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Analytical Methods for Extraction of Microplastics from Compost in Sri Lanka

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Abstract

Microplastics (MP) are the plastics with 1 µm-5 mm dimensions. Meanwhile, compost has been identified as a major source of MP in the soil, although compost is a great plant nutrient source, and it provides tremendous benefits for crops. This is primarily ascribed to most of the compost being produced through Municipal Solid Waste Management projects. However, due to the detrimental impacts on soil's biological, physical, and chemical health, together with the high accumulation probability of MP caused by repeated application of compost, regulations should be implemented on the limitation of MP in compost. Even though there are a few different methods available in the literature for MP extraction and quantification in organic matter (OM)-rich matrices, like compost, sludge, and sediments, a properly validated, routine analytical procedure is missing in Sri Lanka Standards (SLS). Therefore, in this project, the effectiveness of four different MP extraction methods in the literature were compared and validated for compost, to implement an MP analysis method suitable for compost specifications in the SLS. The methodologies included MP extraction by density separation using NaCl or $ZnCl_2$ solutions followed by digestion of OM using 30% KOH: NaOCl solution or Fenton's reagent. The common MP analysis method for the four protocols was staining with the hydrophobic, fluorescent stain Nile Red, and visual observation. Digestion efficiency of OM and spike recovery of Polystyrene (PS), Polyvinyl Chloride (PVC), Polyethylene terephthalate (PET), High-Density Polyethylene (HDPE), and Polypropylene (PP) microplastics in 1-2 mm dimension by the four MP extraction methods were compared for the validation. T-tests (confidence level=95%) were carried out to determine the significant difference between the OM digestion efficiency in each of the four methods. Each of the combinations compared was significantly different from the other except for $ZnCl_2$/Fenton and NaCl/30% KOH:NaOCl comparison. Meanwhile, the OM removal by $ZnCl_2$/Fenton and NaCl/30% KOH:NaOCl excluding the density separation step also was not significantly different. The spike recovery analysis showed $ZnCl_2$/Fenton combination as the best out of the tested combinations with above 95% recovery percentages for PS, PVC, PP and 100 for HDPE and PET by particle count. However, precipitate formations in the $ZnCl_2$/Fenton combination might cause false negative or positive results for spike recovery when applied to the real samples with smaller MP. The extraction reagents, NaCl was not an ideal solution and $ZnCl_2$ was a good solution for the MP types used. Moreover, in this project, double digestion of OM with NaCl/30% KOH:NaOCl before and after the density separation with $ZnCl_2$ is suggested as a novel and more effective OM digestion protocol before Nile Red staining, and further validations are suggested prior to its final implementation.

Keywords: Microplastics, Compost, Extraction, Organic matter