}
4	Tap water	Surgical	1	S_{1TR}
			7	S_{7TR}
			30	S_{30TR}
			90	S_{90DR}
			180	S_{180DR}

3 Visual Counting and Qualification of Microplastic

The substrate on the filter paper was analyzed using a metallurgical microscope and images were captured by a 3 Megapixel camera accessory equipped with this metallurgical microscope. Microplastics were examined under the microscope based on their texture, shape and size. A hot needle test technique was carried out for differentiating microplastic and any other organic matter [10] and for the confirmation of the presence of microplastics in the sample.

4 Quality Control and Quality Assurance

All the equipments were prewashed using DI water for avoiding any type of contamination and after prewashing these equipments were kept in a desiccator with the covering of the parafil foil. Cotton masks and laboratory coats were used for avoiding the use of any type of plastic accessories. Proper sanitization process was used for avoiding any type of cross contamination of the sample. One blank sampling was done to avoid any statistical error.

5 Results and Discussions

Microplastics particles have been observed in all types of samples regardless of the type of masks and different conditions. Figures 1, 2 show the microscopic images of the microplastic released from the different face masks.

The average amount of microplasticfibre released from the branded cloth masks varied from 831 particles/piece in one day to 2907 particles/piece in 180 days, from the surgical masks varied from 1471 particles/piece in one day to 3659 particles/piece in 180 days, N95 masks varied from 1010 particles/piece in one day to 3331 particles/piece in 180 days, KN95 masks varied from 739 particles/piece in one day to 2300 particles/piece in 180 days. Highest amount of microplastic particles release was observed from the surgical face masks followed by branded cloth face mask,

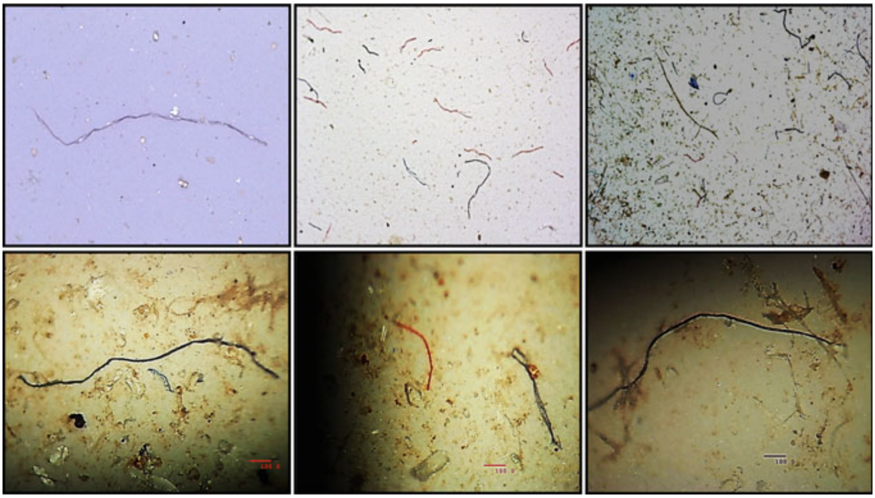

Fig. 1 Microscopic images of MPs fiber released from Branded cloth mask (Upper images) and surgical mask (Lower Images)

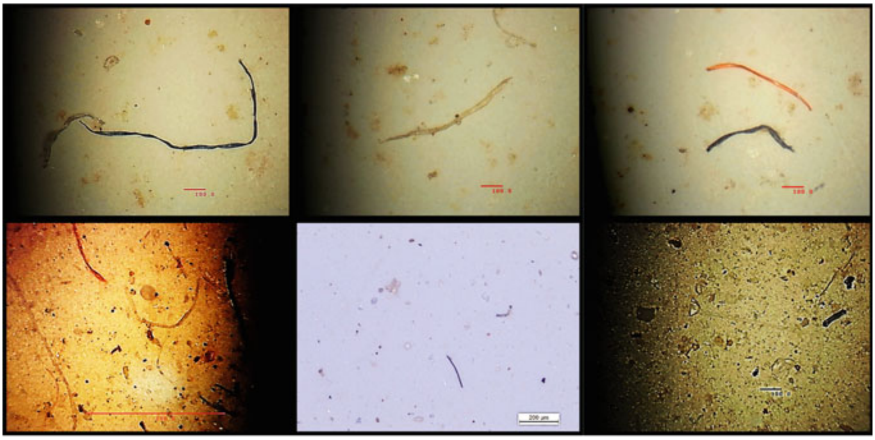

Fig. 2 Microscopic images of MPs fibre released from N95 mask (Upper images), KN95 mask (Lower Images)

N95 masks and least amount was released from KN95 mask. Figures 3, 4 shows the line diagram and bar chart for the microplastic particle abundance over the period of time which clearly indicate that surgical masks releases the highest amount of microplastics.

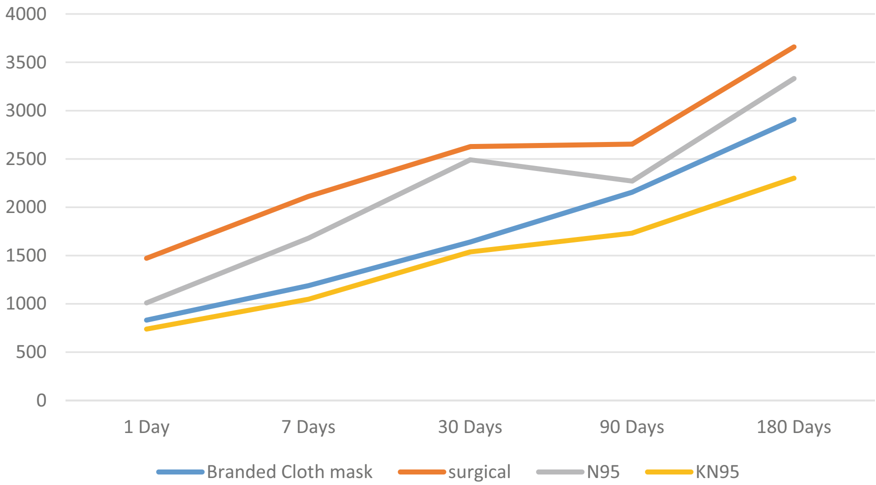

Fig. 3 Microplastic Particle abundance over the period of time (Line diagram)

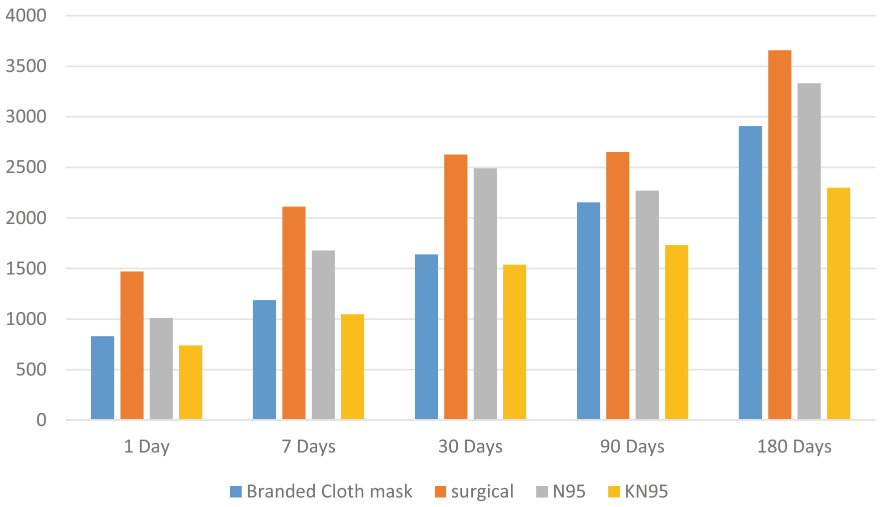

Fig. 4 Microplastic Particle abundance over the period of time (Bar Chart)

6 Conclusions

This study clearly indicates that the face masks have now become the prominent source of microplastic release in the environment be it water air or soil. From this study it can be concluded that:

- Face masks are the emerging source of microplastic release in the environment.
- Surgical masks release highest quantum of microplasticfibre as compared to the other face masks when left undisturbed in the environment for a long period of time.
- There is a need to implement a stringent policy for proper disposal of these face masks after their use to reduce the release of microplastic in the environment.

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