INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	**Naveenkumar Ashok Yaranal**
Roll Number	:	**176107022**
Programme of Study	:	**Ph.D.**
Thesis Title:		**Identification, Quantification and Removal of Microplastics from Various Sources**
Name of Thesis Supervisor(s)	:	**Prof. Kaustubha Mohanty** **Prof. Senthilmurughan S**
Thesis Submitted to the Department/ Center	:	**YES**
Date of completion of Thesis Viva-Voce Exam	:	**28/11/2023**
Key words for description of Thesis Work	:	**Microplastics, Freshwater, Seawater, Beach sediment, Laundry effluent, Membrane technology, and Electrocoagulation**

SHORT ABSTRACT

Microplastics in the environment pose a significant threat to the entire ecosystem. The frequent utility of plastic in daily life, inadequate disposal, and improper waste management leads to a wide distribution of microplastic in atmospheric, terrestrial, and aquatic environments. Household, industrial, tyre wear and tear, construction, incineration, plastic litter, landfill, and agricultural activities are the major sources of microplastics in the environment. Microplastics are associated with various monomers and plastic additives. On the other hand, it becomes the carrier of toxic and hazardous chemicals from the surrounding environment. Microplastics enter the human body through the air, food, and drinking water (tap and bottled water). Taking all these issues into consideration, the main objectives of this work are divided into four sections. The first section deals with microplastics in Brahmaputra River water, tap water, and household

purified water. The second section deals with the identification of microplastics in sea water and beach sediments. The third section deals with the identification of microplastics in Indian edible salts and the removal of microplastics to produce microplastic-free salt. The fourth section deals with the quantification of microplastics and removal from the laundry outlets using the electrocoagulation method.

Firstly, the work is focused on determining abundance, chemical composition, and selective elemental composition to assess the toxic potential of microplastics in Brahmaputra River water, tap water, and household purified water in the Guwahati city of Assam, India. Approximately 0.30 ± 0.08 to 2.56 ± 0.13 and 0.20 ± 0.03 to 0.52 ± 0.09 microplastic particles/L were determined in the river and tap water, respectively. There were no significant differences in microplastic concentration based on the water supply system (tap water) or season. Approximately 55 - 60 % of all microplastics observed in river water were smaller than 1 mm in size, and with increasing size, the percentage contribution of various microplastic ranges reduced. Most of the microplastics found in the river water were fibers (58 %), colorless (49 %), polyethylene (30 %), polyester (20 %), and polypropylene (13 %). The tap water had 56 % fibers, 53 % colorless, and 31 % polyethylene, followed by 15 % polypropylene and 15 % pigmented polymer. An attempt was made to remove microplastics from tap water using hollow fiber ultrafiltration (HF-UF) membrane. The result showed that ultrafiltration was 100 % effective at eliminating microplastics (≥ 20 μm) from tap water.

The occurrence and distribution of microplastics in the marine water and beach sediments are collected from Karnataka state. The results revealed that marine water and sediments from Indian beaches has been polluted with microplastics. The total mean microplastic abundance in sea water from all considered locations is 8.2 ± 3 m^3. The highest microplastic concentration in

beach sediments was found in Malpe beach (1002 ± 174 MP kg^{-1}), followed by Panambur beach (931 ± 156 MP kg^{-1}), which can be connected with a population, tourists, and industry around the shores. Based on morphology, the occurrence of fragment-shaped microplastics was dominant, followed by fibres. Polyethylene, polypropylene, and polystyrene microplastics were abundantly observed in all selected locations. The effects of long-term exposure to microplastics in the environment were visualized from FESEM images which showed the cracking and roughness on the surface of plastic particles. According to present study, microplastic concentration in the beach sediment is connected with the population, tourists, and industry around the shores.

Further, the work focuses on the presence of microplastics in edible salts, creating a potential health hazard for humans. The occurrence of microplastics in edible salts and their extraction procedure is limited. A facile and cost-effective protocol for the extraction and separation of microplastics from the edible salt sample was developed. The visual assessment was performed to identify the shape, size, number, and colour of microplastic particles using light and fluorescence microscopy. The composition of the sample was analyzed by micro-Raman spectroscopy. A wide range of microplastics was found: 1400 ~ 1900 particles/kg in refined sea salt, 1900 ~ 2300 particles in unrefined sea salts, and 200 ~ 400 particles in rock salts. A relatively high number of microplastics were found in sea salts rather than rock salts. Sheet-type microplastics with size 1 ~ 4 μm were observed in rock salts. The most common microplastics were polyethylene, polypropylene, polyethylene terephthalate, nylon, and polystyrene. Additionally, microplastics were effectively removed from synthetic seawater with the help of a microfiltration membrane, which has the capability of arresting the transfer of microplastic particles into edible salts.

The last study focused on releasing and removing contaminants from laundry wastewater, particularly microplastics, and surfactants. The electrocoagulation method was used to remove the pollutants from laundry wastewater. According to the results, a reference load of 2 kg of synthetic materials releases 92,700 to 1,14,300 synthetic microfibers. The removal efficiency of microfibers, surfactants, and COD is higher at neutral pH. The percentage removal efficiency of microfibers, surfactants, and COD was 97.9 %, 91.2 %, and 86.3 %, respectively, at an operating time of 25 min, with a current density of 300 A/m^2 with optimum power consumption. The total operation cost of laundry wastewater treatment by electrocoagulation was 0.53 US $ $/m^3$ or 44.12 INR/m^3.