Development of Microplastic Sampling and Pretreatment Device by M-Raman Spectroscopy and Distribution Characteristics of Microplastics in Fresh Water

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Abstract

Microplastics (MPs) were founded not only ocean, but also in various media such as tap water, fresh water, air, soil, and sediment where plastics can exist. Although the direct harmfulness to the human body has not been clearly clarified, it has been clarified that nano-sized plastics can cause toxicity. Recently, studies have shown that under 3 μm substances have cell permeability, global interest possibility of the toxicity by small MPs is growing. While studies on MPs larger than 100 μm is being actively conducted, studies on microplastics smaller than 50 μm was insufficient which is more harmful to the human body.

Although an accurate analysis should be performed to characterize MPs in the environment, an appropriate method for selectively extracting small-sized MPs has not been established. Therefore, to identify distribution of MPs, established sampling, pretreatment, and analysis methods are needed. Furthermore, since there are various types and different densities of plastics, the MPs can be distributed in various locations depending on the depth in the water system. In order to specify the distribution of new pollutant which is MPs according to the depth in water system, sampling device minimized cross-contamination, pretreatment and accurately analysis method for classify shape, size, and type of MPs are required.

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In this study, our groups made sampling device that could both apply to small size MPs sampling and size separation. Sampling was based on physical filtration through a stainless filter. Wet peroxide oxidation process and density separation were performed to separate microplastics after collecting all particles. The device was made of aluminum alloy and the filter was fabricated with 1 to 45 µm pores by woven stainless filter. The recovery rate of the sampling device was over 93.84±2.88%, and the cross-contamination rate was also very low.

Using this device, we sampled major water supply sources such as river and lake in Republic of Korea by depth. A µ-Raman spectrometer capable of analyzing the shape, size, and type of MPs with a size of 20 µm or less was used to confirm the distribution of MPs of various densities present according to the water depth. As a result, it was confirmed that the distribution type of MPs in the upper, middle, and lower depths was different. Especially, some high-density plastics such as PET and PVC were not detected in surface samples. These results indicate that small size of MPs, which has toxic possibility to human, have different distribution characteristics depending on the depth of water supply sources, so the results will be an important basic data for treatment and regulation.

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