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Sources, Distribution, and Characteristics of Micro plastics in Millet's

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***Abstract*--Micro plastics (MPs) have been reported globally in ecosystems such as beaches, oceans, and marine and freshwater environments and now food grains especially in millets.**

MPs varied from 0.8 to 5.9 MPs/L in millet samples and 0.05 ± 0.00 to 0.25 ± 0.07 MPs/L in various millets samples. The abundance of MPs observed in the hotspot area is 15 MPs/L. Fibers are the prevalent shapes of MPs observed in millets samples. Small- sized MPs (<1mm) were higher in millets samples. A variety of colors were observed in these millets samples in the following order, viz., blue>red>black>white >green>yellow, in the millet sample, viz., blue> black> red> green> white > yellow. FTIR spectroscopy was used for the polymer identification of MPs. Polypropylene (PP) is an abundant polymer in millets, polycyclohexylenedimethylene terephthalate is found in millets samples, and high-density polyethylene (HDPE) is found in foxtail millet samples. High concentrations of MPs are also found in the foxtail millets.

I. Introduction

Sometimes, people come across new materials that go beyond conventional materials. Plastic, known as "a material with 1,000 uses," is a substance that has undergone revolutionary change. Because of its many uses throughout human history, including lightweight, excellent durability, flexibility, and low cost of production, plastic has found widespread use **(Pilapitiya & Ratnayake, 2024).** Plastic makes up much of the world's anthropogenic waste mass (54%). However, much of it is wasted annually because most plastic products are made to be used once **(Rodrigues et al., 2019)**. Over time, the amount of plastic produced worldwide has increased, reaching 400.3 million tonnes in 2022 **(PlasticsEurope,2023).** Environmental pollution from plastic waste is primarily caused by large-scale production,low levels of recycling and reuse, and a lack of sustainable policies that support the circular economy of plastics **(Hermabessiere et al., 2017).**

Furthermore, this persistence enhancestheir temporal and geographical dispersion throughout ecosystems, having abiotic as well as physiological and biochemical effects on various organisms.

II. Microplastics

Microplastics (MPs) refer to plastic particles, fibers, and films with a particle size less than 5 mm, mainly from plastic film covering, followed by sludge utilization, organic fertilizer application, wastewater irrigation, and atmospheric deposition [1]. Low-density polyethylene (LDPE) is extensively utilized as a plastic film in farmland due to its cost-effectiveness, ease of processing, and high durability. It represents the most common type of MPs found in soil [2,3]. However, LDPE's remarkable chemical stability, resulting from its high molecular weight and hydrophobic nature, contributes to severe ecological issues due to its non-biodegradability [4].

Therefore, this study was designed to investigate the effects of micro plastics in 4 types of millets(1) properties, and contaminated with LDPE-MPs. Specifically, the objectives were: (i) to examine the impact of LDPE-MPs on millet properties (ii) to analyze the influence of LDPE-MPs on millets diversity, structure, composition, function, co-occurrence network.

Consequences of microplasticson human health and theenvironment

Microplastics' physicochemical characteristics have a significant impact on human health. For example, microfibers and smaller size MP pose a greater risk to human health **(Ebrahimi et al., 2022).** Three major health risks associated with MPs include: (1) Exposure to toxic chemical components, including both organic and inorganic constituents and additives, and the potential for leaching; (2) MPs acting as carriers for harmful external substances, either chemically or biologically; and (3) Direct physical harm resulting from plastic debris, such as organ blockages caused by ingested particles.

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The dosage, size, polymer type, shape, surface chemistry, and hydrophobicity of MPs can all affect their physical and chemical toxicities, which in turn can affect their bioavailability **(Bouwmeester et al., 2015; Hollman & Peters, 2015).** The process of making plastics can involve the inclusion of various other substances **(Hahladakis et al., 2018).** Medical research has shown a strong correlation between persistent organic pollutants (POPs) and different human and wildlife ailments, including cancers and tumors, neurological impairments and abnormalities, reproductive issues, and other diseases **(Azoulay et al., 2019).** A common phthalate used to soften PVC, diethylhexyl phthalate (DEHP), is carcinogenic and can make up as much as 50% of the weight of the plastic **(Cole et al., 2011).**

Another significant threat to human health is MPs, which act as a vector of contaminants. MPs have the capacity to serve as carriers for biological agents and harmful substances, either through adsorption, absorption, or both, presenting an added risk to human health. They can accumulate both organic and inorganic pollutants from their surroundings and subsequently release them into other ecosystems, posing considerable threats to human.

III. Objectives

The objectives of the present study are:

- To demonstrate the abundance and distribution of MP in the millets
- To study the structural characteristics and polymer identification of MPs in millets
- To investigate MPs'sources and distribution.
- To assess the litter composition of the Millets.

IV. Materials And Methods

Analysis of microplastics in millets

Millets collection

Millet samples were collected from different sites which is stored in plastic bags. Four millet samples were collected. The millet samples were collected using plastic bags contamination from MPs. At each time, the collected millet sample was sieved using 20µm sieves. The resulting filtrate was then transferred to glass bottles, properly labeled, and transported to the laboratory. These filtered samples were stored in the laboratory refrigerator until further analysis.

Analysis of microplastics from collected millets

In the laboratory, collected millet samples were transferred to glass beakers and 10 mL of 30% Hydrogen Peroxide (H2O2) at 60°C for 72 hours for the breakdown of organic substances. After complete digestion of organic particles, 100 mL of saline solution (120 g/L NaCl) was added to the samples stirred well and left undisturbed for 1 hour for density separation. The treated samples were filtered a polycarbonate membrane filters (1µm pore size and 47 mm diameter). The filtered membranes were subsequently gathered in pre-rinsed, sealed petridishes and air-dried for 24 hours to facilitate qualitative and quantitative analysis (Robin et al., 2020).

The collected samples were air dried and the sediment clumps were gently broken with with mortar to pestle. About 20g of sediment was measured and about 10 mL of 30% H2O2 was added to minimize interference from organic impurities. This was succeeded by wet-sieving with a 20 µm mesh size sieve to isolate sediment and plastic particles. The sieved contents was carefully transferred to glass beakers and covered with aluminum foil .About 100mL of filtered millet sample (0.45µmporesizeWhatman glassfiber;47mm diameter) was added and stirred for10minutes to segregate MPsbased on density flotation. Finally, the filter membranes were collected in pre-rinsed, sealed petridishes using cleaned steel forceps and air-dried for 24 hours for further qualitative and quantitative analysis (Strady et al., 2021).

Micro plastic identification using FTIR

To know the chemical composition of the plastic-like particles analysis using a PerkinElmer Frontier™ Fourier Transform Infrared Spectrometer (FTIR) equipped with Attenuated Total Reflectance (ATR). Each sample underwent 16 scans at a resolution of 4 cm^{-1} across a wavelength range of 4000 to 450cm^{-1}.Beforeanalyzingeachsample, a background scan was conducted, and the ATR-diamond crystal was cleaned with isopropanol. The chemical composition of polymer particles within the samples was determined by comparing their spectra to reference spectra from the synthetic polymer ATR library (with a correlation coefficient of $r \geq 0.70$). Special precautions were taken during sample handling and processing in the laboratory to prevent airborne contamination **(Karthik et al., 2018; Robin et al., 2020).**

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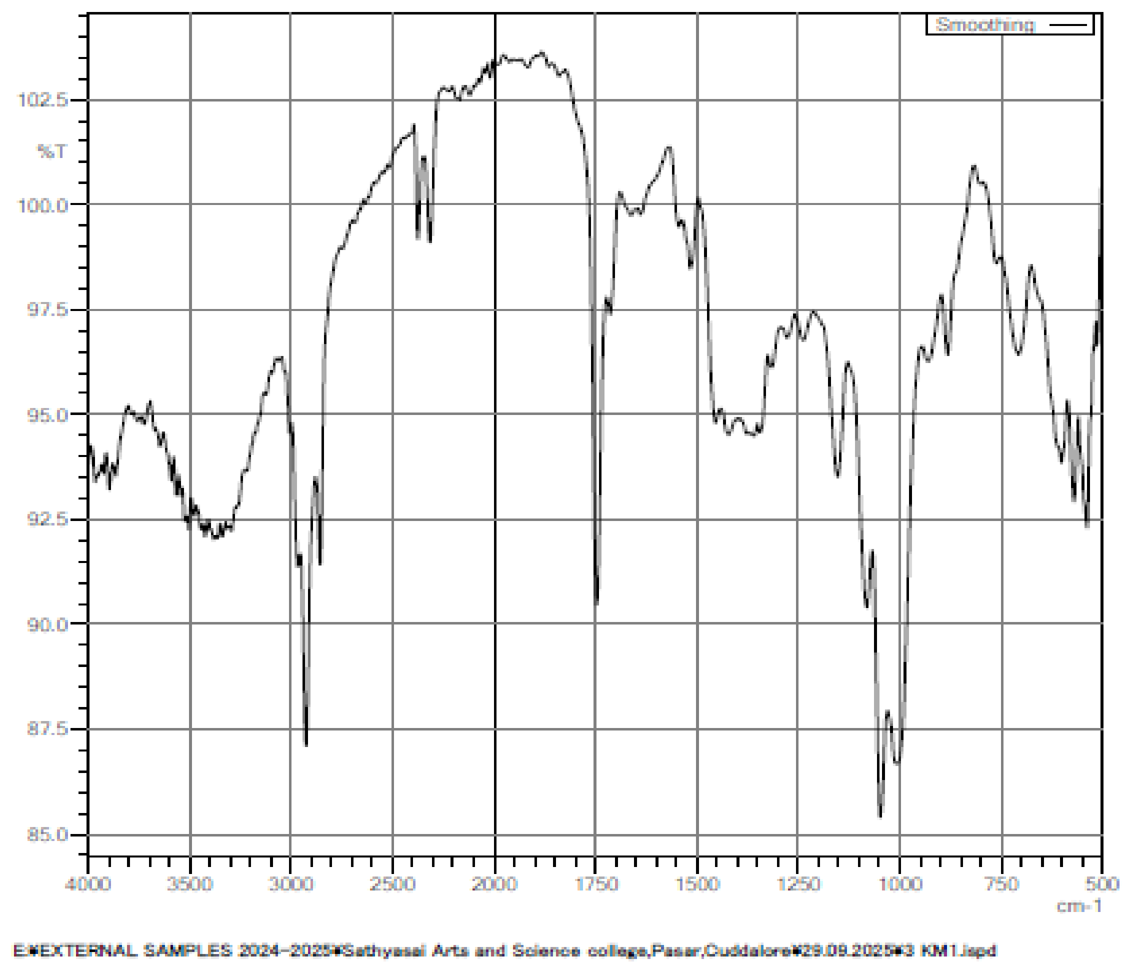
V. Results And Discussion



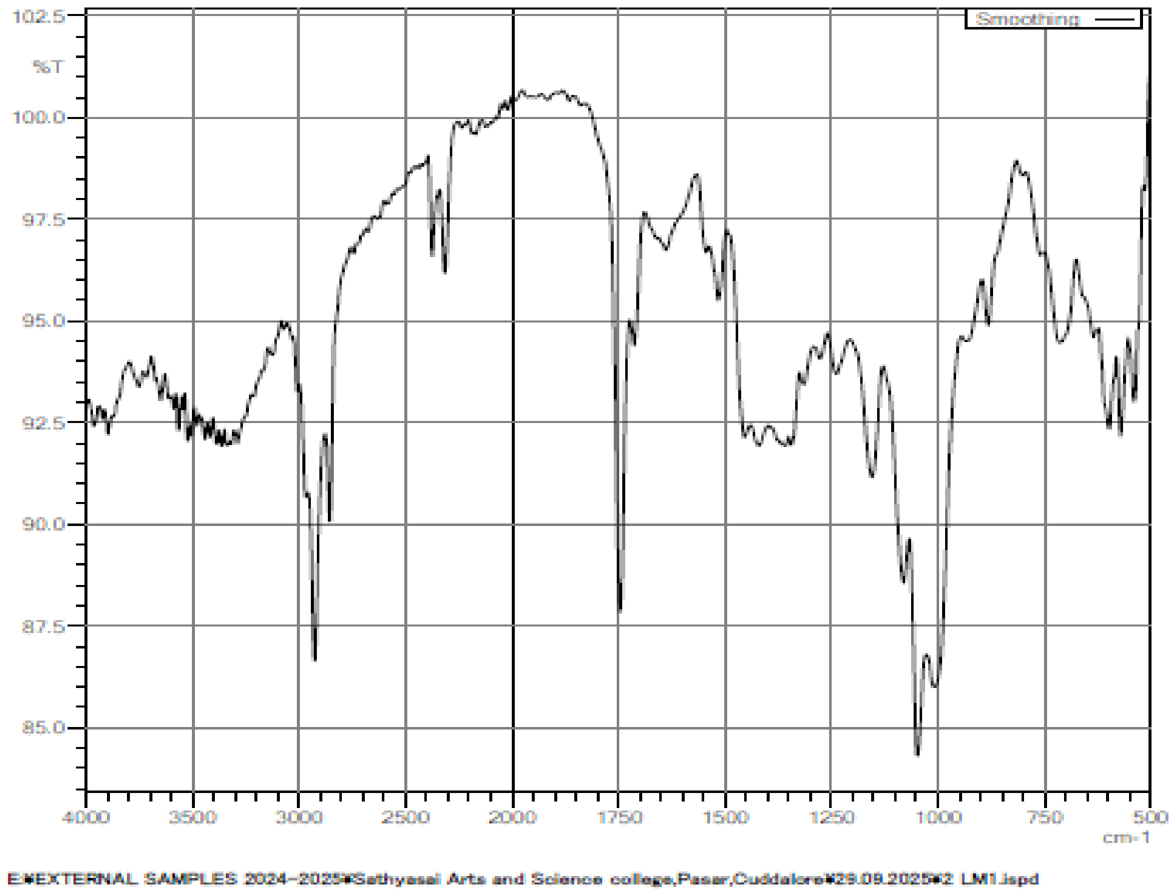


Figure FTIR spectrum of polymer observed

The MPs analyzed in the surface sediments exhibited a variety of sizes, shapes, and colors. Various colors were observed in the MPs present in the sediment sample, categorized into white, red, black, yellow, green, and blue. The most prevalent color observed in the foxtail Millets sample collected is blue (36%) followed by red (23%), white (16%), green (6%), and yellow (3%) . When studying the colors of MPs in the surface sediment sample some studies are similar to the present study (Zang et al., 2017; Bošković et al., 2021; Filgueiras et al., 2019 and Zamprogno et al., 2021). The different colors of MPs provide information about the source (Hartmann et al., 2019). For instance, transparent plastic items might originate from plastic bags and, bottles, or may become discolored due to weathering processes (Wong et al., 2020a).

The color of MPs has been demonstrated to affect their ingestion by organisms, as certain colors may attract predators when they resemble the color of their prey (Naji et al., 2019).

Studies indicate that smaller MPs including those at the nanoparticle scale present in millets are readily consumed by many organisms, causing internal harm, blockage and the accumulation of harmful substances (Smith et al., 2018). Moreover, their diminutive size facilitates their entry into multiple trophic levels, potentially disrupting entire food webs and ecosystems (Wrightet al., 2013).The polymer compositions of MPs in sediment samples were analyzed by using FTIR-ATR spectroscopy. Out of the total floated particles (n = 40), only those exceeding 0.5 mm particles were separated.

Subsequently, a selection was made by all unique and different particles, as well as triplicates of identical particles (n = 20) were separated for the analysis. When going through FTIR results PCT (48%) is the most abundant polymer in the foxtail millets followed by PA (36%) and SAN (16%) shown in FTIR Analysis**,**. PCT is one of the variants of PET. PCT finds extensive use across various industrial applications, serving as a filter in filaments, fibers and textiles (Tatlı et al., 2022). Furthermore, it is utilized in packaging, bonding plastic films and as dispersible powders in plasters and cement renders (Gedik & Eryasar, 2020). Similar results were found in the studies conducted by Bråte et al. (2016) and De-la-Torre et al. (2020) where the PCT was the common polymer. PA Is also identified in the MPs, and it exhibits enhanced environmental reactivity owing to its unique surface characteristics and functional group attributes (Tang et al., 2020).

VI. Summary And Conclusion

MPs were present in all the millets samples collected. Millets is collected rinsed with ethanol, and filtered using a sieve. Sediment samples are collected using a scoop. The highest abundance of MPs was found in the foxtail millet, which is the main source of micro plastics. The inflow of plastic usage as most of the plastic waste is dumped by them, due to the absence of a proper waste management system. The hydrodynamics of the and increased concentration of MPs on the where high abundance was found. A high concentration of MPs was observed in the foxtail millet serving as a hotspot for the introduction of MPs entering the food grains especially foxtail millet, indicating direct exposure of MPs to human consumption. Therefore, it is essential to disinfect before using it as food. The presence of MPs in food grains especially millets is attributed to disease in human population. MPs were also found in millets samples collected from various areas. The identical polymer present in most of the millets collected. The high concentration of fibers is found in both most samples, followed by fragments and films, indicating increased utilization of synthetic materials and human activities. Small-sized and colored MPs are most prevalent in most millets samples, posing a higher risk to both humans and aquatic fauna present in the lake. Some aquatic fauna ingests colored MPs, mistaking them are prey. The FTIR analysis also confirming that the MPs obtained from the millets collected. Further study need to be done with SEM & TEM

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