International Conference on Microplastics, Nanoplastics & Human Health

August 28-30, 2024

Dublin, Ireland

Young Scientist Travel Grant | Best Poster Award | OPTIR Hands-on Training

Welcome

Dear Delegates,

On behalf of the Organising Committee at University College Dublin, I am delighted to welcome you to IC-PlasticHealth-2024, an international conference dedicated to unravelling the complex relationships between micro(nano)plastics and human health. As we gather here from August 29-30, 2024, we look forward to a program rich with insights and opportunities for cross-disciplinary collaboration.

Our agenda is designed to engage and inspire. It features a practical, hands-on workshop utilising cutting-edge Optical Photothermal Infrared spectroscopy for microplastic analysis, which promises to enhance your research capabilities. Over the following two days, you will also experience a series of keynote speeches and invited talks. Experts will share their latest research on methodologies for detecting micro(nano)plastics in biological samples, assessing exposure levels in humans, investigating potential health outcomes, and discussing strategies for reducing microplastic pollution. The implications of these findings for future policy development will also be a focal point.

We are particularly pleased to support promising young scientists through our Young Scientist Travel Grants, fostering the next generation of researchers in this vital field. In recognition of the exceptional and innovative research presented by our delegates, the conference will proudly feature a special award for the best poster presentation, designed to highlight and celebrate outstanding scholarly contributions.

As you immerse yourself in the conference, I hope you will also take the opportunity to explore the beautiful landscapes and rich cultural heritage of Ireland. Wander through the historic streets of Dublin, visit the ancient Book of Kells at Trinity College, or enjoy a scenic hike along the cliffs of Moher. Ireland's vibrant music scene and cosy pubs offer a warm welcome to all visitors, providing a perfect backdrop for networking and relaxation after conference hours.

Thank you for joining us at IC-PlasticHealth-2024. We wish you an informative and enjoyable conference experience.

Dr. Junli Xu

Conference Chair

On behalf of the Conference Organising Committees

Organizing Committee

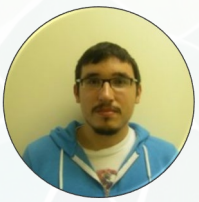
Professor Aoife Gowen
Professor

Dr. Amy O'Higgins
Associate Professor

Dr. Clare Reynolds
Assistant Professor (Ad Astra Fellow)

Dr. Rajat Nag
Lecturer/Assistant Professor

Dr. Anna Molter
Lecturer/Assistant Professor



Dr Leonard Koolman
Lecturer,
Technological University Dublin, Ireland

Dr. Abhrajyoti Tarafdar
Research Scientist

Dr. Nazan Altun
Research Assistant

Dr. Tamírís Da Costa
Lecturer/Assistant Professor

Dr. Xiaohui Lin
IRC Postdoctoral Fellow

Conference Sponsors

UCD DUBLIN

Ollscoil na hÉireann
National University of Ireland

Science Foundation Ireland sfi For what's next

PRIORITY

LASER 2000

Environmental Science Advances

epa Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Thursday, 29 August

8:15 am **Registration**
Main Entrance, UCD Health Sciences Centre

9:00 am **Conference Opening Session**
Health Sciences Centre, Room C007

Session I: Methodology Development for Micro- and Nanoplastics Analysis
» Chair: Prof. Aoife Gowen

9:15 am **Plenary Lecture**
Plastic Pollution – Human Health vs. Environment
» Prof. Jacob de Boer, Vrije Universiteit Amsterdam

10:00 am **Cultured Kidney Cells Show Nanoplastic Uptake and Impairments in Growth and Cell Cycle Following Long-Term Exposure**
» Hayden Gillings, Flinders University

10:15 am **EnderScope: A Low-Cost 3D Printer Based Microscope for Microplastic Detection**
» Niamh Burke, University College Dublin

10:30 am **Non-Contact Detection of Fluorescent Microplastic Particles in Water Flow Using Spectrometry**
» Nico Merck, University of Rostock

10:45 am **Painting Microplastics: A Novel Generative Methodology for Future Microplastic Research**
» T Joshua Osborne, University of Surrey

11:00 am **Coffee Break & Networking**

Session II: Methodology Development for Micro- and Nanoplastics Analysis
» Chair: Dr. Rajat Nag and Dr. Abhrajyoti Tarafdar
Health Sciences Centre, Room C007

11:30 am **Automated Microplastics Identification from <500nm to mm's: Particle Shape/Size Artefact-Free Submicron IR and Simultaneous Raman with Fluorescence Imaging to Pre-Filter**
» Miriam Unger, Photothermal Spectroscopy Corp. GmbH

11:45 am **Exploring Micro- and Nanoplastic Pollution Through More Realistic Test Materials**
» Stefania Federici*, University of Brescia

12:00 pm **Microplastic Detection in FFPE Colon Tissue Sections Using High-Resolution Infrared Spectroscopy**
»Verena Karl, RECENDT GmbH

12:15pm **Neurotoxicity Induced by Microplastics and Nanoplastics**
» John Placheril*, IIS (Deemed to be) University

12:30 pm **Degradation Products of Plastics Are Markers of Microplastics**
» José P. Da Silva, Centre of Marine Sciences Algarve

12:45 pm **Development of a Quality Control Tool for Standardising Microplastics Testing on the Laser Direct Infrared Imaging System**
» Fisayo Olotu, Queen Mary University of London

1:00 pm **A New Screening Framework to Support The Identification of Microplastic Particles *in Situ* in Pathological Tissue Samples**
» Stephanie Wright*, Imperial College London

1:15 pm **Lunch Break & Networking**

2:00 pm **Virtual Poster Showcase**
Health Sciences Centre, Room C007

Continued from Thursday, 29 August

Session III: Potential Health Impacts of Micro- and Nanoplastics

» Chair: Dr. Eoin Brennan

Health Sciences Centre, Room C007

3:00 pm **Plenary Lecture**
Microplastic Exposures at the Beginning of Life
» Prof. Amy O'Higgins, University College Dublin

4:00 pm **Impact Of Nano- and Microplastics on Blood Pressure**
»Liesa Geppner, Danube Private University

4:15 pm **Detection of Microplastics in Bottled Water Using Optical Photothermal Infrared**
» Xiaohui Lin, University College Dublin

4:30 pm **Toxicological Assessment of Benzo(A)Pyrene-Coated PET Microplastics in Vitro On A 3D Model of The Human Bronchial Epithelium**
» Safaa MAWAS, Université Paris Cité

4:45 pm **Epithelial Barrier Theory for The Development of Allergic and Autoimmunity Diseases: Exploring Implications for Microplastics**
»Cezmi Akdis*, University Zurich

5:00 pm **Nanoplastics in Coastal Environments: Challenges, Solutions, and Future Directions**
» Wei Xu*, Texas A&M University - Corpus Christi

5:15 pm **Validation of A Protocol to Measure Size and Concentration Measurements of Microplastics in Synthetic Samples by Dynamic Light Scattering**
»Paola Jimenez Chaves, University of Costa Rica

6:00 pm **Gala Dinner at UCD University Club**

Friday, 30 August

8:15 am **Registration**
Main Entrance, UCD Health Sciences Centre

Session IV: Human and Environmental Exposure to Micro- and Nanoplastics

» Chair: Dr. Clare Reynolds

Health Sciences Centre, Room C007

9:00 am **Plenary Lecture**
Advancements and Challenges in Assessing Human Exposure to Nanoplastics and Microplastics
» Prof. Kevin Thomas, The University of Queensland

10:00 am **Analysis of Plastic Distribution in Coastal and Farming Areas of Shanghai**
» Shuai Chen*, Shanghai Polytechnic University

10:15 am **An Assessment of Microplastic Contamination in Commercially Important Brachyuran Crab Portunus Sanguinolentus of Gujarat State, India**
» Vasantkumar Rabari, Hemchandracharya North Gujarat University

Continued from Friday, 30 August

10:30 am **Assessment of Suspended Atmospheric Microplastics in Qatar: Sources, Distribution and Potential Health Risks**
» Hashir Puthukkudi Kuningarath, Qatar University

10:45 am **Sustainable Edible & Ecofriendly Packaging Films & Tableware Tackling Plastic Pollution**
» Paramasivam Raajeswari*, Avinashilingam University

11:00 am **Coffee Break & Networking**

Session V: Human and Environmental Exposure to Micro and nanoplastics
» Chair: Dr. Anna Molter
Health Sciences Centre, Room C007

11:30 am **Mapping Human Immune Responses to Micro and Nanoplastics: The Norwegian Football Field Study**
»Berit Granum, Norwegian Institute of Public Health

11:45 am **Prevalence of Microplastics in Estuarine Ecosystem: Insights from India**
» Aiswriya Vijayalekshmi Padmachandran, Central University of Kerala

12:00 am **Investigation of Microplastics Release from Plastic Products**
» Liwen Xiao*, Trinity College Dublin

12:15 pm **Microplastics Abundance and Distribution Across Composting Phases of Municipal Solid Waste**
» Chijioke Emenike, Dalhousie University

12:30 pm **Pathways of Human Exposure to Micro and Nanoplastics: Food, Air, and Medical Treatment**
» Sedat Gündoğdu*, Cukurova University

12:45 pm **Marine Plastisphere: Vector for Accumulation of Trace Metals and Interesting Species**
» Joao Frias*, Atlantic Technological University

1:00 pm **Effects of Microplastics on Growth and Yield of Tomato Under Greenhouse Condition**
» Adeola Adelugba, Dalhousie University

1:15 pm **Lunch Break & Networking**

2:00 pm **Virtual Poster Showcase**
Health Sciences Centre, Room C007

Session VI: Remediation Strategies for Micro- and Nanoplastics
» Chair: Dr. Tamírís Da Costa and Dr. Xiaohui Lin
Health Sciences Centre, Room C007

3:00 pm **Floating Solar Panel-induced Microplastic Contamination in Surface Water**
» Mainak Bhattacharya, Indian Institute of Technology Delhi

3:15 pm **Predicting Micro- and Nanoplastic Reduction in Drinking Water Distribution System Via Biofilm Attachment**
» Ahana Sarkar, University College Dublin

3:30 pm **Synthesis Gas Production from High-Temperature Gasification Treatment of Microplastic Waste Using Thermal Plasma**
» Yang Zhou, China University of Mining and Technology

Continued from Friday, 30 August

3:45 pm **Remediation of Toxic Nanoplastics and The Heavy Metal Ions from Water**
» Zahid Ahmad Ganie, Indian Institute of Science Education and Research Kolkata

4:00 pm **Biodegradation of Pristine and Pretreated High-Density Polyethylene Microplastics by Fungus *Aspergillus Flavus***
» Sheetal Kothawale, IIT Bombay

4:15 pm **Additive Chemicals in Daily Use Food-Grade Plastics- A Serious Concern**
» Garima Kaushik, Central University of Rajasthan

4:30 pm **Beyond Beads: A Story of Plastic Microbeads Regulations and Future Policy Needs**
» Riya Kumbukattu Alex, Cochin University of Science and Technology

4:45 pm **Closing Remarks**
Announcement
Young Scientist Travel Grant
Best Poster Award

Instructions for Online Attendance

How to Attend Online

To attend the conference virtually, simply use the Zoom link provided below. This will grant you access to all live sessions, including keynote speeches, panel discussions, and virtual poster showcases.

Zoom Link: https://ucd-ie.zoom.us/j/61322739767?pwd=ZFASmdXuuLFjKYWxqgdZb7o9a0gfwd.1

Guidelines for Online Speakers

- Join the webinar **10 minutes** before the session begins. You will receive a notification saying, "The host would like to promote you to panelist." Please click "Join as Panelist" to proceed.
- To share your PowerPoint presentation:
  - Open Your PowerPoint Presentation: Start the **"Slide Show"** in PowerPoint.
  - Return to Zoom: Make sure the Zoom window is active.
  - Click **"Share Screen"**: In the Zoom meeting controls, click the "Share Screen" button.
  - **Select the PowerPoint Window**: Choose the "PowerPoint Slide Show" window from the list of available screens or applications.
  - Click **"Share"**: Click the "Share" button to begin sharing your presentation.

  Online speakers are encouraged to participate in a **testing session** before the conference. Please coordinate with Cihang Yang (cihang.yang@ucdconnect.ie) and Zhongyuan Liu (zhongyuan.liu@ucd.ie) to schedule this testing.

General information

1. **Conference Venue**

   Room C007, Health Sciences Centre, University College Dublin, Belfield, Dublin 4, Ireland.

   Please check the following Google map link for the location: https://maps.app.goo.gl/w56hVi19c6nnniam6

2. **Gala dinner Venue**

   UCD University Club, University College Dublin, Belfield, Dublin 4, Ireland.

   Please check the following Google map link for the location: https://maps.app.goo.gl/i8hLbbsDjJ7qqu4t7

3. **Navigation**

   Please download the map of Ireland offline in the Google map for navigation.

4. **Public Transit**

   Conference attendees can take the bus of 46A, 145, 155, 39A, 11, and S4 and the aircoach of 700 to UCD.

   4.1 Taking bus, you need to purchase a leap card. For more information, please visit: https://about.leapcard.ie/leap-visitor-card

   4.2 Checking the real time bus information, please visit: https://www.transportforireland.ie/plan-a-journey/live-departures/

   4.3 Taking aircoach, for the best fares and a guaranteed seat we recommend booking on the website (www.aircoach.ie) up to 1 hour pre departure. At Dublin Airport you can purchase your ticket from any aircoach staff member at the aircoach departure stand at Terminal 1, Zone 2 and Terminal 2, Zone 20. If you depart from UCD, you can purchase ticket from the driver by cash or card.

5. Driving

For attendees who drive to UCD please check parking information at: Driving and Parking - UCD Estate Services

6. Campus Accessibility

UCD is committed to making its campus, its information and its goods and services accessible to everyone. For more information, please visit: Campus Accessibility - UCD Access and Lifelong Learning

7. Things to bring

Attendees are highly recommended to bring their own water bottles, notebooks and pens for the purpose of Environmental sustainability.

8. WiFi

On-campus wireless connection is provided through the ucd-wireless.

9. Financial Needs

The Allied Irish Banks (AIB) ATM is located at UCD James Joyce Library, University College Dublin, Belfield, Dublin 4, Ireland.

10. First aid assistance

For first aid assistance, please reach out to our certified personnel, Dr. Eva Achata Gonzales, who will be present throughout the entire conference.

11. Emergency Numbers

+353 17167999 (UCD Estate Service), 999/112 (Ireland's national police service)

12. Food on Campus

UCD campus has a wide range of lunch options, we recommend staying on campus if looking to purchase lunch to ensure enough time during the conference. Seating is available in all the options below. Options below are organised closest to the conference venue to the furthest from the venue.

- **Pulse**: Ground Floor, Health Sciences Centre. Offers soup and freshly made sandwiches to order or pre-made sandwiches. Cost €4.50 to 7 for lunch.
- **Pi Restaurant**: Ground Floor, O'Brien Centre of Science. Hot food options, including vegetarian options. Cost approx. €8 for lunch.
- **Confucius Restaurant**: Confucius Institute. Authentic Hakkahan Chinese Food. Approx €11 to €15 for lunch.
- **Main Restaurant**: First Floor, Gerard Manley Hopkins Building. Range of sandwiches, salads and hot food options are available.
- **UCD Village**: Located on the opposite side of campus but a wide range of options, including, Pan-Asain food, burritos, and an American style diner. Approx €6 to €12 for lunch.

Campus map

1 UCD health science centre

2 UCD Club

Coffee shop

Restaurant

Guest parking

Dublin bus stop

Aircoach bus stop

Scan here

Keynote Speakers

Jacob de Boer

Topic: Plastic Pollution – Human Health vs. Environment

Jacob de Boer is emeritus professor. From 2006-2022 he was Professor of Environmental Chemistry and Toxicology at the Vrije Universiteit Amsterdam, The Netherlands. Prof. De Boer has worked for 49 years on the environmental contamination and analysis of polychlorinated biphenyls, flame retardants, perfluorinated compounds, PAHs and other contaminants. In 1998 he won the Excellent Scientist Award of the Wageningen University. In 2015 he was honored as one of the most cited scientists in his field (Top 1%) according to Thomson & Reuter. He has (co)coordinated a large number of European research projects, including the CleanSea project , the first European research project on microplastics, and many research projects for other international organizations and industries. He organized numerous international interlaboratory studies on contaminants including microplastics.

Amy O'Higgins

Topic: Microplastic Exposures at the Beginning of Life

Amy O'Higgins is Associate Professor of Obstetrics & Gynaecology at The Coombe Hospital, Dublin and Director of the UCD Centre for Human Reproduction. She graduated from UCD with a BSc in Chemistry and worked in analytical chemistry before studying medicine. She specialized in Obstetrics & Gynaecology in Ireland and completed sub-specialist training in Maternal-Fetal Medicine with the University of Toronto in Mount Sinai Hospital, Canada. Her clinical and research interests include diabetes mellitus and metabolic health in pregnancy as well as maternal and fetal complications of pregnancy.

Elvis Genbo Xu

Topic: Unraveling Micro and Nanoplastics: Towards a "One Health" Perspective

Dr. Elvis Genbo Xu is an Associate Professor and Sapere Aude Research Leader at the Department of Biology, University of Southern Denmark. Xu's research combines state-of-the-art techniques from environmental toxicology, aquatic biology, omics, and bioimaging to understand the impacts of emerging pollutants. His recent micro(nano)plastics findings are covered in Nature, Science, and 500+ global media. He has secured over two million euros in research grants and published 100+ peer-reviewed articles in PNAS, ES&T, Water Res, etc. He also serves as an editorial board member for Water Res X, Eco-Environ Health, J Hazard Mater, Front Environ Sci Eng, Environ Syst Res, and Managing Guest Editor of Environ Inter on "Micro(nano)plastic & Health".

Kevin Thomas

Topic: Advancements and challenges in assessing human exposure to nanoplastics and microplastics.

Professor Kevin Thomas is Director of the at Queensland Alliance for Environmental Health Sciences (QAEHS) The University of Queensland (UQ), Australia. Kevin is an environmental health scientist with a particular interest in understanding the environmental exposures associated with contaminants of emerging concern (CECs) with the goal of protecting environmental and human health. Kevin also leads the Minderoo Centre-Plastics and Human Health at UQ and is Deputy-Director of the Australian Research Council Industrial Transformation Training Centre for Hyphenated Analytical Separation Technologies (HyTech). His current research is focused on understanding human exposure to plastics pollution and developing mass spectrometric analytical methods for characterizing plastics and other CECs, assessing community-wide health status through analysing wastewater (wastewater-based epidemiology) and establishing alternative approaches to exposure monitoring.

Invited Speakers

Cezmi Akdis

Professor

Topic:Epithelial Barrier Theory for the Development of Allergic and Autoimmunity Diseases: Exploring Implications for Microplastics.

Institution:

University Zurich, Switzerland.

Shuai Chen

Associate Professor

Topic: Analysis of Plastic Distribution in Coastal and Farming Areas of Shanghai

Institution:

Shanghai Polytechnic University, China.

Joao Frias

Ph.D.

Topic:

Marine Plastisphere: Vector for Accumulation of Trace Metals and Interesting Species

Institution:

Marine and Freshwater Research Centre (MFRC), Atlantic Technological University, Ireland.

te Federici

Associate Professor

Topic:

Exploring Micro- and Nanoplastic Pollution Through More Realistic Test Materials

Institution:

Chemistry for Technologies Laboratory, Department of Mechanical and Industrial Engineering, University of Brescia, Italy

---

Sedat Gündoğdu

Professor

Topic:

Pathways of Human Exposure to Micro and Nanoplastics: Food, Air, and Medical Treatment.

Institution:

Cukurova University, Faculty of Fisheries.

John Placheril

Dean

Topic:

Neurotoxicity Induced By Microplastics and Nanoplastics

Institution:

Faculty of Sciences, IIS (Deemed to Be) University, Jaipur, India.

Wei Xu

Associate Professor

Topic:

Nanoplastics in Coastal Environments: Challenges, Solutions, and Future Directions

Institution:

Texas a & M University - Corpus Christi

Paramasivam Raajeswari

Associate Professor

Topic:

Sustainable Edible & Ecofriendly Packaging Films & Tableware Tackling Plastic Pollution

Institution:

Avinashilingam University, Institute for Home Science & Higher Education for Women, Dept of Food Science & Nutrition, Coimbatore, India

---

Stephanie Wright

Lecturer

Topic:

A New Screening Framework to Support the Identification of Microplastic Particles in Situ in Pathological Tissue Samples

Institution:

Imperial College London

Liwen Xiao

Associate Professor

Topic:

Investigation of Microplastics Release From Plastic Products

Institution:

Department of Civil, Structural and Environmental Engineering, Trinity College Dublin

Oral Presentation Abstract

Plastic pollution – human health vs. environment

Jacob de Boer

Vrije Universiteit Amsterdam, The Netherlands
Corresponding author : jacob.de.boer@vu.nl.

Abstract

Plastic pollution has been around since the 1960s. However, scientists have ignored this for several decades. The presence of pieces of plastics on our beaches was simply not recognized as a possible problem for the environment and certainly not for human health. It was not until the beginning of this millennium, and on the wave of the nanoparticles, that microplastics started to draw the attention of environmental scientists. Subsequently, NGO's and related organisations took the subject of plastic pollution and widened it by including macroplastics, which, again, were already there for a long time, but, admittedly, had now increased to enormous volumes. Suddenly, public attention was focused on plastics in general, and substantial funds for scientific research became available. This resulted within a few years in a steep rise of articles on – mainly - microplastics in the scientific literature.

Despite huge analytical difficulties, a lot of information on microplastics in the environment and also in human matrices has become available. Information on macroplastics is, however, staying behind. Environmental damage of macroplastics should not be underestimated as was shown, e.g., by several good quality papers on plastics in birds. Obviously, microplastics can be detrimental to the environment as well. If they are also detrimental to humans will be discussed. A proper answer on this question can only be given when analytical methods are of high and comparable quality, and toxicological/epidemiological interpretation is beyond doubt.

Microplastics exposures at the beginning of life

AC O'Higgins

Associate Professor of Obstetrics & Gynaecology at The Coombe Hospital, Dublin and Director of the UCD Centre for Human Reproduction

Abstract

Microplastics are plastic polymers and additives <5mm in size. They can persist in the environment for decades and can enter the human body through diverse routes, particularly through inhalation and ingestion. There is increasing interest in trying to understand the potential impact of microplastic exposure on human health. The fetal and neonatal periods of life are recognised as key moments in human development when changes in physiological function can have impact of life-long health. This talk will explore the current evidence on microplastic exposure in pregnancy and examine potential routes of microplastic transmission, particularly in relation to the intrauterine environment. It will also explore potential relationships between early life microplastic exposure and longer-term health outcomes.

Predicting micro- and nanoplastic reduction in drinking water distribution system *via* biofilm attachment

Ahana Sarkar*, Rayhan Uddin, Rajat Nag

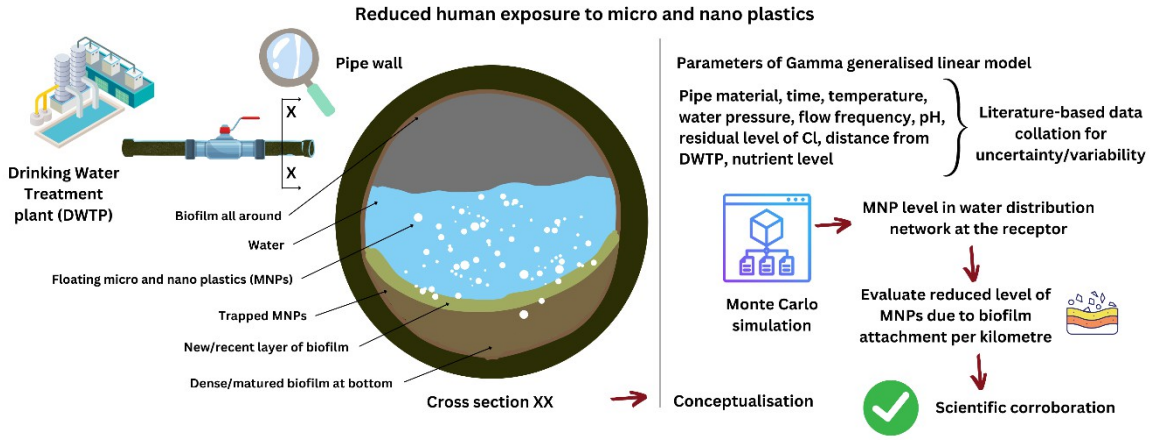
UCD School of Biosystems and Food Engineering, University College Dublin, Ireland
corresponding author: ahana.sarkar@ucdconnect.ie

Abstract

Biofilms are naturally occurring in drinking water systems, presenting both advantages and disadvantages. These biofilms, whether thin and tightly attached or thick and loosely attached to pipes, can act as natural traps for suspended micro and nano plastics (MNPs) in the water. This research aimed to quantify the reduction of MNP levels in drinking water distribution systems by comparing the initial MNP levels at the Drinking Water Treatment Plant (DWTP) with the predicted levels at the receptor point. Data from literature was collated around probabilistic parameters of the Gamma Generalised Linear Model, including pipe material, time, temperature, water pressure, chlorine levels, distance from the DWTP, and nutrient levels, all of which influence biofilm growth and its attachment or detachment. The attachment potential of MNPs per wet mass of biofilm was also calculated from literature data. The model incorporated the Manning equation and Stoke's law. Results indicated that denser MNPs (with a density > water) sediment quickly within a metre, whereas suspended particles take longer to settle and may attach to biofilms. The simulated mean reduction in MNP levels per kilometre for copper, plastic origin, steel, concrete, and cast iron was 132, 138, 121, 1271, and 1052 n/L/km, respectively. MNP attachment to biofilm and biofilm growth on different pipe materials are found to be the most sensitive parameters (positively correlated), whereas the distance from DWTP and the diameter of the distribution pipe for a similar discharge correlated negatively. Future research may explore the impact of pH and flow frequency on biofilm growth and attachment-detachment (advection process of MNPs) phenomena. The findings on the reduction of MNP levels in the drinking water distribution system could be a valuable tool for exposure assessment in unified risk assessments, informing policymakers and consumers for improved MNP management in water distribution networks, thereby ensuring food safety.

Keywords: *environmental fate, food safety, human health, probabilistic modelling, risk assessment.*

Graphical abstract



EnderScope: A Low-Cost 3D Printer Based Microscope for Microplastic Detection

Niamh Burke[1,*], Gesine Müller[2], Vittorio Saggiomo[3], Amy R. Hassett[1], Jérôme Mutterer[4], Patrick Ó Súilleabháin[5], Daniel Zakharov[1], Donal Healy[1], Emmanuel G. Reynaud[6], Mark Pickering[1].

[1]UCD School of Medicine, University College Dublin, Belfield, Dublin 4
[2]Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, Göttingen, Germany [3]Laboratory of BioNanoTechnology, Wageningen University and Research, Bornse Weilanden 9, Wageningen, The Netherlands
[4]CNRS & Strasbourg University, Institut de biologie moléculaire des plantes, Strasbourg, France. [5]Boston College, Department of psychology and neuroscience, MCAS, Chestnut Hill, Massachusetts, United States
[6]UCD School of Biomolecular and Biomedical Sciences, University College Dublin, Belfield, Dublin 4
[7]UCD Centre for Biomedical Engineering, University College Dublin, Belfield, Dublin 4 Email address of
**corresponding author: niamh.burke2@ucdconnect.ie*

Abstract

Marine microplastic pollution is a global problem which requires globally accessible solutions to address it. The conventional way to measure marine microplastics involves imaging filtered seawater samples, stained with Nile Red to aid the detection of microplastics. These particles can be manually counted using traditional fluorescence microscopy however, this is a resource and labour intensive task. We have developed a novel, low-cost microscope for automated scanning and detection of microplastics filtered from seawater samples, based on the mechanics of a low-cost 3D printer (Creality Ender 3). The hotend of the printer is replaced with an optics module, allowing for the reliable and well calibrated motion system of the 3D printer to be used for automated scanning over a large area.

The EnderScope is designed to be capable of both reflected light and fluorescence imaging using low-cost LEDs for illumination and lighting gels as emission filters. The system was optically and mechanically validated, and proof of concept experiments were performed to test the ability of the EnderScope for large-field white light and fluorescence scanning and particle analysis.

The EnderScope was found to have minimal positional error (±4 µm in the x-axis and y-axis), distortions, and can achieve a resolution of 20 µm. The EnderScope is capable of automatically scanning a large (150 mm diameter) filtered seawater sample and detecting Nile Red stained microplastics within this sample. EnderScope: A Low-Cost 3D Printer Based Microscope for Microplastic Detection costing <€500, this scanning microscope is a fraction of the cost of commercial alternatives. We believe this tool is a cost-effective and scalable solution for microplastic measurement.

Keywords : *open-source microscopy, 3D-printing, marine microplastics*

Additive chemicals in daily use Food-grade Plastics- A serious concern

Preksha Palsania[a], Garima Kaushik[a*]

Department of Environmental Science, School of Earth Sciences, Central University of Rajasthan, BandarSindri, Ajmer 305817, Rajasthan, India

*E-mail address of the corresponding author: *garimakaushik@curaj.ac.in*

Abstract

This study addresses the significant issue of BPA migration from single-use plastics in the food packaging industry. It seeks to determine the concentration of leached BPA from commonly used food-grade plastic items using a UV-Vis Spectrophotometer and assess its toxicity on soil microfauna, *Rhizobium*, and *Chlorella* species. Additionally, the study aims to identify and characterize novel bacterial species from a landfill site to evaluate their susceptibility to BPA and their effectiveness in biodegradation using various analytical techniques like U-HPLC and GC-MS. By doing so, the paper highlights the problem of BPA contamination and proposes ecologically viable methods for the remediation of such emerging contaminants.

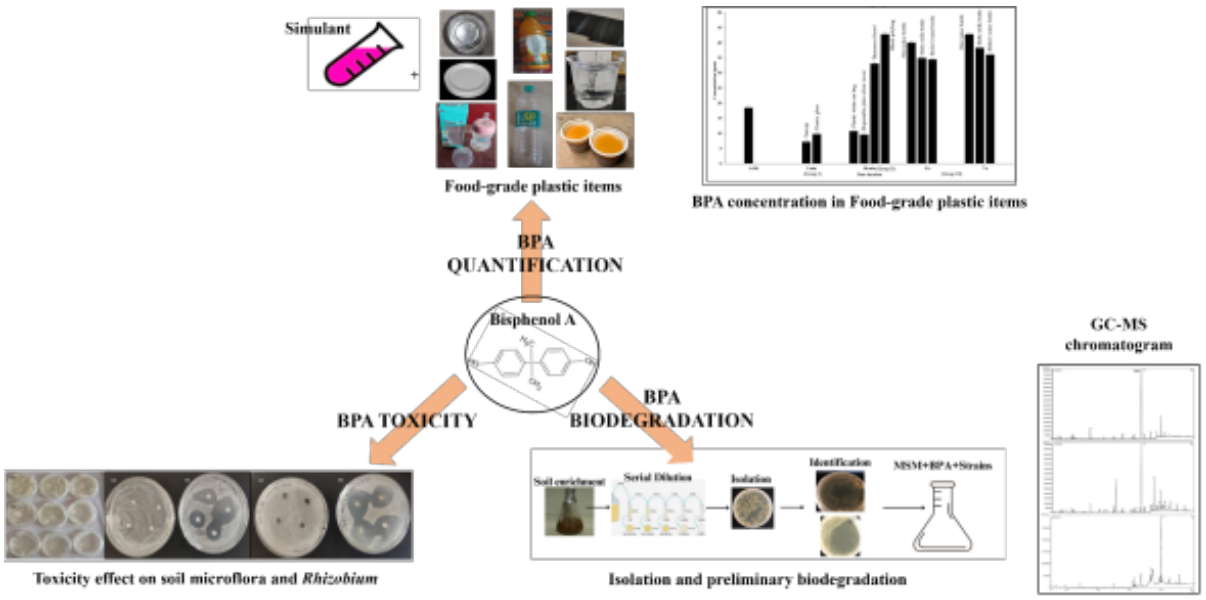
In group I (consisting of teacups and plastic glasses), the simulant or water solution was heated to 70 °C and poured into these samples for 5 minutes (Benecyo, 2016). Group II (comprising black and white poly bags, Styrofoam plates, and disposable plate silver covers) immersed the samples in the simulant or water solution at 100 °C for 20 minutes. To minimize evaporation losses, these samples were covered with parafilm. In group III (including slice juice bottles, Bisleri water bottles, and infant milk bottles), the simulant or water solution was heated to 100 °C, then poured into the samples and left at room temperature for 2 hours. Group III items were additionally incubated for a total of 7 hours, with screw caps securely fastened to prevent loss of volatile mixtures as much as possible. The remaining BPA concentration was measured using a UV-vis spectrophotometer (Agilent Carry-100) at 272 nm (Benecyo, 2016; Kadri et al., 2021). To identify bacterial strains capable of degrading BPA, soil samples were gathered from a landfill leachate site heavily contaminated with organic pollutants, predominantly plastic waste. The selection of these microbes was guided by a prior study (Bargiela et al., 2015), which suggests that the diversity of microorganisms present, particularly phylotypes, is directly influenced by the chemical composition of pollutants released into the environment. Pollution levels serve as suitable reservoirs for isolating potential microbial candidates. Six distinct morphological strains (PG1, PG2, PG3, PG4, PG5, and PG6) were recovered using isolation and enrichment culture techniques. In order to quantify the BPA concentrations in control and test samples under biodegradation, culture supernatants were examined with U-HPLC. These isolates were subsequently screened on MSM plates supplemented with BPA (100 ppm) as the sole carbon and energy source. Among the six isolates, the cell growth of PG3 and PG4 strains was better in the presence of BPA (100 ppm). PG3 was Gram-negative, rod-shaped bacteria producing small, white-pigmented round colonies and PG4 was Gram-positive, rod-shaped bacteria having small, white-pigmented slimy textured colonies.

Despite considerable efforts to mitigate chemical seepage in the food and beverage industries, BPA remains a significant challenge in food package manufacturing. It leaches into food from commonly used inexpensive plastic containers, especially under high temperatures and solvent conditions. The black poly bags exhibited the highest BPA concentration at 42.78 ppm, followed by the slice juice bottle (42.11 ppm) and infant milk bottle (38.56 ppm). Group III displayed noticeable levels of BPA, indicating substantial leaching had occurred. Unsaturated vegetable oil is widely recognized as the most suitable alternative for fatty foods. UV/Vis spectrophotometric and U-HPLC methods have proven effective for detecting BPA in liquid samples. Toxicity experiments have shown the long-term adverse effects of BPA exposure on soil organisms and aquatic microfauna. In remediation efforts, biodegradation experiments conducted in batch cultures using potential bacterial strains, *Brucella sp.* (PG3) and *Brevibacillus parabrevis* (PG4), demonstrated their capability to degrade BPA under in vitro conditions. GCMSMS analysis identified several BPA metabolites.

Bisphenol A (BPA) from food-grade plastics has become a cause of great concern due to the widespread use of these materials as food and beverage containers. When these plastics or the food in contact gets heated, BPA leaches into the food item and is thereby consumed, making it a potential candidate for causing serious health hazards. The present work gives an insight into the migration properties of BPA in food by using food-grade plastic, and when it is improperly disposed off in the environment, it results in damaging effects to the soil and aquatic ecosystems. This study underscores the importance of addressing the risks associated with BPA leaching from low-grade plastic containers and exploring ecological solutions for biodegradation. It emphasizes the need for stringent measures to control such contaminants in food packaging and single-use plastic waste management, as well as further research to understand the specific toxic impacts on human health through in vivo studies.

Keywords: *Bisphenol A, Biodegradation, Rhizobium, Food-grade Plastics, Toxicity*

Graphical Abstract



Innovative solutions for the mitigation of plastic pollution

Synthesis gas production from high-temperature gasification treatment of microplastic waste using thermal plasma

Yang Zhou[1, 2, *], Ruizhi Chu[1, *], Xianliang Meng[1, *]

[1]*School of Chemical Engineering and Technology, China University of Mining and Technology, Xuzhou, 221116, China.*

[2]*Department of Chemical Engineering, KTH Royal Institute of Technology, Stockholm, 11428, Sweden. Email address of corresponding author:*

zhouyangcn@cumt.edu.cn; 4038@cumt.edu.cn; meng27@cumt.edu.cn

Abstract

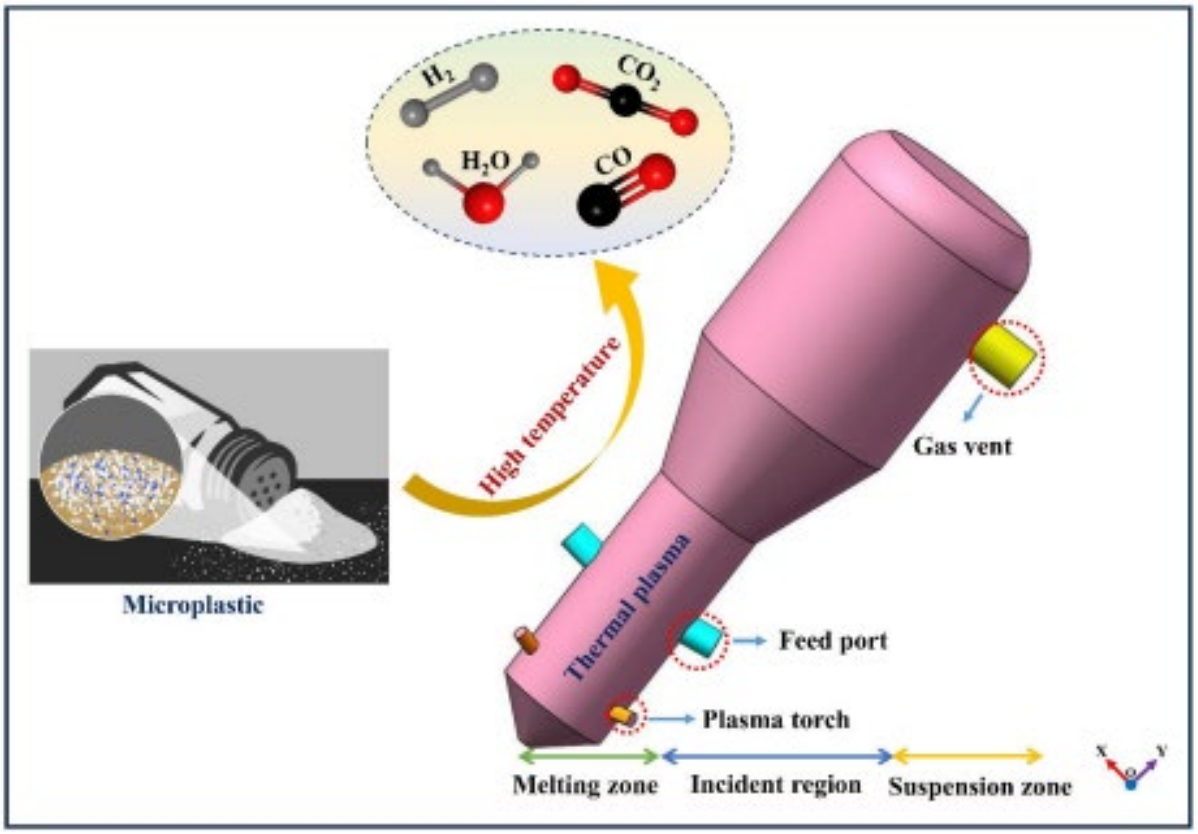
Plastics are widely used in people's lives because of their unique convenience, practicality and low cost. However, with the use of plastics, the accompanying microplastic pollution problem has become increasingly serious. Conventional treatment methods such as pyrolysis, biodegradation, photocatalysis will produce waste or cause secondary pollution while treating microplastics. Therefore, thermal plasma technology is chosen to treat plastic waste in this paper. It can convert the tail gas into syngas while treating plastic waste, and the solid residue can be used as road base material, which is highly economical.

The plastic waste was introduced into the plasma gasifier with water vapor as the work gas for combustion by Fluent simulation, and the temperature and concentration fields were simulated. The simulation results show that the temperature in the melting zone of the plasma furnace can reach 4300 K, which is much higher than the degradation temperature of microplastics. The simulation results of the concentration field indicated that the average molar fractions of CO, CO2, H2 and H2O in the outlet flue gas were 0.17, 0.08, 0.27 and 0.44, respectively. And the contents of CO and H2 in the outlet flue gas were high, which resulted in a high degree of resource utilization.

The results of this paper show that the thermal plasma technology treatment of microplastics has the advantages of high processing efficiency and high degree of resourceful utilization of by-products, which provides theoretical basis and data support for the application of plasma technology and efficient and clean treatment of microplastics.

Keywords: *thermal plasma, microplastic treatment, numerical simulation, syngas*

Graphic Abstract



Remediation of toxic nanoplastics and the heavy metal ions from water

Zahid Ahmad Ganie and Gopala Krishna Darbha

Indian Institute of Science Education and Research Kolkata, India-741246

gkdarbha@iiserkol.ac.in

Abstract

The unceasing release of the emerging contaminants microplastic and plastic additive metal ions into freshwater systems via anthropogenic sources is a globally escalating problem. Their synergistic toxicological effects on many living species are well established; hence, their remediation is requisite. The current study aimed at exploring the simultaneous removal of nanoplastics (different functionality and size) and metal ions (Ni^{2+}, Cd^{2+}, AsO_4^{3-}, CrO_4^{2-}) from water using nano-Zerovalent Iron-loaded biochar composite derived from Agro-waste. Fixed bed column and batch sorption experiments were performed to evaluate the synthesised composite's efficacy for removing nanoplastics and metal ions. The target contaminants were efficiently removed with *q max* 90.3 mg/g for carboxylate-modified NPs of size 500 nm and 44.0 and 87.8 mg/g for Cd^{2+} and CrO_4^{2-} ions, respectively. The pseudo-second-order kinetic and Sip's isotherm models were the best-fitted kinetic and isotherm models for both NPs and metal ion removal. The synthesized material worked efficiently in variable pH (4-8) and ionic strength (1-20 mM) with >90% removal for both contaminant types. Results from continuous column filtration mode suggested that 1 kg of the designed material may purify a maximum of 39,890 L of water contaminated with 1 ppm metal concentrations and batch experiments suggested 1 kg of composite may purify 90,300 L of water contaminated with 1 mg/L NPs. The Zeta potential, FTIR, TEM, and SEM analysis of the reaction precipitates revealed the electrostatic attraction, complexation and pore retention as the potential mechanisms for the removal of NPs, while reduction co-precipitation observed by XPS analysis and electrostatic attraction by zeta potential studies were confirmed to be the potential mechanisms for removing metal ions. High values of attachment efficiency factor calculated from colloidal filtration theory (CFT) validated the experimental results and justified the high sorption of carboxylate modified 500 nm NPs particles. In conclusion, the synthesized material successfully remediated the target contaminants from different types of water (River water, wastewater), reflecting its broad applicability in realistic environmental and industrial use.

Keywords: *nanoplastics, metal ions, remediation, nzvi biochar*

Graphical Abstract

Biodegradation of Pristine and Pretreated High-Density Polyethylene Microplastics by fungus Aspergillus Flavus

S, S, Kothawale[1], L, Kumar[2], S, P, Singh[1,3,4*]

1Centre for Research in Nanotechnology & Science (CRNTS), Indian Institute of Technology Bombay, Mumbai 400076, India

2Department of Energy Science and Engineering Department (DESE), Indian Institute of Technology Bombay, Mumbai 400076, India

3Environmental Science and Engineering Department (ESED), Indian Institute of Technology Bombay, Mumbai 400076, India

4Interdisciplinary Program in Climate Studies, Indian Institute of Technology Bombay, Mumbai 400076, India

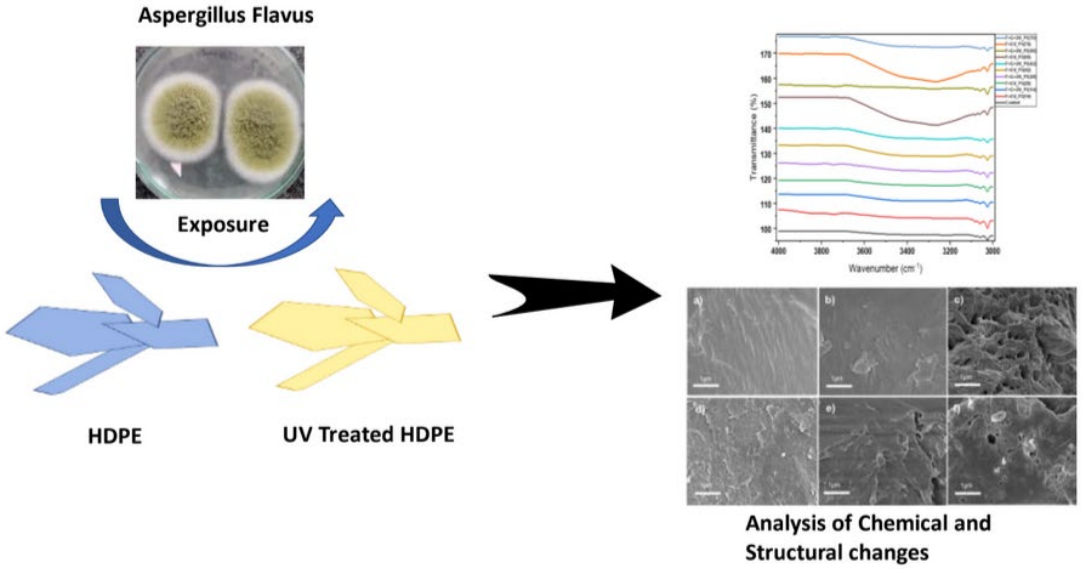
**Corresponding authors e-mail: swatantra@iitb.ac.in*

Abstract

Microplastic (MP) contamination have become a critical ecological concern due to their persistent presence in every aspect of the ecosystem and their potentially harmful effects. The current approaches to eradicate these wastes by burning up, dumping, or recycling are overly expensive and adversely impact the environment. As a result, applying degradation techniques to eliminate these recalcitrant polymers has been a focus of scientific investigation in the recent past. Nevertheless, the degradation techniques that have been used are comparatively inefficient and require further development. The recent research focuses on the potential use of microbes to degrade MPs as a sustainable solution. Because of the pervasiveness of High Density Polyethylene (HDPE) and its resistance to biodegradability, disposal strategies are critical and must be addressed. This manuscript put forth the study on the reaction of the fungus *Aspergillus flavus* sp. to pristine and UV treated HDPE MP particles in minimal growth media for over the time period of 70 days. This organism was evidenced to grow in a minimum growth medium- sole carbon source (SCS) in the presence of MP particles, which, based on the observed modifications, point to their use as substrate by *Aspergillus flavus*. This assertion was based on the weight loss, particle size distribution and SEM analysis. The % weight reduction in pristine and UV treated HDPE MP in SCS media was 29.33±0.28% and 33±0.21% respectively. Furthermore, molecular changes assessed through attenuated Fourier transform Infrared Spectroscopy (FTIR) spectrophotometric analysis also displayed chemical oxidation occurring during biodegradation process. These findings suggest that, natural and ubiquitous occurrence of this microbe in both terrestrial and marine environment may actively contribute to MP biodegradation while requiring few nutrients. Furthermore, fungal isolates were shown to use virgin HDPE as a carbon source without any pre-treatment.

Keywords: *microplastics, HDPE, biodegradation, fungi, minimal media, biodegradation of HDPE microplastics by aspergillus flavus*

Graphic Abstract:



Assessment of Suspended Atmospheric Microplastics in Qatar: Sources, Distribution and Potential Health Risks

Hashir Puthukkudi Kuningarath[1*], Veerasingam Subramanian[2], Fadil Sadooni[2], Saud Ghani[1 1]

Mechanical and Industrial Engineering, Qatar University, Doha – 2713, Qatar [2] Environment Science Center, Qatar University, Doha-2713, Qatar

[*] *hp2009947@student.qu.edu.qa*

Abstract

Plastic pollution, particularly from microplastics, poses significant environmental and health risks globally. This study is aimed to assess the prevalence, sources, and potential health risks of suspended atmospheric microplastics in Doha, Qatar. The suspended atmospheric dust samples collected at selected locations in Doha using a vacuum sampling technique. Microplastics from the dust samples were extracted using NOAA method. The size, shape, and colour of plastic like particles were examined under a stereoscope microscope. The polymer composition of microplastics were identified using μFTIR spectroscopy. The particle trajectory of dust particles in the study area was studied using HYSPLIT model.

Results from the study indicated a widespread presence of microplastics in the suspended atmospheric dusts, with significant variations in concentration and composition across different areas. The microplastics were predominantly composed of polyethylene, polypropylene, and polystyrene, which are commonly used in consumer products and packaging. This study provided a crucial baseline data on the atmospheric dispersion of microplastics in Doha, highlighting significant environmental contamination and associated health risks. The findings underscore the urgent need for strategies to mitigate microplastic pollution and reduce human exposure, particularly in urban settings. Future research should focus on longitudinal studies to assess the chronic health impacts of sustained microplastic exposure and develop more effective environmental monitoring and waste management strategies.

Keywords: *microplastics, suspended atmospheric dust, health risk, pollution, qatar*

Beyond Beads: A Story of Plastic Microbeads Regulations and Future Policy Needs

Riya Kumbukattu Alex[1], Preetha Sadasivan[2], Thomas Maes[3], Suja Purushothaman Devipriya[1]*

[1]School of Environmental Studies, Cochin University of Science and Technology, India 682022 [2]School of Legal Studies, Cochin University of Science and Technology, India 682022 [3]GRID-Arendal, Teaterplassen 3, 4836 Arendal, Norway

Corresponding author (devipriyasuja@cusat.ac.in; +919442234169)*

Presenting author (riyakumbukattu@gmail.com, +917356167240)

Abstract

Plastic Microbeads, which are small plastic beads of size less than 5mm and mostly less than 100nm have found various applications like cosmetics, personal care, agriculture, industries, medicines, etc(Alex et al., 2024; Leslie, 2014). This intentionally added primary microplastics have shown their presence in every sphere of the environment and as well as human samples(Ragusa et al., 2021). The potential toxicities of these beads are still a topic of research among the scientific community. Owing to their potential implications to environment and human health, microbead ban regulations has been formulated by various nations since 2015, pioneered by the 'Microbead-Free Waters Act'(Anagnosti et al., 2021; Pallone, 2015). Thus, this study, after a decade to the first regulation aim to critically analyse the existing global microbead bans to identify potential loopholes and areas that need improvement. This study also did a timeline analysis and SWOT analysis to comprehensively understand different aspects of these regulations to come up with novel perceptions. The result indicated major loopholes in ban implementations, scopes and applicability. There exists a gap in ban implementation and their current state in most of the bans. Furthermore, a critical evaluation of the ongoing global plastic treaty draft instrument on 'intentionally-added microplastics' identified uncertainties regarding the scope of products covered. This study along with the policy recommendations suggested could be a valuable reference to future microbead regulations as well as the ongoing global plastic treaty.

Keywords : *microplastic; pollution; policy; microbeads; personal care products*

Graphical Abstract

Microplastic in commercial crab of Gujarat : An assessment of microplastic contamination in commercially important brachyuran crab *Portunus Sanguinolentus* of Gujarat State, India

Vasantkumar Rabari and Jigneshkumar Trivedi*

Animal Taxonomy and Ecology Laboratory, Department of Life Sciences, Hemchandracharya North Gujarat University, Patan-384265, Gujarat, India.

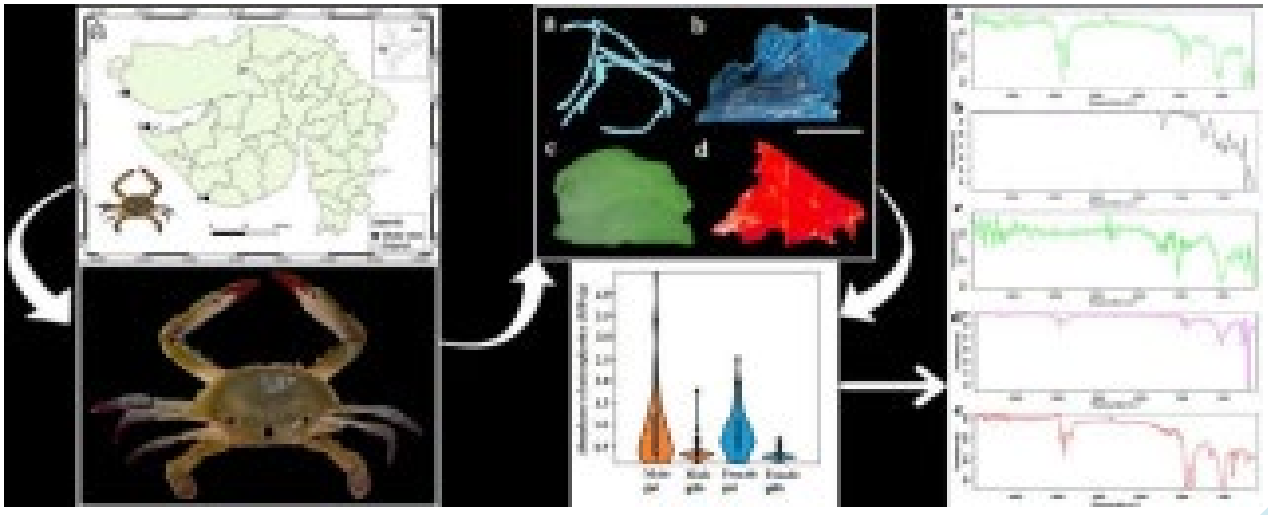
Corresponding author: jntrivedi26@yahoo.co.in

Abstract

Microplastic (MP) in seafood is a growing area of food safety. In the present study, MP contamination in the commercially important crab Portunus sanguinolentus of Gujarat state, India was assessed. A total of 300 crab specimens were collected from three principal fishing harbors of Gujarat. The collected specimens were dissected, and the gastrointestinal tract (GIT) and gills were removed to check for MPs. The GIT and gills were digested using 10% KOH. Later, the floatation was carried out using a saturated salt solution as per the density gradient principle. After floatation, the supernatant was filtered through ashless filter paper, and the filter paper was dried at room temperature. Each filter paper was observed under a stereo zoom microscope and counted, and the physical (shape, size, and colour) characteristics of MPs were recorded. The average abundance of MP was recorded as 0.67 ± 0.62 MPs/g. The pollution indices revealed very high contamination and fell under class IV (Jakhau) and V risk categories (Okha and Veraval). Threads were found dominantly. Blue and black-coloured MPs with 1–2 mm sizes were recorded dominantly. Polyethylene, Polyethylene tetraphene, polyurethane, polystyrene and polypropylene were identified as polymer compositions of MPs. Concludingly, the present study gives an insight into the MP in crab, which can be useful to design further investigations on the toxicity of MPs in seafood.

Keywords : *food contaminant, Gujarat coastline, microplastic pollution, pollution indices, shiva* crab

Graphical abstract



Impact of nano- and microplastics on blood pressure

Liesa Geppner[1], Sophie Grammatidis[1], Harald Wilfing[2], Maja Henjakovic[1*]

[1] *Department of Medicine, Faculty of Medicine and Dentistry, Danube Private University, Steiner Landstrasse 124, 3500 Krems, Austria*

[2] Human Ecology Research Group, Department of Evolutionary Anthropology, University of Vienna, 1030 Vienna, Austria

Corresponding author: maja.henjakovic@dp-uni.ac.at

Abstract

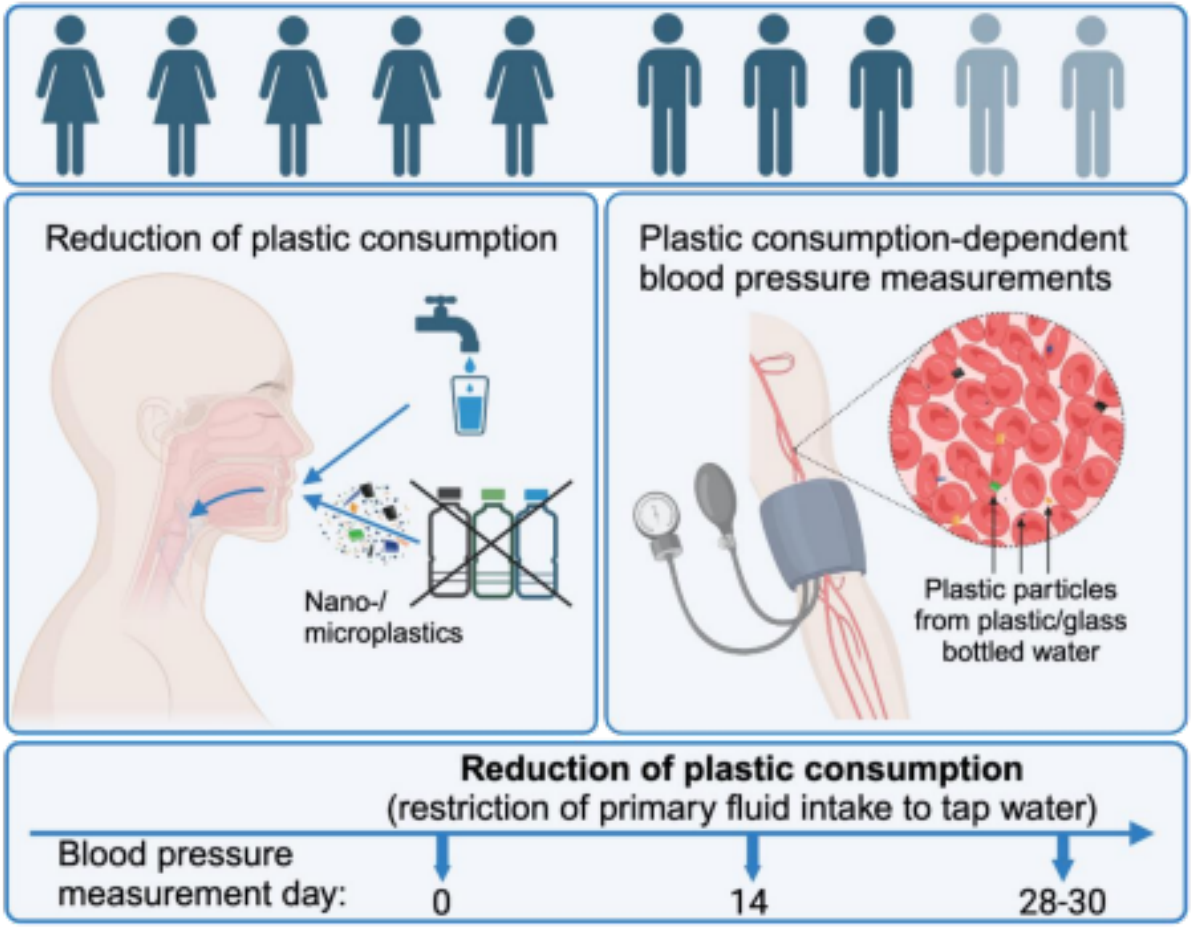
The global microplastic pollution issue, as a result of their indispensable usage in building materials, packaged food, medical products or consumer goods, poses significant health problems for the population. These small particles can penetrate intact cell barriers in the intestines and alveoli, thereby entering the bloodstream [1,2]. Our hypothesis is that microplastic particles may induce alterations in blood pressure through interactions with blood cells and the vascular endothelium. Consequently, the objective of this pilot study was to examine the impact of reduced plastic consumption on blood pressure.

Eight adult and healthy participants abstained from consuming commercially produced bottled beverages and to restrict their primary fluid intake to tap water. The blood pressure was measured after 14 days and after 28 to 30 days of this partial plastic diet. Our findings suggest that a gender-unrelated analysis reveals a tendency toward decreased systolic blood pressure after two weeks, with a subsequent further decline after four weeks. Significant findings are evident even at the two-week mark for diastolic blood pressure. Considering blood pressure separately for women only, a significant decrease can be seen after two and four weeks.

The results of the study suggest, for the first time, that a reduction in plastic use could potentially lower blood pressure, probably due to the reduced volume of plastic particles in the bloodstream. These particles have the potential to interact with blood cells, potentially activating platelets, inducing vascular changes, triggering inflammatory responses, and consequently facilitating plaque formation [3–5]. To confirm the results of our study, a larger sample of male and female participants must be examined, ideally with the monitoring of plastic concentration in the blood.

Keywords : *microplastics, nanoplastics, partial plastic reduction, drinking water, blood pressure*

Graphic Abstract



Prevalence of Microplastics in Estuarine Ecosystem: Insights from India

Aiswriya Vijayalekshmi Padmachandran, Malavika, Muthukumar Muthuchamy, Anbazhagi Muthukumar*

Department of Environmental Science, School of Earth Science Systems, Central University of Kerala, Kasaragod, Kerala, India.

*Email address of corresponding author: *sanbazhagi@cukerala.ac.in*

Abstract

Microplastics (MPs) have been receiving global attention in recent years due to their widespread distribution and potential health impacts. As an ecotone of freshwater and marine water ecosystems, estuaries play a significant role in harbouring a wide variety of living organisms along with supporting the livelihood of the population depending on it. Hence, the presence of microplastics in estuaries can impose long-term impacts on its stability and diversity. The study focuses on the distribution of microplastics in the sediments and benthic biota of two riverine estuaries, Chittari and Bekal along the Malabar coast of Kerala, India.

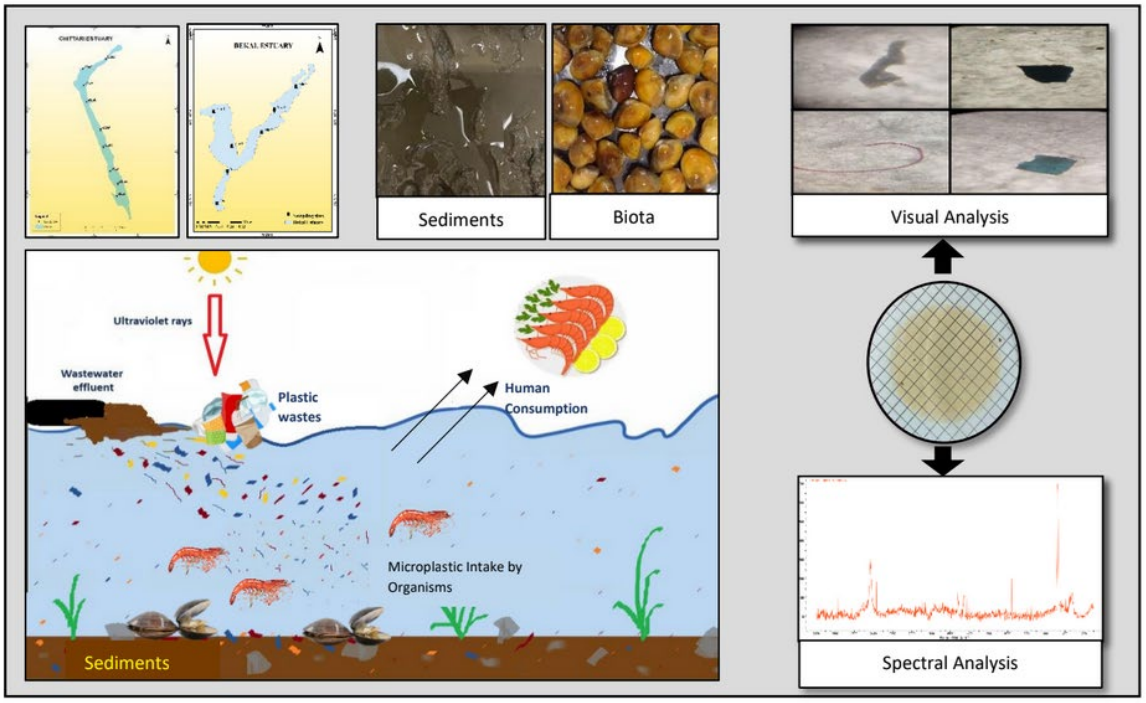
Sediment samples were collected using a grab sampler while live clams and shrimps were hand-gathered from the sediments. Isolation of microplastics from the sediment and biota samples was achieved by the procedure explained by Padmachandran et al. [1] and Ghosh et al. [2] respectively. Treatment involved multiple sets of density separation, organic matter digestion followed by membrane filtration. Visual identification and structural classification were done using Optical Microscopy while chemical evaluation was performed using Confocal Raman spectroscopy.

The presence of microplastics was detected in all sediment samples, with an average abundance of 49.23 ± 13.32 MP/kg in Chittari Estuary and 71.03 ± 13.91 MP/kg in Bekal estuary. In biota samples, microplastic abundance was 1.88 to 3.13 MP/gram. Majority of microplastics were fibre followed by fragments in colours blue, black, white, red and green. Raman spectroscopic analysis revealed the predominance of Polyester, which also include Polyethylene terephthalate. Other major polymers include polyethylene, polyamide, polystyrene, polypropylene, and polyvinyl alcohol. Prominent sources of microplastics input in the river estuaries were fishing and aquaculture activities, wastewater discharge from local households and improper solid waste disposal in and around the riverbanks.

The study underscores the widespread contamination of estuarine environments along the Malabar Coast with microplastics and their potential health implications. The accumulation of microplastics in edible aquatic organisms poses risks to human health through bioaccumulation in higher trophic levels. Effective waste management practices and community awareness are critical to mitigate plastic pollution and safeguard both ecosystem and human health, contributing to SDG 14 (Life Below Water).

Keywords: *biota, estuary, microplastics, raman spectroscopy, sediments*

Graphical Abstract



Detection of Microplastics in Bottled Water Using Optical Photothermal Infrared

Authors: Xiaohui Lin*, Aoife A. Gowen, Jun-Li Xu

School of Biosystems and Food Engineering, University College Dublin (UCD), Belfield, Dublin 4, Ireland

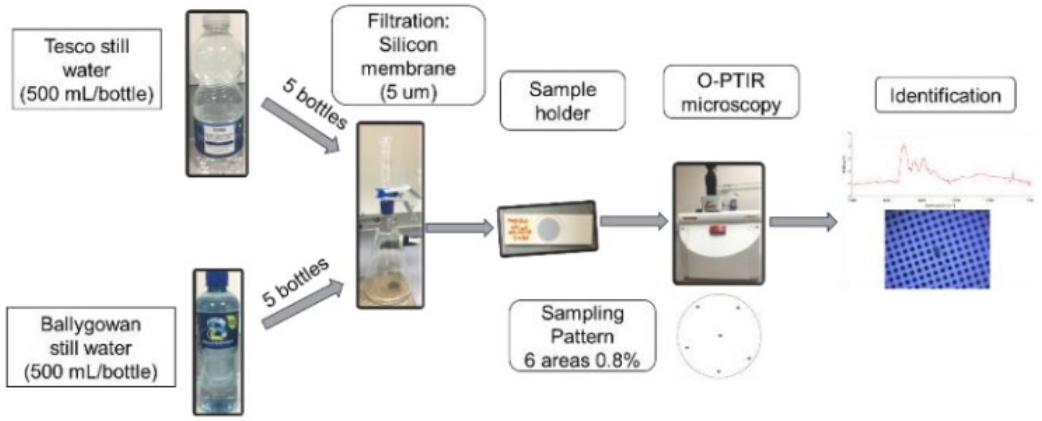
Email address of corresponding author: xiaohui.lin@ucd.ie

Abstract

The microplastic (MP) contamination of the home and the environment raises growing concerns for our human health. It is important to quantify the daily exposure to human. Most of researchers utilise Fourier transform infrared spectroscopy (FTIR), Raman, pyrolysis gas chromatography-mass spectrometry (GC-MS) and scanning electron microscope/energy dispersive X-ray spectra (SEM/EDX) to identify the MPs from the environment. Optical photothermal infrared microscopy (O-PTIR) is an emerging technique that overcomes the IR diffraction limit and reaches the detection resolution of 500 nm, which can detect smaller MPs than other techniques. This study aims to use optical photothermal infrared microscopy to identify and detect MPs in the bottled water. The bottled water was collected in the silicon membrane. MPs in six areas of the membrane were identified and quantified under the O-PTIR microscopy. Polyethylene and polyethylene terephthalate were found in the bottled water. The number of the MPs ranged from 1036-1578 MPs/L. The finding of this study indicates a smaller particle size (1 um) of MPs in bottled water than other studies and suggests the feasibility of using O-PTIR to identify and detect MPs. However, the sampling area of the O-PTIR needs to be optimized to achieve a more accurate and robust results.

Keywords: *optical photothermal infrared, microplastics, bottled water*

Graphic Abstract



Mapping Human Immune Responses to Micro and Nanoplastics: The Norwegian Football Field Study

Igor Snapkow[1], Monica Andreassen[1], Unni C. Nygaard[2], Raymond Pieters[3], Hubert Dirven[1], Berit Granum[1]

1. Department of Chemical Toxicology, Norwegian Institute of Public Health, Norway 2. Department of Method Development and Analytics, Norwegian Institute of Public Health, Norway

3. Institute for Risk Assessment Sciences, Utrecht University, the Netherlands Corresponding author: Berit Granum, Berit.Granum@fhi.no

Abstract

The issue of plastic pollution has gained significant attention from the scientific community, policymakers, and the general public over the past decade. To date, numerous studies have demonstrated the presence of micro- and nanoplastics (MNP) in both the environment and living organisms [1–3]. However, the potential human health implications of MNP exposure remain poorly understood. In vitro models yield contradictory findings, while most human studies are limited to the mere detection of plastics in various tissues and organs [4–6]. In the Norwegian Football Field Study, part of the EU-project POLYRISK [7], we aimed to evaluate the immune system-related effects of short-term MNP exposure in a controlled human scenario.

Thirty-six healthy adolescent volunteers participated in 90-minute games on indoor artificial fields with two different types of infill: crumb rubber or sand/olive pits. The games were separated by a 14-day washout period. Participants completed questionnaires on physical activity, habits, medication use, and potential sources of plastic exposure in their daily lives. Venous blood samples were collected before, 2 and 18 hours after the games. Single-cell immune profiling of whole blood (14 participants, 3 samples/person) was performed using mass cytometry (CyTOF) with a panel comprising 42 phenotype and activation markers. Unsupervised analysis using the FlowSOM algorithm [8] with subsequent manual cluster merging and annotation were used to identify cell populations. Plasma cytokine levels were measured in all participants (2-3 samples/person) using the Olink Target 48 Cytokine panel. Statistical analysis applied were general linear mixed models with time/infill and subject as fixed and random effects, respectively.

We identified 35 distinct immune cell populations. Differential analysis revealed a statistically significant increase in several T cell subpopulations, including effector memory and regulatory T cells, 18 hours post-game on the crumb rubber field. Notably, we observed changes in the proportions of multiple NK cells, dendritic cells, and granulocyte subsets 2 hours after the game on both fields, with levels returning to baseline after 18 hours. Several cytokines showed altered plasma levels 2 and 18 hours post-game, with a greater number of significant changes observed after playing on the crumb rubber field.

Short-term exposure to MNP in a real-life scenario can induce immune responses in humans, particularly at the plasma cytokine level. Our novel approach employing state-of the-art laboratory methods, along with advanced bioinformatics and biostatistics analysis, will Immune Responses to MNP exposure: the Norwegian Football Field Study pave the way for more comprehensive epidemiological studies aimed at a better understanding human health effects of chronic exposure to plastics.

Keywords : *micro- and nanoparticles; immune system; immunomics; mass cytometry; proteomics; polyrisk*

Floating Solar Panel-induced Microplastic Contamination in Surface Water

Mainak Bhattacharya*, Arun Kumar, Arvind Kumar Nema, Arya Vijayanandan, Sovik Das

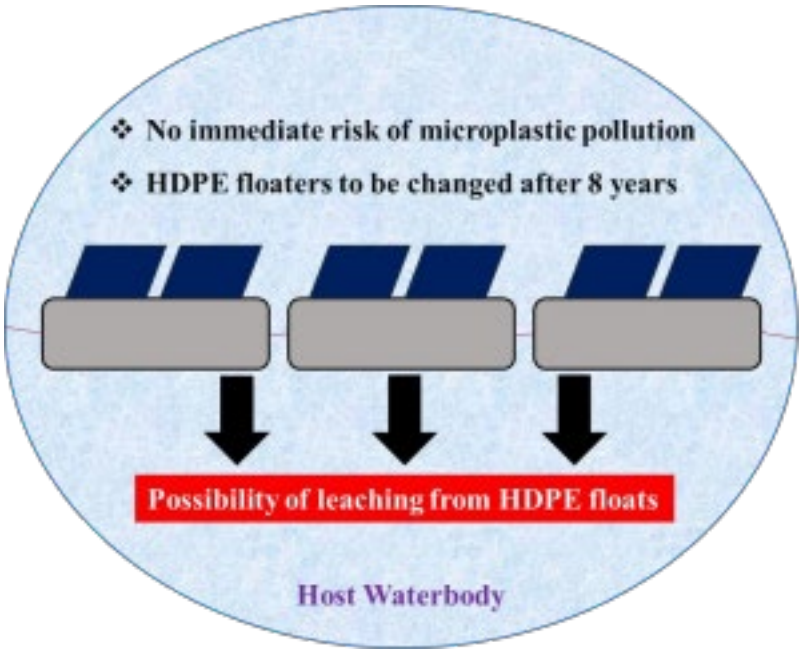
Department of Civil Engineering, Indian Institute of Technology Delhi, New Delhi, India
**mainakb@civil.iitd.ac.in*

Abstract

Floating solar photovoltaic (FPV) system is widely getting attention as an alternative to fossil fuel based power production in the energy sector. While past researchers indicated the potential benefit of FPV in terms of surface water protection due to decrease in net evaporation loss [1]; its environmental impact on the host waterbody is not yet completely understood. The possibility of release of microplastics or additives, present in the HDPE/LDPE floating materials, in the surface water is one such environmental concern that needs to be probed. In the present study, effect on evaporation loss due to coverage of a reservoir at identical meteorological condition was mathematically determined. The percentage of decrease in evaporation loss increased from 15% to 70% when the percentage coverage was varied from 10% to 100%. Furthermore, a theoretical framework was developed to predict the possible pathways and mechanisms of microplastic leaching in the surface water from the floaters. The processes were mathematically modeled and the process kinetics was estimated collating the information related to each theory developed in this study available in the literature [2-4]. Release of additives or other toxic chemicals from HDPE was attributed to – i) UV-assisted photodegradation, ii) biodegradation, and iii) mechanical stress. It was proposed that any toxicant from HDPE material will leach in two steps – i) the toxicant should diffuse in the bulk material, ii) the toxicant should release in the water due to diffusion through the aqueous boundary layer. Since ionic strength of the surrounding water could enhance the diffusion, saline or brackish waterbodies might be more susceptible to HDPE-induced contamination. However, kinetic modeling suggested that the timescale of such leaching from HDPE material is infinitely long. Although degradation of HDPE floaters was feasible in marine environment, no such occurrence was reported from an on-field HDPE floating material before a period of 9 years [5]. Comparing our results of infinitely long leaching time with the on-field data it can be interpreted that HDPE floaters of 30 years lifetime might be changed after a duration of "9 – 1 = 8 years" for risk-free sustainable operation of the floating solar systems. Data availability of microplastic leaching from FPV sites is a constraint since the technology is relatively new. However, rapid expansion of FPV in last 5 years demands environmental monitoring and water quality data availability of these projects, especially in the ecologically sensitive locations. Environmental risk management of mid-life and end-of-life HDPE wastes should be studied by the researchers and planned by the stakeholders for sustainable operation of FPV systems.

Keywords : *floating solar system; evaporation; hdpe; leaching kinetics; environmental risk management*

Graphical Abstract



Microplastics Abundance and Distribution Across Composting Phases of Municipal Solid Waste

Authors: *Chijioke Emenike1,2, Adeola Adelugba1, Mason MacDonald1, Sam Asiedu1, Lord Abbey1

Affiliation: *[1]Department of Plant, Food, and Environmental Sciences, Faculty of Agriculture, Dalhousie University, Canada*

[2]Department of Microbiology, Faculty of Natural and Applied Sciences, Hezekiah University, Umudi, Nigeria

Corresponding author: ***chijioke.emenike@dal.ca***

Abstract

Plastics are widely used in domestic and industrial settings, resulting in significant waste disposal in landfills and aquatic ecosystems. Composting, a sustainable waste management method, converts organic waste into soil additives and enhancers for improved agricultural productivity. However, compost application could be a major entry route for microplastics (MPs) in soil. The mesophilic-I, thermophilic, mesophilic-II, and maturation phases of composting are distinguished by microbial activities and temperature levels. This study investigated the abundance of MPs in municipal solid waste (MSW) compost through the four phases of composting. Plastics were extracted from each composting phase using a three-step extraction method on wet MSW/compost. The captured microplastic fragments (1 – 5 mm) were processed and identified using both physical examination and attenuated total reflectance Fourier transform infrared (ATR-FTIR) spectroscopy. The FTIR spectral data were matched on some databases (Bruker Optics, ATR-LIB-Chemicals-1-472-2.S01, and ATR-LIB-Complete-3-472-2.S01). Polymers found include polypropylene (PP), polystyrene (PS), high-density polyethylene (HDPE), polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polyester (PES), polyacrylic acid (PAA). Derivatives such as acrylonitrile butadiene styrene (ABS), PA6 and PA12 were also identified. Additionally, some polymer additives like natural dye 20, Metholat LA 524, N-Stearyl Stearamide, olefin fibers, and alkyl diethanolamine were identified. Statistical analysis was conducted using the General Linear Model of analysis of variance (ANOVA), with Tukey's test (95% confidence) employed for comparisons. The results confirmed the presence of MPs in organic compost – an impairment to compost quality. While the abundance of MPs across the composting phases did not show a significant difference ($p > 0.05$), the comparison of mean MP distribution of different sizes (1mm – 5mm) varied significantly across the four composting phases, with MPs increasing down the phases. The microbial and mechanical interactions during the composting process impacted plastic fragmentation. Chemical additives identified in the study suggest the potential of MPs as vectors for co-contamination in the food system. These MPs could become bioavailable in plants via uptake of the fragments or chemical derivatives, thereby causing food safety issues and enhancing bioaccumulation risk in humans. This calls for additional investigation into the mechanisms of crop-microplastics interaction in agricultural ecosystems to ensure food security and health safety.

Keywords: *microplastics; compost; municipal solid waste; agriculture; atr-ftir spectroscopy*

Automated Microplastics Identification from <500nm to mm's : Particle Shape/Size Artefact-Free Submicron IR and Simultaneous Raman with Fluorescence Imaging to Pre-Filter

Miriam Unger[1] and Mustafa Kansiz[2]

[1]*Photothermal Spectroscopy Corp GmbH, Duisburg, Germany*

[2]*Photothermal Spectroscopy Corp, Santa Barbara, 93101, CA, USA*

Corresponding Authoer Email: miriam@photothermal.com

Abstract

Microplastic (MP) contamination have been recognized as a global environmental problem. MP particles are found globally in water, air, soil and regularly ingested by marine life. MPs can enter the human body by via contaminated water, beverages, and food, and by breathing airborne particles. The MP research community has grown quickly to address questions related to environmental/health risks. Spectroscopic analysis is frequently used to characterize populations of MPs, but most IR microspectroscopic analyses have been limited to >20 um particles. Better spatial resolution techniques such as Raman microscopy exist, but often suffer from limited sensitivity and/or autofluorescence issues. This has left a critical unmet need in the analysis of micron scale MP particles, which are of particular concern for human and animal health, because these particles are able to pass through the gut wall to accumulate in tissue with potential impact to organ function.

We have developed an optical microscopy based platform with automated capability for the measurement and analysis of micron scale MP particles based on Optical Photothermal Infrared Spectroscopy (O-PTIR) and complementary and simultaneous Raman spectroscopy. Preparations of microplastic particles can be automatically screened via optical microscopy (or Fluorescence imaging with Nile Red) to identify particles of interest and then automatically measured by O

PTIR and/or Raman. While conventional infrared spectroscopy (and even Raman) can struggle to spectroscopically identify micron scale MP particles, the O-PTIR approach overcomes the spatial resolution limits of conventional infrared spectroscopy by using a photothermal detection mechanism that employs a separate visible probe beam to detect infrared absorption. Because of the smaller wavelength or the probe beam, O-PTIR can achieve spatial resolution 10-30X smaller than infrared diffraction limits, while also avoiding size and shape dependent scattering artifacts that often limit the repeatability of traditional FTIR/QCL based techniques.. O-PTIR is also insensitive to autofluorescence which can be problematic with Raman.

This presentation will review O-PTIR technology and operating principles and then discuss the automated measurement and analysis of arrays of MP particles whilst providing key measurement performance metric

Validation of a protocol to measure size and concentration measurements of microplastics in synthetic samples by dynamic light scattering

Authors: Paola Jiménez Chaves[1], Natalia Hernández Montero[1], Paula Solano Sánchez[1], Adrián Serrano Mora[1]

[1] *Chemical Engineering Department, University of Costa Rica (UCR) - University of Costa Rica (UCR) – 11501-2060, San José, Costa Rica*

Affiliations: Chemical Engineering Department, University of Costa Rica (UCR) Email address of corresponding author: paola.jimenezchaves@ucr.ac.cr

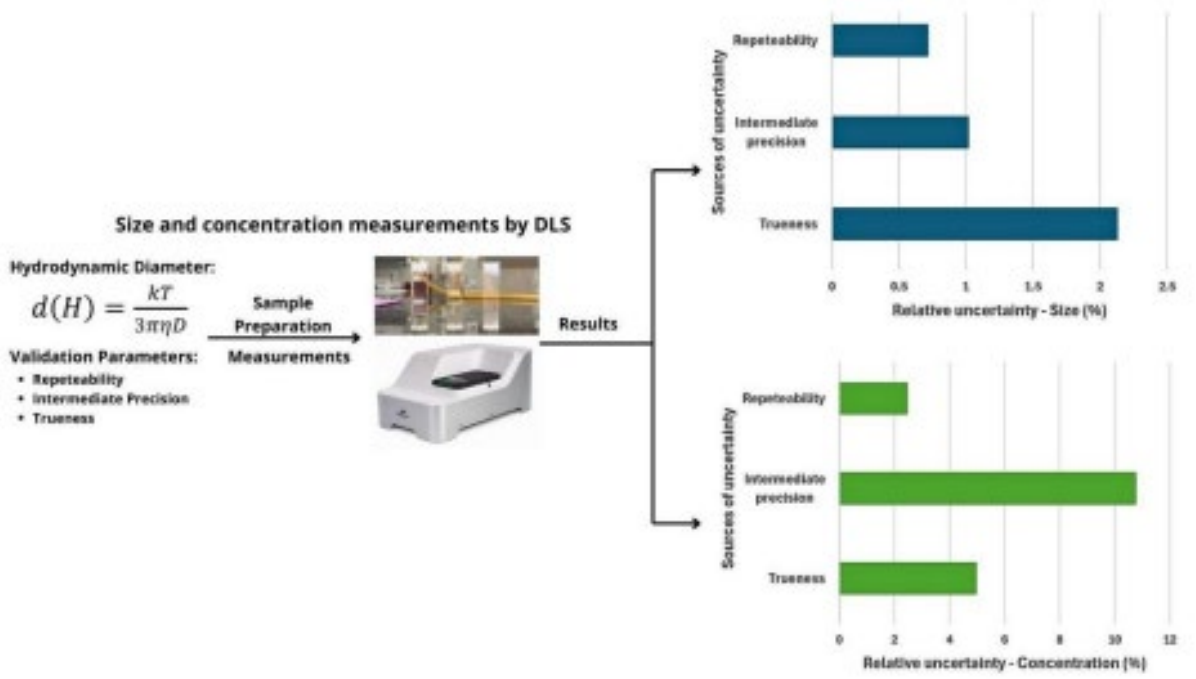
Abstract

Due to the prevalence of microplastics in the environment, the development of characterization and quantification techniques is essential to further the assessment of their impact in our surroundings. Nevertheless, there exists a lack of standardized protocols that hinders the possibility to obtain data that can be compared between studies.

In this study, the ISO 22412:2017 was used to validate a protocol to measure size and guide the proposal of a method to determine the concentration of microplastics in synthetic samples by dynamic light scattering in the chemical engineering instrumentation laboratory. After its implementation each protocol was tested by means of the following statistical parameters: trueness, intermediate precision, and robustness. With the aid of the Student´s t-test and an analysis of variance (ANOVA) the expanded uncertainty was calculated to be 24.25 % for concentration measurements. In contrast, the expanded uncertainty for the determination of size was only of 4.94 %. The high variability found for the proposed concentration protocol was determined to be caused, primarily, by the intermediate precision analysis results. A cause-and effect analysis was performed to find probable causes for the results obtained and to recommend improvements to the developed protocol. Among these, it is possible to mention that further work is required to overcome the variability introduce by the sample preparation process. In addition, this study pinpoints the need for the development and availability of reference materials and international standards to measure concentration by DLS to provide tools to further assess the impacts of microplastics in the environment.

Keywords: microplastics, dynamic light scattering, method validation,

Graphic Abstract



Title: Cultured Kidney Cells Show Nanoplastic Uptake and Impairments in Growth and Cell Cycle Following Long-Term Exposure

Authors: Hayden L. Gillings[1,2], Jonathan M. Gleadle[2,3], Darling M. Rojas-Canales[2,3], Soon Wei Wong[3], Melanie MacGregor[4,5]

[1]College of Science and Engineering, Flinders University, Bedford Park, Australia, [2]College of Medicine and Public Health, Flinders University, Bedford Park, Australia, [3]Department of Renal Medicine, Flinders Medical Centre, Bedford Park, Australia, [4]Nano and Microplastics Research Consortium, Flinders University, Bedford Park, Australia, [5]Flinders Institute for Nanoscale Science and Technology, Flinders University, Bedford Park, Australia

Email address of corresponding author: hayden.gillings@flinders.edu.au

Abstract

Nanoplastics (NPs) are plastic particles less than 100 nm in size, typically generated through the degradation of plastic waste.[1, 2] Knowledge of their exposure effects on the kidney are extremely limited. The aim of this study was to determine effects of short- and long-term exposure to polystyrene NPs in human kidney-2 (HK-2) proximal tubular cells (PTC).

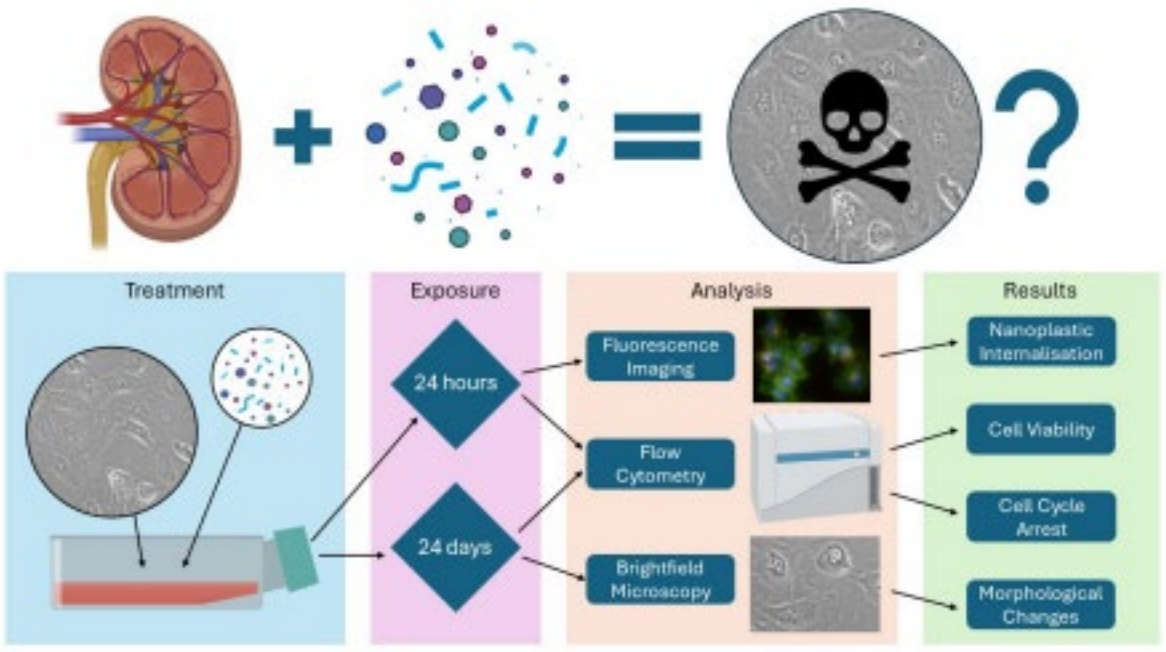
The HK-2 cell line was exposed to 0.2 to 200 µg/mL of 20 nm and 100 nm spherical NPs for 24-hours, or at a concentration of 100 µg/mL every 72-hours for a total 24 days. Cell viability and cell cycle analysis was completed by flow cytometry. Fluorescent and phase contrast microscopy was used to determine NP internalisation and cell morphology changes respectively.

The viability of HK-2 cells was not significantly affected by exposure to 20 nm and 100 nm NPs, with only 1-2% increase in Annexin-V positive cells. However, cell cycle analysis revealed increased entry into S-phase ($n=3$, $P<0.01$) with the 20 nm NPs, while no significant changes were seen with the 100 nm particles. Fluorescent NP internalisation studies showed uptake and accumulation within the cytoplasm after 24-hours, whilst little morphological changes were observed. Long-term exposure (24-days) showed gross morphological changes, with decreased total cell numbers and increased doubling times, most evident in cells exposed to 20 nm NPs.

HK-2 PTC are able to internalise NPs. The most significant changes were observed with the 20nm particles, which showed reduced proliferation despite S-phase entry, suggestive of S-phase cell cycle arrest and possible DNA damage. This however did not affect cell viability. Further research is needed to characterise the toxic effects of NPs less than 100nm on kidney health and function.

Keywords: *nanoplastics, kidney, uptake, exposure*

Graphic Abstract



Microplastic Detection in FFPE Colon Tissue Sections Using High-Resolution Infrared Spectroscopy

Verena Karl[1], Kristina Duswald[1,2], Mukund Sricharan Bhamidipalli[1], Lukas Kenner[2,4,5,6], Elisabeth Gruber[3], Markus Brandstetter[1,2]

[1]*Research Center for Non-Destructive Testing GmbH (RECENDT), Linz, Austria* [2]*Center for Biomarker Research in Medicine (CBmed), Graz, Austria*

[3] *Department of General Surgery, Medical University Vienna, Austria*

[4]*Christian Doppler Laboratory for Applied Metabolomics, Medical University of Vienna, Austria* [5] *Division of Experimental and Laboratory Animal Pathology, Department of Pathology Medical, University of Vienna, Austria*

[6] *Unit of Laboratory Animal Pathology, University of Veterinary Medicine Vienna, Austria*

Email: markus.brandstetter@recendt.at

Abstract

Microplastics (MPs) have raised significant environmental concerns and potential risks to human and animal health. Recent studies have demonstrated that biological organisms can absorb microplastic particles, and once the body ingests it, it can infiltrate various organs. Current standard procedures for detecting MPs involve a time-consuming tissue digestion to remove organic components before analytical evaluation. However, this method needs to include details about the exact locations of the particles within the tissue, highlighting the need for more precise detection techniques to explore the effects of microplastics on human health. Direct analysis of paraffin-embedded samples provides notable advantages, such as preserving the complete tissue architecture of the sections and making historical samples available for examination

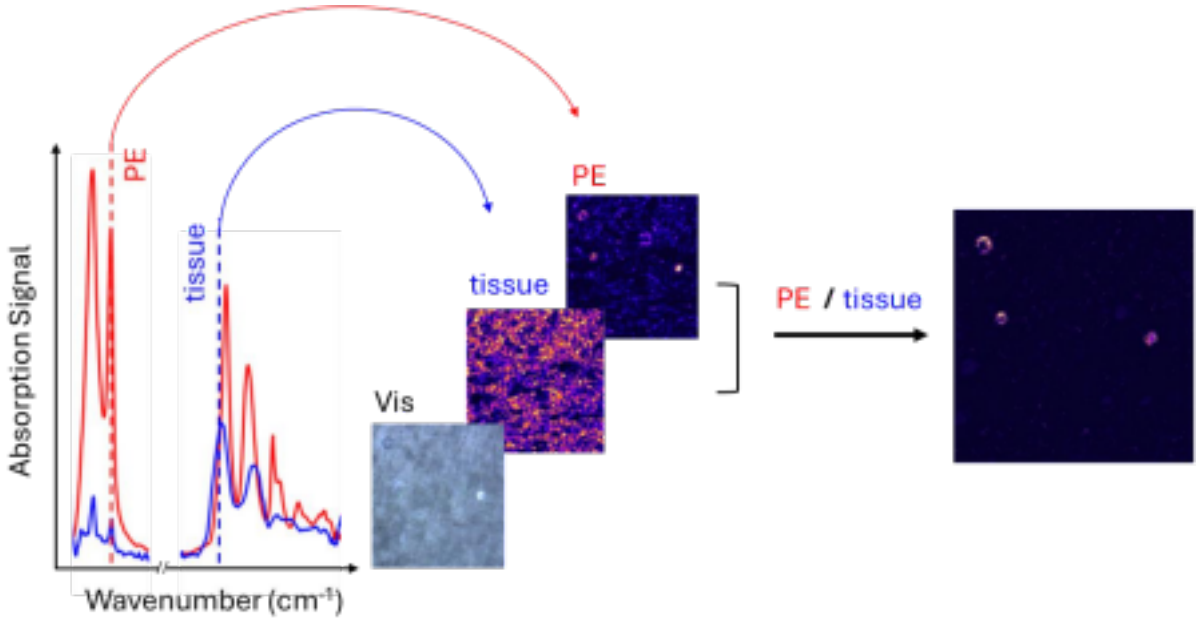
Analysis of biological samples was performed using Optical Photothermal Infrared Spectroscopy (O-PTIR) technology, which delivers high-resolution chemical images by surpassing the diffraction limit of conventional FTIR spectroscopy. This recently introduced technology allows the recording artifact-free infrared spectra with a resolution of ~500 nm (30 times better than traditional methods). Scanning the sample surface either at plastic-related characteristic wavelengths or across the whole entire spectral range using hyperspectral imaging (HSI) enables the creation of chemical images. Standard clinical formalin-fixed and paraffin-embedded (FFPE) histological sections of human colitis samples were subjected to MP detection. With this approach, the availability of standard FFPE samples in clinical settings is leveraged, offering a method well-integrated into the clinical analysis of microplastics in tissue.

The well-preserved structure of cross-sections allowed a precise determination of the tissue regions where MPs are located. This is highly relevant for clinical analyses, as it is not yet known in which tissue regions MPs tend to accumulate. Further, clear identification of MP material was accomplished based on information provided by the infrared spectra. Within this contribution, various human colon samples taken from a clinical study revealed the presence of polyethylene (PE) and polystyrene particles (PS) in various tissue types.

Examining tissue sections using the OPTIR technology simplifies the process by overcoming several steps of a time-consuming pretreatment (digestion) while preserving spatial information on particle distribution. However, our current methodology has provided results on the localization of particles in human FFPE tissue using visible images, chemical imaging techniques, and full spectral analysis.

Keywords : *FFPE tissue sections, human intestine, chemical mapping, photothermal, infrared, spectroscopy*

Graphic Abstract



Development of a Quality Control Tool for Standardising Microplastics Testing on the Laser Direct Infrared Imaging System

Fisayo Olotu[1,2], Nabil Hajji[1,2*], Andy Blackhall[2], Vahitha Abdul Salam[1*]

[1]*Centre for Cardiovascular Medicine and Device Innovation, William Harvey Research Institute, Barts and The London School of Medicine and Dentistry, Queen Mary University of London, United Kingdom.*

[2]*Water Research Centre Limited, Swindon, United Kingdom.*

Corresponding authors: v.abdulsalam@qmul.ac.uk & nabil.hajji@wrcgroup.com

Abstract

Microplastics (MP) in the environment pose significant ecological and human health risks, with potential links to cancer and cardiovascular diseases [1,2]. Accurate risk assessments for human MP exposure are hindered by lack of standard methods to consistently detect, measure, and characterise MP. The Laser Direct Infrared Imaging (LDIR), despite its wide usage [3], lacks standardised reference methods to distinguish 'procedural' polymers from 'actual' MP. This compromises data accuracy and hinders risk assessments protocol development [4]. Existing laboratory guidelines also fail to prevent MP contamination effectively [5]. Herein, for the first time, we present a quantitative standard method for monitoring MP quantification in environmental samples with LDIR imaging system.

The analytical method developed, validated, and applied in this study detected individual polymer from Kevley Low-e IR reflective glass slides (*Kv*), VWR® Polysine®glass slides (*Pol*) and Polycarbonate Gold-Coated Membrane filters (*Gf*) were used with LDIR to detect, quantify, and characterise MPs. These materials were scanned as blanks or subjected to a filtration procedure using negative (1L, microplastic-free water, MfW) or positive (pure polyethylene [PE], polytetrafluoroethylene [PTFE] and polyvinylchloride [PVC]) control samples (*n=4/group*). For us to consider any polymer for positive identification, it must have an estimated quality of ≥ 0.8 (high confidence) and detected in at least three of the four runs.

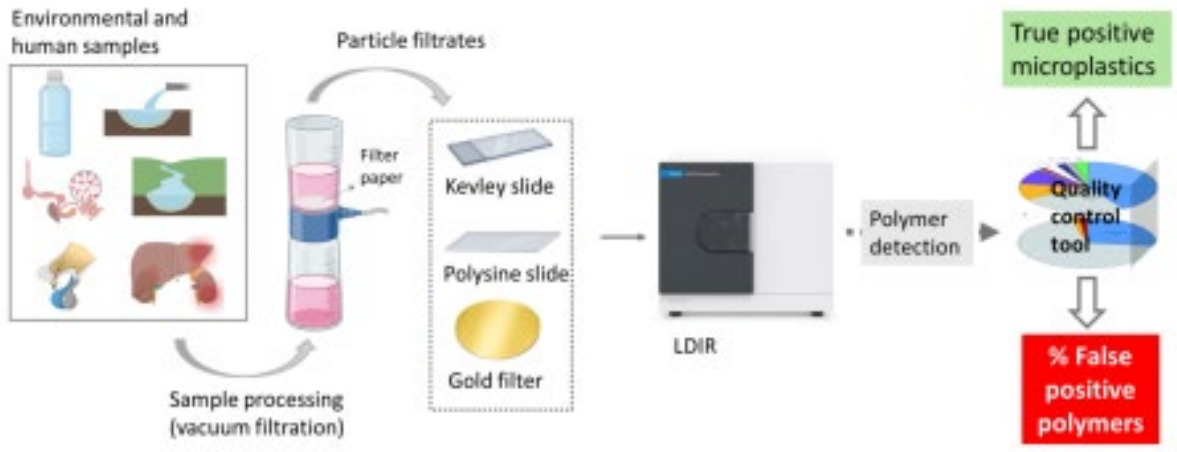
High number of rubber (110.25±56.52), polytetrafluoroethylene (PTFE), polyamide (PA), and cellulose were found in blank *Pol* and *Kv* Background contamination was significantly lower in *Gf,* predominantly with naturally occurring polyamide (PA_n) (3.5±0.58), while others were PA, cellulose, polycarbonate (PC) and polymethyl methacrylate (PMMA). Negative control filtration on Gf (Gold filter) detected cellulose (1.75±0.5), PA (1.0±0.8), Pan LDIR Microplastics Detection Quality Control (9.75±5.3) and PMMA (1.5±1.3) with PA_n being the most abundant. Low-confidence background contamination (quality <0.8)

included polyurethane (PU, 20.75±30.1). Control experiments with glass slides necessitated the use of glass fibre filters and isopropanol, showing significant presence of rubber (106±39.6), PE (5.75±3.5) and PA (2.25±1.9). These quality control (QC) data helped eliminate background noise in positive identification experiments for PE, PTFE and PVC using the *Gf*. The LDIR correctly detected PE, PTFE and PVC but also identified PA_n, cellulose, and some other polymers that we were now able to correctly define the source based on our QC data.

Establishing a standard LDIR QC protocol for identifying background contamination and verifying authentic real MPs is essential for developing accurate human exposure risk assessments. This QC approach can accurately quantify MPs in human tissues or fluids, as well as environmental samples containing polymers like PA, Rubber, cellulose, PMMA and PC.

Keywords: *microplastics, laser direct infrared (ldir) imaging system, polymer, blanks, quality control.*

Graphic Abstract



LDIR Microplastics Detection Quality Control

Painting Microplastics; a Novel Generative Methodology for Future Microplastic Research

Authors: Osborne, TJ*[1]; Preston, J[2]; Couceiro[2], F; Guo, Bing[1]; Commandeur, D[1], Al-Sid Cheikh[3], M.

University of Surrey[1], in partnership with the University of Portsmouth[2]. With contribution from the University of Edinburgh[3]

*Email address of corresponding author: *t.osborne@surrey.ac.uk*

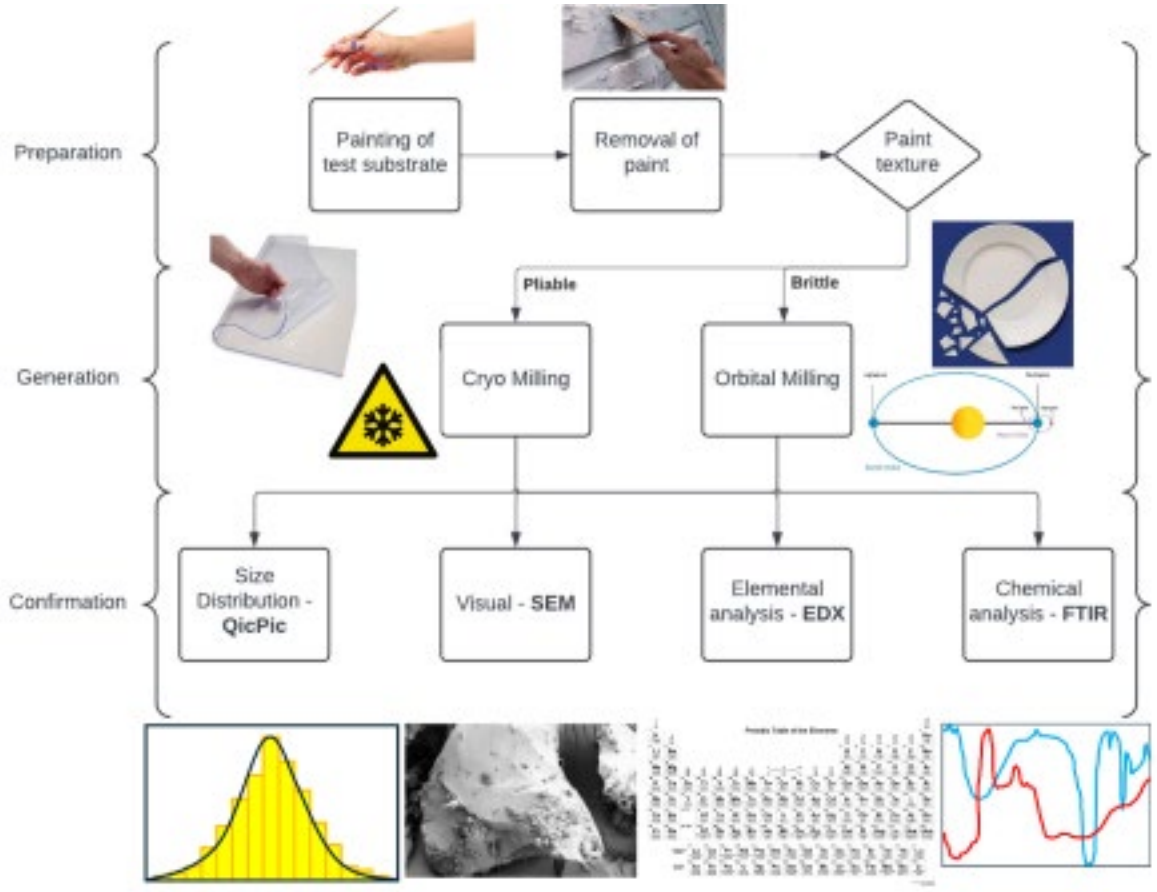
Abstract

Within the field of microplastics (MPs) research, the in-house generation of MP particles has expedited the discovery and exploration of their ecotoxicological effects. Paint has only been identified as a major source of microplastic pollution within the last three years (Turner, 2021; Paruta et al., 2022). As a result, development within the field has been slow to catch up with standard MP research, in part due to the difficulties in successfully finding and identifying paint particles, potentially resulting in an underestimation of paint as a source of MPs. Here, the investigation aims to tackle these challenges and provide a robust methodology by which paint particles (PPs) can be generated from freshly painted material in a form that adequately represents particles found *in situ,* both in chemical and physical characterisation. A combination of mechanical milling techniques has been applied, and particles have been analysed using

Dynamic Image Analysis (DIA) technology with QicPic, Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDX), and Fourier Transform Infrared Spectroscopy (FTIR). The dissemination of such a method will provide a standard operating procedure and enable researchers to generate and manipulate PPs for analytical use in a wide range of environmental, biological, or chemical conditions, dramatically increasing the scope and feasibility of paint MP research worldwide. This methodology may be adapted for use in all fields of paint MP research or built upon to further increase efficacy in particle replication.

Keywords: *microplastic, pollution, generation, paint, plastisphere*

Graphic Abstract



Non-Contact Detection of Fluorescent Microplastic Particles in Water Flow Using Spectrometry

Nico Merck*, Martin Schaeper, Jonas Otto, Nils Damaschke

Institute of General Electrical Engineering, University of Rostock, Albert-Einstein-Straße 2, 18057 Rostock, Germany

*nico.merck@uni-rostock.de

Abstract

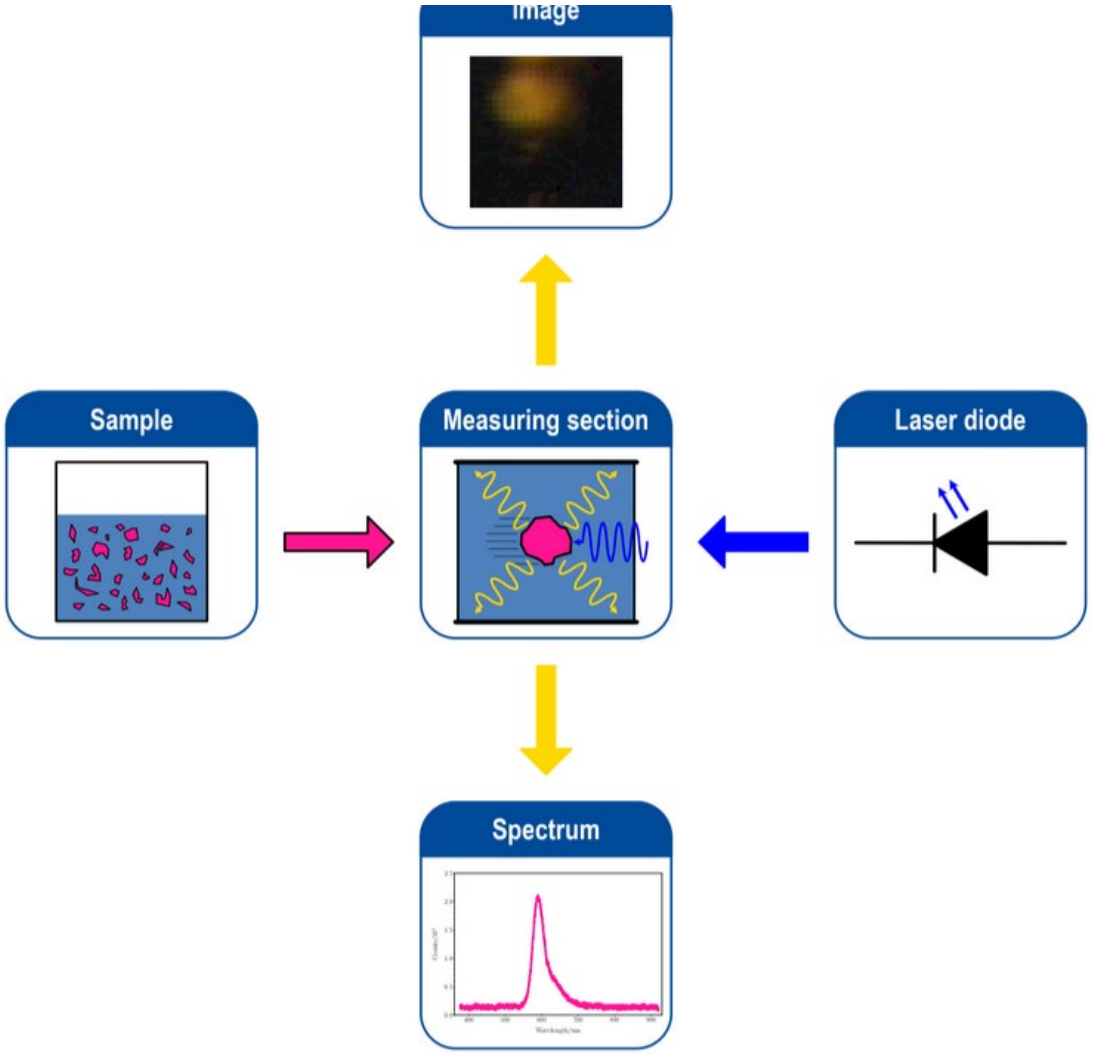
Microplastic pollution increasingly threatens marine habitats, posing serious risks to aquatic organisms. Analysing microplastic sources, sinks, and concentrations remains challenging due to limited sampling possibilities and time-consuming laboratory analyses. Current methods for analysing microplastic concentrations (e.g. manual sampling, filtration, microscopic analysis, FTIR, or Raman spectroscopy) are unsuitable for continuous, large-scale measurements. Therefore, in-situ solutions with continuous process sampling of adequate temporal resolution are required.

There are several measurement techniques for estimating particle concentrations. A distinction is made between integral methods, e.g. LISST, and counting methods, e.g. Phase Doppler, defocussed particle imaging, and shadowgraphy. The latter classify each particle according to properties such as size, speed, shape, etc. Especially in the field of two-phase flow measurement technology, there are many in-situ measurement approaches for the quantitative determination of particle concentrations, volume concentrations, and flow parameters [1]. However, most of these methods are not sensitive to the material properties of the particles. Fluorescence spectroscopic methods present an ideal approach to address the challenges mentioned. Polyethylene (PE), polypropylene (PP), and polystyrene (PS) are among the primary types of plastic found in marine pollution studies [2]. While PE and PP, as olefinic polymers, are non-fluorescent in pure form, they often contain fluorescent impurities [3]. PS is inherently fluorescent [4]. Thus, microplastic classification can be based on the fluorescence properties of these plastics or their impurities. For effective in-situ detection of microplastics, a measurement technique is needed to detect the fluorescence of individual particles in a water flow. In parallel, it is necessary to determine the particle size, especially the volume and surface area, to estimate contamination and chemical reactions by the integral free surface and the mean volume fraction.

This study investigates the feasibility of detecting fluorescent microplastic particles in-situ in a flowing water system. For this purpose, a PP sample with a fluorescent dye is placed in an isopropanol-water mixture corresponding to the density of PP and pumped through a measuring section (Figure 1). A PP sample without the addition of a fluorescent dye is also analysed. In the measuring section, the sample flows into a cuvette with a layer thickness of 2 mm. It is illuminated by a laser diode, and the fluorescence phenomena are recorded by an IDS colour camera and a spectrometer.

Keywords : *fluorescence spectroscopy; fluid flow; microplastic detection; in-situ analysis; laser induced fluorescence*

Graphic Abstract



Toxicological assessment of benzo(a)pyrene - coated PET microplastics in vitro on a 3D model of the human bronchial epithelium

Safaa Mawas[1], Dorian Miremont[1], Linh Chi Bui[1], Justine Renault[1], Charlotte Izabelle[2], Victor Alcolea-Rodriguez[3], Raquel Portela[3], Julien Dairou[4], Stéphanie Devineau[1], Sonja Boland[1]

[1] Unité de Biologie Fonctionnelle et Adaptative, UMR 8251 CNRS, Université Paris Cité [2] Cellular and Molecular Imaging Platform, US25 Inserm-3612 CNRS, Université Paris Cité [3]CSIC-Instituto de Catálisis y Petroleoquímica. 28049, Madrid (Spain)

[4] Laboratoire de Chimie et de Biochimie Pharmacologiques et Toxicologiques, UMR 8601 CNRS, Université Paris Cité

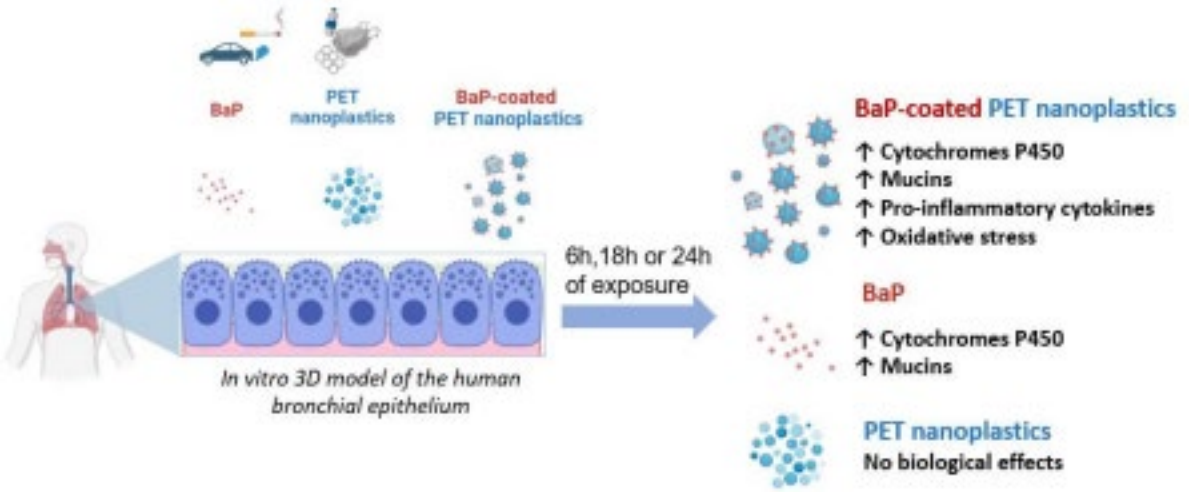
Email address of corresponding author: safaa.mawas@etu.u-paris.fr

Abstract

Exposure to airborne microplastics (MPs) may pose a potential threat to human health, as several studies have detected MPs in the respiratory tract[1,2]. These MPs may act as carriers of airborne pollutants, like polycyclic aromatic hydrocarbons (PAHs). The aim of our study is to perform a toxicological assessment of co-exposure to airborne MPs and a PAH known for its toxicity, benzo(a)pyrene (BaP). To evaluate this, we developed the coating of polyethylene terephthalate MPs (PET, 70 nm) with BaP and assessed their toxicity in vitro on a 3D model of the human bronchial epithelium[3]. The Calu-3 cell line was exposed to PET (15 µg/cm^2) or BaP (10 µM) alone or in combination (15 µg/cm^2 PET MPs coated with BaP) at the air liquid interface. Transmission electron microscopy has shown that PET can be internalized by the bronchial epithelium. No effects on the barrier integrity (Transepithelial electrical resistance) and cell viability (AlamarBlue assay) were observed after 6h, 18h and 24h of exposure. BaP and BaP-coated PET induced the overexpression of cytochromes P450 mRNAs. This suggests that BaP is bioavailable when adsorbed on PET MPs. We are currently assessing the metabolization pathway of BaP desorbed from PET MPs in the bronchial epithelium. BaP coated PET induced the overexpression of mucins, anti-oxidants and inflammatory cytokines mRNAs after 6h, 18h and 24h of exposure. Repeated exposuresto BaP-coated MPs are ongoing to assess the long-term effects of daily exposure to PAH-contaminated MPs. Our results emphasize the importance of studying the interaction of MPs with airborne contaminants and its influence on their toxicity.

Keywords : nanoplastics, airborne contaminants, human bronchial epithelium, internalization ,inflammation, Toxicity of inhaled Benzo(a)pyrene contaminated-PET nanopalstics

Graphical abstract



Marine plastisphere: vector for accumulation of trace metals and interesting species

Joao Frias, Ph.D.

Marine and Freshwater Research Centre,Atlantic Technological University,

Dublin Road, H91 T8NW, Galway, Ireland

Abstract

Plastic pollution is a global environmental problem described under the novel entities of the planetary boundaries as having an increased risk, as it is already surpassed the safe operating space. Once released into the marine environment, plastics undergo fragmentation and degradation processes resulting from ultraviolet radiation, salinity, temperature, and abrasion. These processes are enhanced by the plastisphere, a biofilm layer that surrounds plastics in the marine environment. The plastisphere can concentrate persistent organic and inorganic pollutants while hosting a variety of microorganisms, some of which being potentially pathogenic.

This talk highlights the results from the MicroplastiX project, an international project focussed on the effects and consequences of biofilm growth in several polymers that were deployed *in situ* in cages across Europe and South America. The purpose of this project was to assess how biofilm would influence fragmentation and degradation processes, while estimating concentrations of trace metals and interesting species found hitchhiking plastics, particularly in the West of Ireland.

Effects of Microplastics on Growth and Yield of Tomato Under Greenhouse Condition

Adeola Adelugba, Mason MacDonald, Sam Asiedu, Lord Abbey, Chijioke Emenike

Department of Plant, Food, and Environmental Sciences, Faculty of Agriculture, Dalhousie University, Canada

Email address of corresponding author: adeola.adelugba@dal.ca

Abstract

Microplastics (MPs), which have been commonly defined as plastic particles of diameter sizes between 1000 to 5,000 µm are fast becoming an increasing cause of environmental and health issues. Compost application has proven to be a highly effective method for incorporating nutrient-rich humus into the soil to stimulate robust plant growth, however, this soil enhancer has also been reported as a major route of MPs contamination in agricultural soils. Previous studies have illuminated MPs as a potential threat to plant growth, yield, and quality, hence, the need to investigate the effect of MPs on plants. Tomato (*Solanum Lycopersicum L.*) is globally recognized as one of the most grown vegetables, with a significant increase in annual production. This study investigated the effect of varying MP types [polyethylene (PE), polystyrene (PS), and polypropylene (PP)] on Tomato plant growth under greenhouse conditions. The tomato pot experiment was spiked with the various MP types at 1% w/w (MPs/soil) while the non-spiked growth media served as the control system. Statistical analysis was carried out using the General Linear Model of analysis of variance (ANOVA), and Tukey test (95% confidence) was used for comparison of the treatments and control. The results showed that PS-treated plants outperformed the control plants in all physiological parameters including the chlorophyll fluorescence (Fv/Fo –2.13 %, Fv/Fm – 0.44 %), sub-stomata CO2 concentration (3.75 %), transpiration rate (27.47 %), stomata conductance (55.58 %), and photosynthetic rate (22.99 %). Similarly, the morphological data showed that the performance of PS-treated plant exceeded other treatments including control in the total fruit weight (15.77 %), total root length (22.25 %), root tips (79.02 %), and the fruit diameter (8.43 %). Additionally, PP performed better than control in the fruit number, but the control outperformed all treatments in both root volume and total root surface area by 12.16 %. These findings suggest that the presence of PS-MP in soil can cause improvements in the above-ground performance of tomatoes. However, MPs in agricultural soil can disrupt the below-groundmactivities causing reduction in the root surface area, and volume causing an improvision of elongated root length and more tips.

Keywords: *Microplastics; vegetable production; polystyrene; Solanum lycopersicum*

Poster Presentation Abstract

Potential Human Health Risk of Microplastics and NanoPlastic at Cellular, Organismand Population Levels.

Kingsleysomtochukwuokoli, nigeria. Anambrastate primaryhealthcaredevelopmentagency
Email: nursesomto1982@gmail.com

Abtract

Potential human health risk posed by Microplastics and Nanoplastics have been matters of advancing trends and concerns pertaining to impact on human health. There has been also attendant result of Microplastic and Nanoplastic on human health becoming undefinable. This Research work focuses on potential health risk of Microplastics and Nanoplastics at a cellular, organism and population levels. This project highlights the three most outstanding routes resulting to human vulnerabilityto micro and nano-plastics. They are skin contact, ingestion and inhalation.

Provisions were made for forecast and possible outcome on future research substantiated for Microplastics and Nanoplastics in human health. There are notable instances that microplastic -and nanoplastics are found in body fluid and human tissue. Laboratory investigations involving vivo animal models and in vitro human-derived cell culture indicated that microplastics and nano-plastics exposure has the tendencyto complicate human health.

Exposure to Microplastics and Nanoplastics manifest to cytotoxicity, oxidative stress, tissue disruption, homeostasis imbalance, endocrinal collapse, disorganization of gastro intestinal tract, low immunity, reproductive and developmental toxicity. Limited sources of epidemiological studies suggest that disease condition such as blood thrombus, Lung Nodules and Asthma may possibly be escalated by exposure to Microplastics and Nanoplastics.

Clear evidence of potential human health risk of Microplastics and Nanoplastics remain unavailable and future research in this aspect is needed to allocate quantitative assistance for identifying the damages posed by Microplastics and Nanoplastic to humanHealth.

A review of microplastics and nanoplastics and their impact on human and planetary health with bioethical considerations.

Alexander R. Waller
American University of Sovereign Nations
Corresponding email: arwaller1@hotmail.com

Abstract

Microplastics and nanoplastics are now ubiquitous in the natural environment and are being found in ever-increasing quantities in various tissues of living organisms. Several components of synthetic polymers such as bisphenol plasticisers have been linked to the endocrine system, others have been linked to allergic reactions such as asthma and some have been identified as carcinogens. When these impacts are repeated throughout numerous organisms in food chains, food webs and ecosystem cycles then there are going to be further, possibly as yet unidentified, synergistic impacts.

These collective detrimental effects on the health of the planet as a whole are worthy of ethical consideration to add weight to arguments that call for immediate action to address this form of pollution. There is also a need for greater awareness raising and education regarding the health consequences of microplastics and nanoplastics in the environment and what people can do to reduce the health risks.

Keywords: *bioethic, endocrine disrupting chemicals (EDCs), planetary health*

Microplastics removal from water using triethoxy(octyl)silane modified superhydrophobic geopolymer filter

Mohammad Bhuyan[1,*], Rosa Busquets[2], Luiza Campos[3], Tero Luukkonen[1]

[1]*Fibre and Particle Engineering Research Unit, University of Oulu.*
[2]*Kingston University.*
[3]*University College London.*
Corresponding author: mohammad.bhuyan@oulu.fi

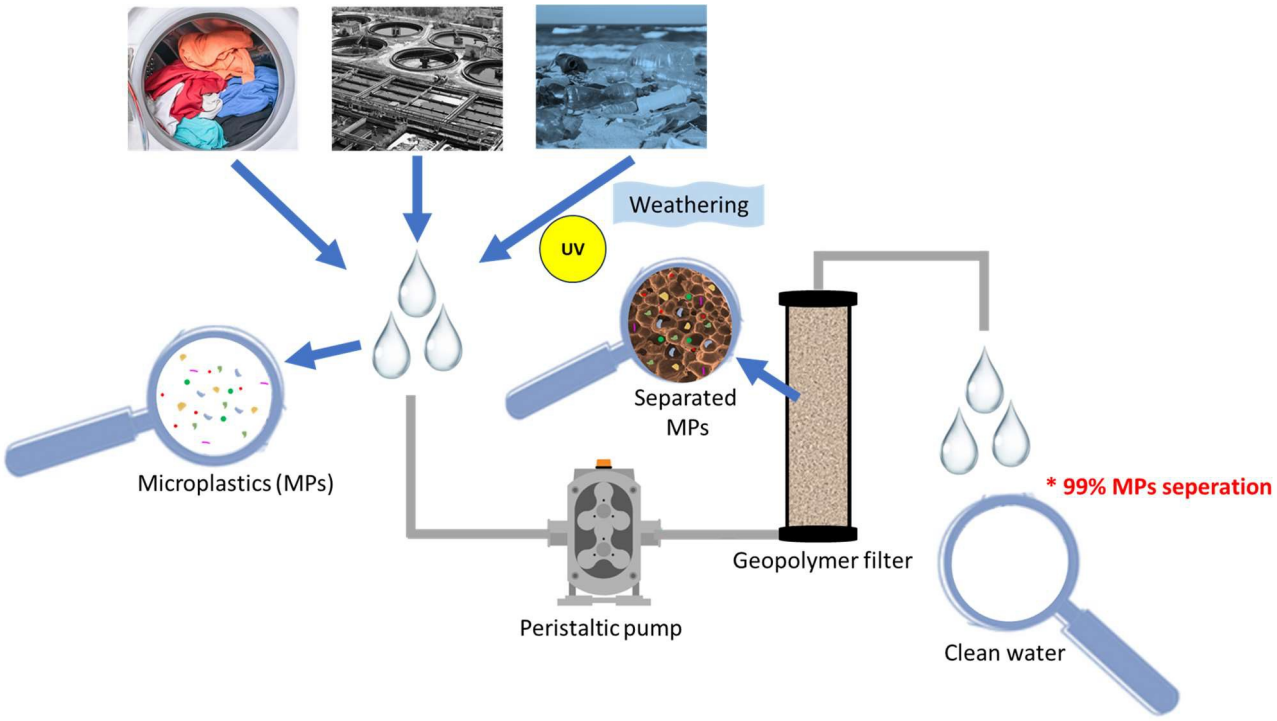
Abstract

The use of plastics has increased significantly. According to an estimation in 2018, the production of plastics or plastic products was roughly 359 million tons per year[1]. A large fraction of plastics is introduced into the environment, which poses a serious problem as plastics are not degraded easily[2]. Microplastics (MPs), particles of plastic with a size smaller than 5 millimeters, have been identified as a new form of environmental pollution[3]. MPs are produced either industrially for specific purposes and then released into the environment directly, or they are generated from the fragmentation of large plastic pieces in the environment. MPs are already in the soil and aquatic environment, furthermore, their presence in the human body and aquatic organisms has already been identified[4]. MPs have the potential to serve as carriers for a variety of harmful substances, such as persistent organic pollutants, heavy metals, and drug-resistance genes, due to their large surface area, hydrophobicity, and capacity for high adsorption[5].

Given the detrimental effects of these pollutants, the presence of MPs in aquatic environments and their ingestion by humans has become a growing concern. The utilization of alkali- activated materials or geopolymers, which are produced through the processes of alkali-activation and geopolymerization from industrial by-products or natural minerals, has garnered significant attention in the field of water and wastewater treatment. Geopolymer filter after hydrophobic modification exhibits promising potential in the removal of MPs from aquatic environments because of hydrophobic-hydrophobic interaction. In our study, geopolymer filters were successfully developed from metakaolin using direct foaming technique and modified to hydrophobic geopolymer with a silane coupling agent and employed for MPs separation from water. Filter with and without modification have been investigated for the removal of polyethylene MPs (53 -63 µm) removal from model water (containing 5 mg/L of polyethylene MPs) for different empty bed contact times. The modified filter performed better than the filter without modification. In the longer-time experiment, the modified filter performed more than 99 % MPs (1.9 million) removal for the treatment of 200- bed volumes of water (≈ 30 L). Moreover, the study examined the removal of microfibers (2 – 2000 µm) from the wastewater produced by washing three blankets using both modified and unmodified filters and compared their performance in treating 48-bed volumes of water. Following the treatment of 48 volumes of water, the modified filter demonstrated an efficiency of 84% in removing microfibers, in contrast to the unmodified filter's efficiency of 52%. This result provides a proof concept of effective microplastic separation by using superhydrophobic geopolymer filter. In future the effectivity of geopolymer filter in the separation of smallest microplastic and nanoplastics can be investigated in detail. Furthermore, I am eager to acquire knowledge about the identification and quantification of MPs and nanoplastics, as well as their transport, fate, and ecotoxicology by learning new techniques and methods.

Keywords: *geopolymer, filtration, microplastic, superhydrophobic*

Graphic Abstract



Microplastics removal from water using triethoxy(octyl)silane modified superhydrophobic geopolymer filter

A perspective study on occurance, impacts and sources of microplastics in the marine environment of south china sea and gulf of thailand – A review

Suriyanarayanan Sarvajayakesavalu
Associate Dean Research, JSS Science and Technology University, JSS Technical Institutions Campus, Mysuru, Karnataka, India
Corresponding author: asso.dean@jssstuniv.in

Abstract

The continuous discharge and the presence of the plastic wastes is a global environmental issue requires an immediate mitigation and prevention measures to avoid and safeguard the marine biota and human health. Distribution, fate and effects of microplastics on the environment have gained more attention in recent years. The present study aims to synthesize the available data of microplastics to identify the load and trend of abundance in marine environment of South China Sea and the Gulf of Thailand based on mounting evidences on the microplastics reports. The major input of the microplastics to the South China Sea contributed from Pearl River and the Mekong Rivers of Vietnam and Cambodia. Among the available literature the Gulf of Thailand foundmedium plastic abundance level when compared to the other areas. surrounding areas. The outcome of these findings will be an aid in providing the management strategies and decision making in decreasing the entry of microplastics into the South China Sea and Gulf of Thailand which is considered as the most sensitive hotspots in contributing the discharge of plastics into the marine environment.

Keywords : *microplastics, South China Sea, Gulf of Thailand, Mekong River, Pearl River, Biota*

Bio-based natural colour infused edible films for food packaging : an alternative to single- use plastics

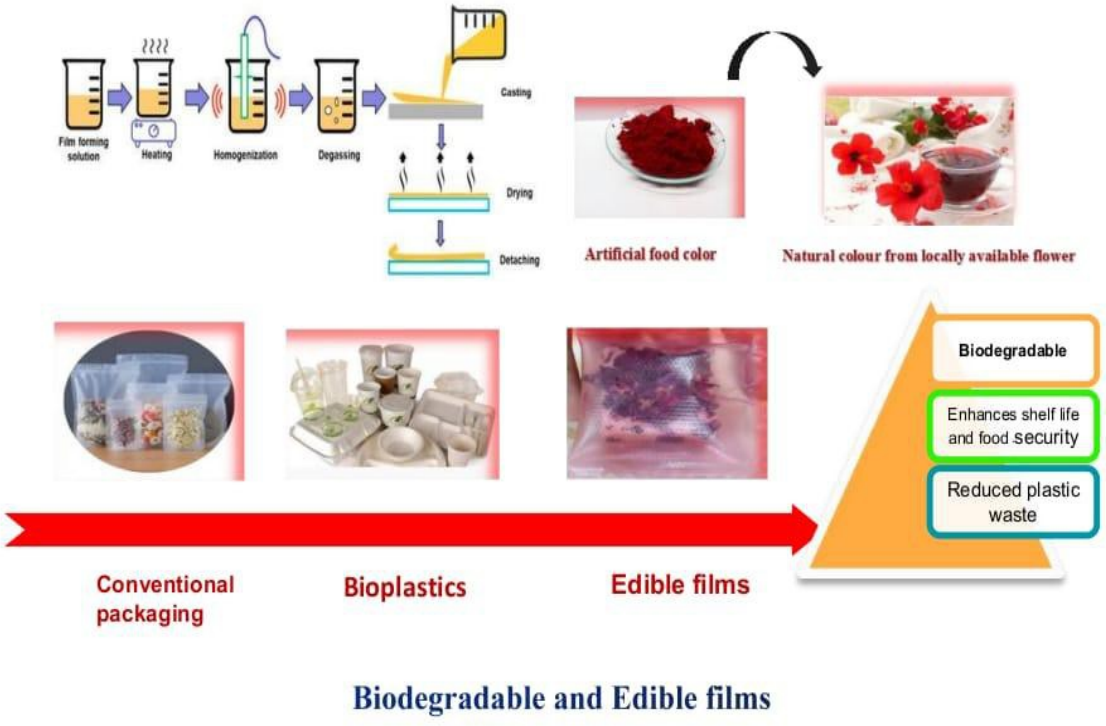
Dr. Paraajeswari, M.Malathi*
Avinashilingam Institute For Home Science And Higher Education For Women,Coimbatore ,Tamilnadu ,India
Corresponding author: malathimahalingam20@gmail.com

Abstract

The development of natural colour - infused edible films from biobased polymers represents an innovative approach to sustainable food packaging which can be obtained from biodegradable materials and have properities similar to common plastics.The objective of this study was to integration of natural colorants into edible films is an excellent substitute for synthetic colorants, the use of natural colorants can also serve as carriers for bioactive compounds,further enhancing food safety and quality.This study determined the potential of *Hibiscus rosa sinensis* flower extract as a substitute for synthetic colorants. The raw material identified for the formulation and development of natural colour infused edible film are of low cost, easily and locally available flower which promotes sustainability and supports biodegradability.The films were developed by the different concentration of hibiscus aqueous extract of 40ml,80ml,120ml, the film developed using tapioca starch as a polysaccharide, glycerol as a plasticizer to increase stability of the film.The film developed and tested for its sensory evaluation. The sensory analysis was done with semi trained panel members evaluated through sensorial method the different treatments in terms of appearance , taste ,texture and colour by nine- point hedonic scale . The film tested for its functional properties like moisture content, moisture permeability,thickness, tensile strength and microbial analysis.The results showed that 120ml of aqueous extract into edible film has improved the colour and appearance. The best formulated natural colour infused edible film contains 9.0% of moisture content,11.5 of moisture permeability, 0.11mm of thickness,1.44 mpa of tensile strength .There was a less growth of bacteria was observed in the seven days of microbial analysis. The incorporation of anthocyanin extract into edible films not only enhances appeal and promoting biodegradability , supports economic sustainability in agriculture through the use of renewable resources and enhances public health by offering safer alternatives to synthetic colorants,contributing to a significantly reduced carbon footprint.

Keywords: *biodegradable films, natural pigments, sustainable food packaging ,bioactive compounds*

Graphical Abstract



Biodegradable and Edible films

Foliar implications of polystyrene nanoplastics on leafy vegetables and its ecological consequences

Muhammad Ilyas [1,2], Xin Liu [1,2], Jie Yang [1,3*], Guorui Xu [1 *]

[1] *CAS Key Laboratory of Tropical Forest Ecology, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Menglun, Yunnan, 666303, China.*

[2] *University of Chinese Academy of Sciences, Beijing 100049, China.*

[3] *National Forest Ecosystem Research Station at Xishuangbanna, Mengla, Yunnan, 666300, China*

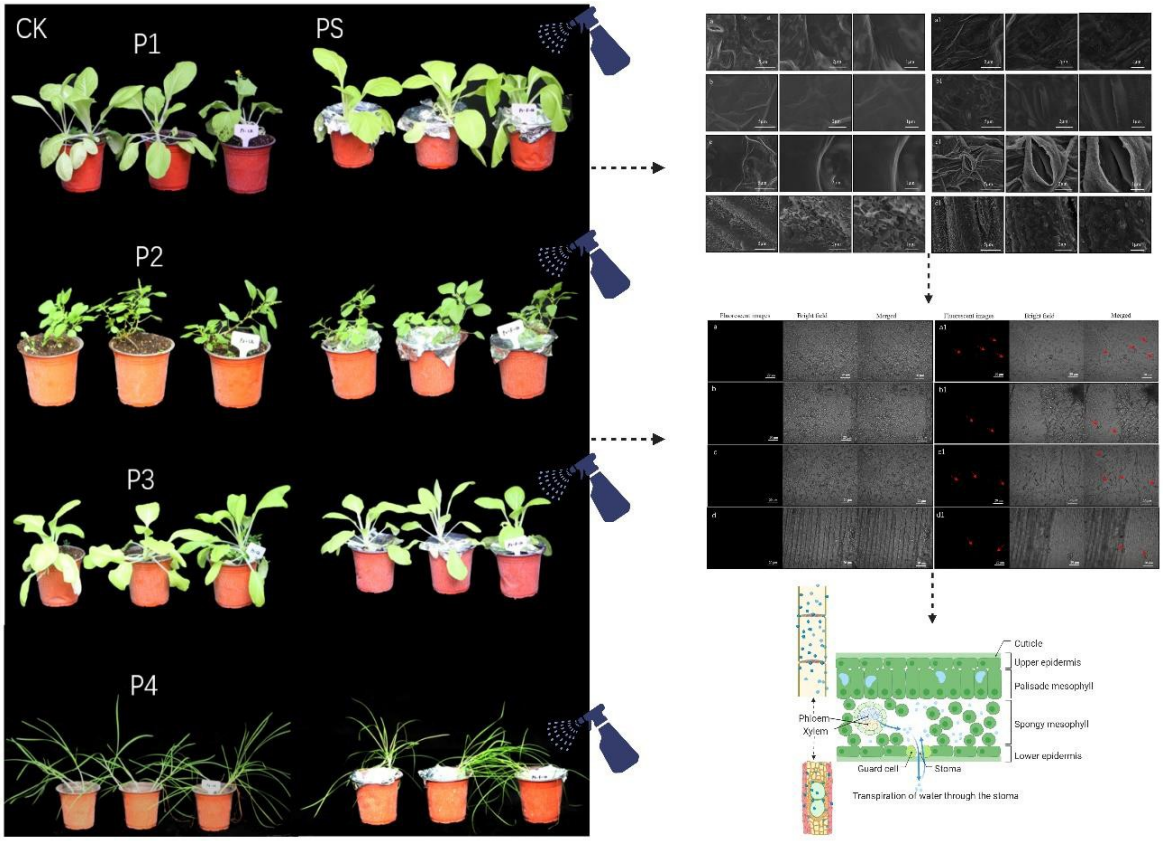
corresponding author: yangjie@xtbg.org.cn, xuguorui@xtbg.ac.cn

Abstract

The rise of airborne micro-nanoplastics (MNPs) pollution is posing a significant threat to agroecological systems. Despite this dilemma, a critical void exists in our understanding of their specific consequences on diverse leaf-textured vegetable species. To bridge this knowledge gap, we conducted a controlled experiment involving the foliar application of Polystyrene Nanoplastics (PS-NPs) on four leafy vegetables, including *Brassica rapa* var. *chinensis*, *B. rapa var. parachinensis, Amaranthus viridis*, and *Allium tuberosum*. The results showed that PS-NPs tended to accumulate within the epidermal layers and cuticles of leafy vegetables, particularly congregating around stomatal apertures. Compared to the cross section, more PS-NPs were found in the adaxial and abaxial side of leaf. The abundance of PS-NPs accumulations significantly varied among the studied vegetable species due to their leaf structure. Notably, the presence of trichrome on the leaf surface demonstrated the potential to entrap more PS-NPs particles. The aggregations and accumulation of these particles had significantly reduced chlorophyll contents and photosynthetic rate, which further altered the growth and nutritional quality of leafy vegetables. Our findings reveal the ecological effects of PS-NPs on the nutrient, phenotype, physiology and fitness of typical vegetable plants and highlight the potential for their accumulation within edible plant tissues, thus raising concerns regarding both food security and human health.

Keywords: *polystyrene nanoplastics (PS-NPs), leafy vegetables, accumulation, fitness, leaf structure, food security*

Graphic abstract



Toxicity of inhaled Benzo(a)pyrene contaminated-PET nanoplastics

Toxicity of inhaled Benzo(a)pyrene contaminated-PET nanoplastics: Assessing plastic trapping in Moroccan macroalgal blooms: Implications for coastal tourism and microplastic studies

Mohamed Ben-Haddad[1,*], Mohamed Rida Abelouah[1], Sara Hajji[1], Jaouad Abou Oualid[1], Nelson Rangel-Buitrago[2], Aicha Ait Alla[1]

[1] *Laboratory of Aquatic Systems: Marine and Continental Environments (AQUAMAR), Faculty of Sciences, Ibn Zohr University, Agadir, Morocco*

[2] *Programa de Física, Facultad de Ciencias Basicas, Universidad del Atlantico, Barranquilla, Atlantico, Colombia*

**Corresponding author: mohamed.ben-haddad@edu.uiz.ac.ma*

Abstract

Coastal tourism, a vital economic pillar for many regions, confronts escalating challenges from macroalgal blooms, notably in the Moroccan Atlantic. These ecologically significant blooms display a dual problem: they detrimentally influence marine ecosystems and interact closely with marine plastic pollution. Thus, this research investigated the blooms' propensity to ensnare plastics. We found that 1068 items were trapped within *Codium decorticatum* blooms with a global mean of 0.022 ± 0.007 items/m^2, predominantly coming from recreational activities. The three most prevalent litter types in bloom areas were food containers, caps/lids, and drinks. Such entrapment, combined with the degradation of coastal aesthetics and the fostering of harmful pathogenic conditions, compounds the threats to coastal tourism. A significant example is the *Ceramium* sp. bloom, which imposed bathing bans and restricted access, affecting core tourism activities in the study area. Comprehensive management encompassing early bloom detection, public awareness, adaptive tourism strategies, and efficient waste handling are crucial. Hence, those strategies will offer a roadmap to navigate the intertwined issues of macroalgal blooms and their ramifications on coastal tourism, as well as the potential impacts of micro- and nanoplastics on algal communities.

Keywords: *plastics, algal bloom, entrapment, anthropogenic activities, pollution, coastal tourism.*

Repurposing fruit waste as a Sustainable Alternatives against Single Use Plastic

Yasmin Basheer Ahmed[1], Dr. Paramasivam Raajeswari[2,*]

[1]*Food Science and Nutrition, Avinashilingam University, Coimbatore 641 043, Clinical Nutrition, University of Hafr Al Batin, Saudi Arabia.*

[2] *Food Science and Nutrition, Avinashilingam University, Coimbatore 641 042*

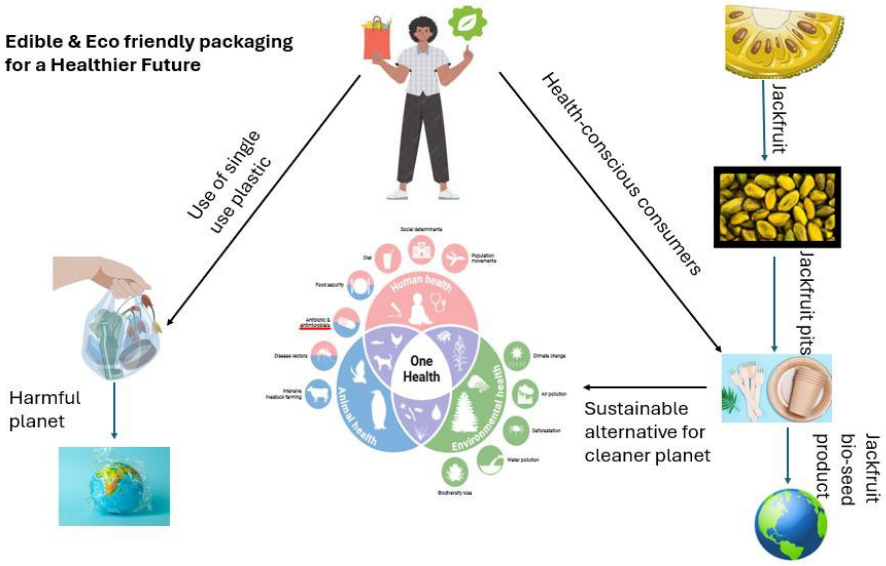
[*]*Corresponding Author, 21phfnp002@avinuty.ac.in, ybahmed@uhb.edu.sa*

Abstract

The study investigated using jackfruit seed flour and date palm powder, both agricultural byproducts, to create edible and eco-friendly cutlery and crockery. Jackfruit seeds were debarked, dried, and ground into flour. Dates were pitted and ground into powder. Edible cutlery and crockery were formulated combining jackfruit seed flour, date palm powder, and binding agents. Different production methods were used, like pneumatic techniques for cups and straws, and hydraulic presses for plates and spoons. Factors like temperature, pressure, and baking time were adjusted to achieve the desired final products. The formulated cutlery and crockery were baked, with eco-friendly options requiring higher temperatures. Sensory evaluation showed that the resulting edible options were well-received. The characterization of the final products included nutrient analysis, texture analysis, drop tests, and exposure tests. The edible cutlery provided some nutritional value, while the texture analysis showed varying degrees of crispness and breaking force. Drop tests assessed how well the cutlery and crockery could withstand falls. Food holding capacity tests were conducted for cups. Microbial load analysis was performed to assess hygiene. Finally, a degradability test demonstrated the eco-friendly nature of both the edible and eco- friendly cutlery and crockery. In conclusion, this study successfully produced edible and eco- friendly cutlery and crockery by combining jackfruit seed flour and date palm powder. The edible options offered some nutritional value and were generally well-liked. Both types of cutleries and crockery have the potential to reduce dependence on traditional plastic utensils and contribute to a more sustainable future. Future research could focus on commercialization and wider consumer adoption of these products.

Keywords: *edible cutlery, eco-friendly cutlery, agricultural waste, valorization, biodegradable tableware*

Graphical abstract :



Bioactive edible packaging film from banana leaves infused with basil essential oil: An alternative to single-use plastics

[1] J Divya Pramitha, [2]Dr.Pa. Raajeswari, [3]Bhavasri.S
Corresponding author: jskdivya@gmail.com

Abstract

The escalating burden of plastic pollution from food packaging highlights the urgent need for alternative green materials with similar functions and properties, particularly packaging materials derived from biowaste is gaining momentum in order to ensure sustainability. Development of edible film utilising the materials derived from agricultural waste and underutilised resources, could successfully alleviate this issue in the long term. The study aims to develop a bioactive and multi-composite edible film utilising two plant-based polysaccharides: cellulose from discarded banana leaves and starch from tapioca for food applications. The film matrix is enriched with banana flower bract anthocyanin extracts (BFBAEs) and basil essential oil (BEO), using underutilised and cost-effective raw materials to offer an alternative to single-use plastics. The primary goal is to create an appealing, health- beneficial, and shelf-life-extending edible packaging solution. BFBAEs, serving as a natural food colourant, and BEO, acting as an antimicrobial agent, are incorporated to enhance the film's properties. The methodology includes extracting polysaccharides from discarded banana leaves and tapioca, integrating BFBAEs and BEO into the film matrix, and evaluating the mechanical, biodegradable, and antimicrobial properties of the resultant film. The infusion of BFBAEs and BEO demonstrated excellent compatibility with the banana leaf and tapioca starch matrix, enhancing sensory parameters, shelf life, and biodegradability compared to films without these additives. The study underscores the potential of using readily available agricultural waste to develop sustainable and functional edible packaging solutions. In conclusion, the development of this bioactive edible film not only utilises waste materials but also provides a promising alternative to conventional plastic packaging. The integration of natural bioactive compounds from banana flowers and basil essential oil enhances the film's mechanical properties, biodegradability, and antimicrobial activity, making it an attractive option for food packaging. This study highlights the feasibility and benefits of creating sustainable, health-promoting, and eco-friendly packaging materials from agricultural waste, paving the way for future advancements in edible film technology.

Keywords: *bioactive and multi-composite edible film, plant-based polysaccharides, green materials, sustainability*

Graphical Abstract


COMPLETE
SOLUTION


1
Identification and selection of cellulosic rich agricultural waste raw materials from food sources.
2
Extraction the lignocellulosic biomass from the agro-waste raw material.
3
Formulation and standardization of the film.
4
Addition of the essential oil for antimicrobial property and food colors
5
Analysis of the edible film for its properties and characteristics.

Navigating the microplastic contamination in surface water: An in depth analysis of the microplastics in surface water bodies of Rohtak district, Haryana India

Nishita Narwal[1*]

[1] *University School of Environment Management, Guru Gobind Singh Indraprastha University, New Delhi-110078, India*

[*] *Correspondence: nishitanarwal@gmail.com*

Abstract

The issue of microplastic contamination has emerged as a significant environmental concern, impacting both land-based ecosystems, water bodies, and the well-being of human beings. Significant plastic fragments disintegrate into smaller particles, presenting a threat to biodiversity. This study investigates the distribution, occurrence, and potential impacts of microplastics in surface water bodies located in the Rohtak area of Haryana, India. The collected results have been used to investigate the pathways of transport, sources, origin, and ecological impacts. The morphology of microplastics was examined using stereo microscopy and FESEM, while the elemental content of polymers was analysed using FTIR. The findings indicated that microplastics were detected in all samples obtained from the five administrative blocks of Rohtak. The study revealed that the concentration of microplastics ranged from 10 to 28 items per litre, with an average value of 6.8 ±0.4 particles per litre. The study region predominantly contained polyethylene, polypropylene, and polystyrene polymers. The bulk of the MPs had a fibrous structure, with the following distribution: fibres (43.9%), fragments (23.7%), films (17%), and pellets (15.4%). The MPs displayed a size distribution ranging from 0.61 to 4.87 mm, with an average size of 2.03 ±0.04 mm. The microplastic pollution load index values for the surface water bodies were determined to be less than 10, giving a risk category of I. This study emphasises the impact of human activities, such as industrial waste, open waste dumping, and improper municipal waste management, on microplastics. It also emphasises the importance of sustainable alternatives and mitigation strategies to address this emerging pollutant in urban water bodies.

Keywords: *microplastics, emerging pollutants, pollution load index, urban water bodies, polymers*

Global perspective of microplastic pollution in surface waters, biodegradation, and corresponding mechanisms

Mohd Ashraf Dar, Garima Kaushik*
Department of Environmental Science, School of Earth Sciences, Central University of Rajasthan, BandarSindri, Ajmer 305817, Rajasthan, India
**Corresponding author: garimakaushik@curaj.ac.in (Garima Kaushik).*

Abstract

Plastics are very beneficial materials that have numerous applications in daily life. However, the widespread use of plastic and products made of plastic has resulted in worrying levels of plastic pollution in several environmental compartments worldwide. Scientists are very concerned about the tiny, persistent, and ubiquitous particles known as microplastics (<5mm) that are produced as a result of several biogeochemical processes from this plastic trash. Microplastics have a negative impact on organisms because they have a tendency to bioaccumulate, carry hazardous chemicals, and have other contaminants adsorbed on their surface. Microplastics are now ubiquitous worldwide, present in nearly every environmental niche. Consequently, the goal of this paper is to provide a summary of the literature on the subject, highlight the evidence of microplastic pollution in surface waters, and analyze the analytical synopsis of current research on the microbial degradation of microplastics, the effects of different parameters on this degradation, as well as the possible mechanism of microplastic degradation. The most recent and pertinent research on microplastic contamination is compiled here, and microorganisms such as bacteria, fungi, and algae that are capable of decomposing different kinds of microplastics are categorized based on their kind. This research acts as a guide for future studies investigating effective strategies to lower the pollution caused by microplastics.

Keywords: *microplastic, microorganisms, degradation, degradation mechanism*

Microplastics meet invasive plants: unraveling the ecological hazards to agroecosystems

Babar Iqbal[a,b,c,†], Xiaoxun Zhao[a,†], Kiran Yasmin Khan[a], Qaiser Javed[a], Mudasir Nazar[a], Ismail Khan[a], Xin Zhao[d], Guanlin Li[a,b,c,*], Daolin Du[a,*]

[a]*School of Emergency Management, School of Environment and Safety Engineering, Jiangsu Province Engineering Research Center of Green Technology and Contingency Management for Emerging Pollutants, Jiangsu University, Zhenjiang 212013, People's Republic of China*

[b]*Ministry of Education Key Laboratory of Pollution Processes and Environmental Criteria, Nankai University, Tianjin 300350, People's Republic of China*

[c]*Jiangsu Collaborative Innovation Center of Technology and Material of Water Treatment, Suzhou University of Science and Technology, Suzhou 215009, People's Republic of China*

[d]*Department of Civil and Environmental Engineering, College of Engineering, Seoul National University, Seoul 08826, Republic of Korea*

[†]*These authors contributed equally to this work and share first author,* [*]*These authors contributed equally to this work and share corresponding author.*

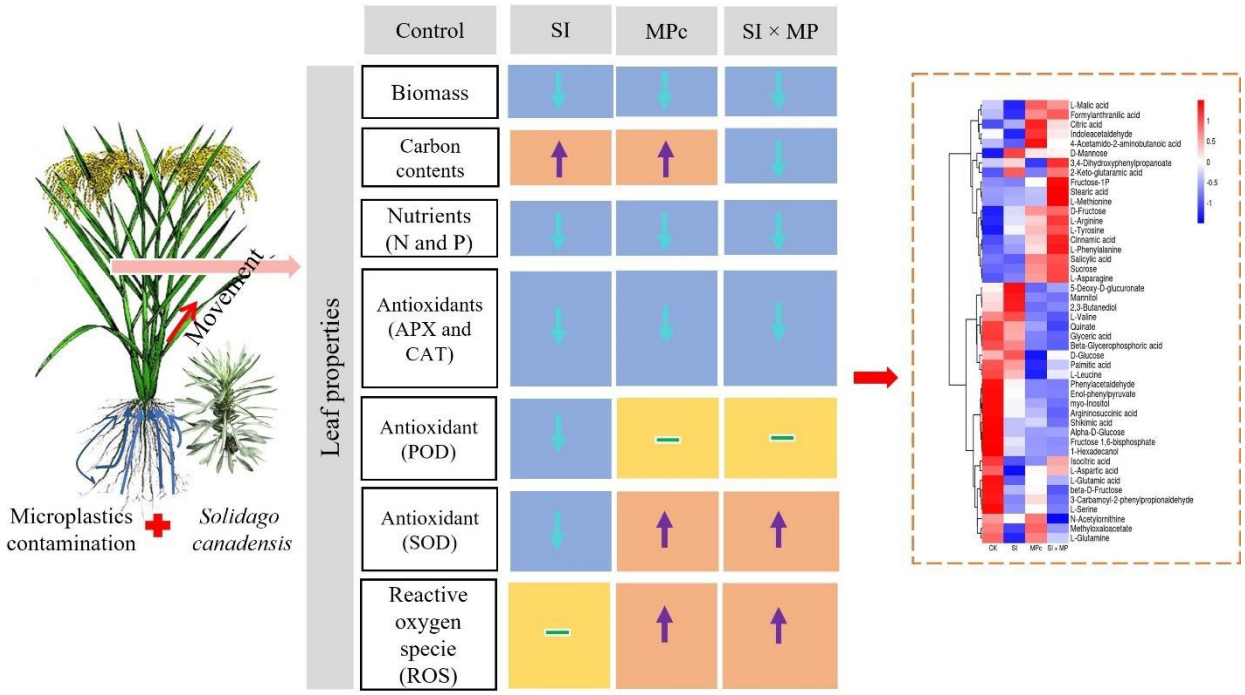
[*]*Correspondence email: liguanlin@ujs.edu.cn; ddl@ujs.edu.cn;*

Abstract

The objective of this study was to assess the combined impact of environmental microplastic pollution and biological invasion which represent critical global eco-environmental challenges. The invasion of *Solidago canadensis* L. and soil microplastic contamination in the agroecosystem pose severe hazards to soil and plant ecology and human health. *Oryza sativa* L. (rice) was examined after individual and combined exposure to *Solidago canadensis* L. invasion (SI) and soil polyethylene microplastic contamination (MPc). Comparing the individual and combination treatments to the control, leaf biomass decreased, with varying changes in carbon, nitrogen, and phosphorus. Antioxidant enzyme activity and reactive oxygen species levels were significantly reduced following SI exposure and increased following the combined treatment (SI × MP). In contrast, ascorbate peroxidase and catalase activities were reduced after the combined treatment. Due to the confluence of various abiotic stressors, the combined treatment had a higher impact on leaf metabolites than the singular SI and MPc treatments. However, in comparison, the combined treatment significantly influenced the metabolic profile. In conclusion, the interaction between SI and MPc resulted in significant metabolic alterations. These changes were characterized by shifts in metabolite pools influenced by antioxidant enzyme activities and nutrient content, ultimately enhancing defense mechanisms within rice crops. Consequently, these stressors threaten the food safety, sustainability, and agricultural output of crops. The co-exposure of invasive plants and microplastics sheds light on the bio-ecological risks associated with microplastics in staple foods and offers valuable insights into the phytotoxicity of invasive plants in the presence of polyethylene microplastics.

Keywords: *plastic contamination; alien plants; soil pollution; crop performance; metabolomic profile; sustainable agriculture*

Graphical abstract



Flooding impact on microplastic abundance and distribution in Jia Bharali River, Assam, India

Jigyashree Lahon, Sumi Handique*

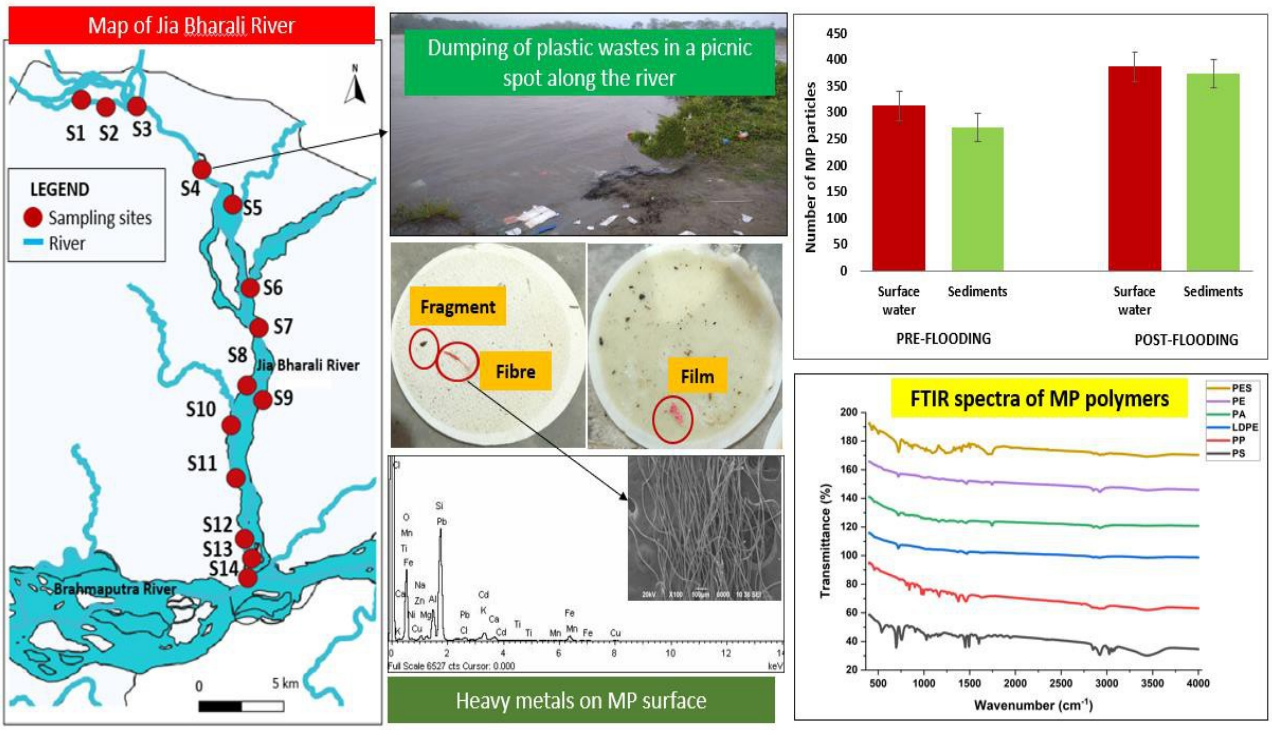
Department of Environmental Science, Tezpur University, Tezpur (Assam) 784028, India
**Corresponding author :*sumi han@t ez u.er net .i n*

Abstract

Microplastics (MPs) are emerging environmental contaminants and is the cause of growing concern in freshwater environments throughout the globe. Rivers act as an important pathway for the transport of MPs into the marine environment. However, there is lack of research on microplastic abundance in rivers of northeast India. This study aims to investigate the flood- induced variation of MPs along the stretch of Jia Bharali River, one of the major north bank tributaries of river Brahmaputra. For the identification of different morphotypes and characterisation of polymeric types of MPs in our samples, stereo-zoom microscope and Fourier-Transform Infrared Spectroscopy (FTIR) was used respectively. The mean concentration of MPs during post-flooding period was highest (27.94 ± 9.25 MPs/L in surface water and 29 ± 8.73 MPs/kg in sediments) as compared to pre-flooding period (22.35 ± 5.55 MPs/L in surface water and 19.42 ± 6.08 MPs/kg in sediments). During pre-flood, fibres accounts for majority of MP particles (36.13% in surface water and 38.23% in sediments). Similar results were observed for surface water samples of post-flood as, fibres were the most dominant type (35.65%) while in case of sediments, fragments (34.10%) were the major type. Polyethylene was the dominant polymer type of MPs followed by polypropylene. Polymer hazard index (PHI) indicated high risk, while coefficient of microplastic impact (CMPI) showed 'average' to 'minimum' risk level in the studied area. Presence of toxic heavy metals on the surface of MPs indicates potential threat to aquatic life. Research on riverine microplastics should be given utmost importance which will help to mitigate marine microplastic pollution in the future.

Keywords: *microplastics, flood, risk assessment, heavy metals*

Graphic Abstract



Enhanced electrochemical degradation of methylene blue by Ultra-thin layer of Ti-NATO electrode

Dr. Navneet Yadav, Prof. Chedly Tizaoui
Swansea University, United Kingdom (Font size:11)
Corresponding author: navneet.yadav@swansea.ac.uk

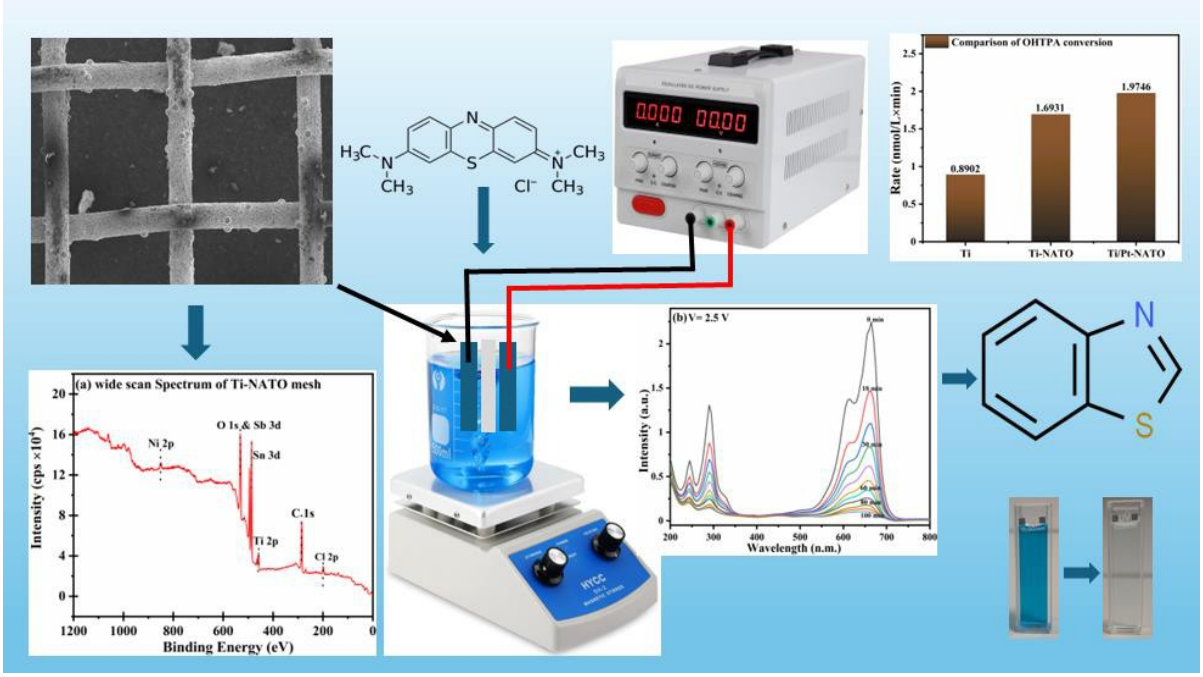
Abstract

With the rapid development of industry, the organic pollutants are causing adverse effects on the environment. These organic pollutants have posed a significant threat to both surface and ground water pollution [1-3]. The most common source of water pollution is dye wastewater containing various synthetic colour [4-5]. Generally, industries that utilize dye including textile and pharmaceutical industries are the most common source of dye wastewater. Recently, the Electrochemical oxidation has attracted significant attention of the scientific community for the treatment of waste water which is a basically depend on the properties of anode materials. The characteristics of the electrodes utilized in the process have a significant impact on the efficiency and selectivity of electrochemical oxidation of organic compounds [6-7].

Here, we have reported electrochemical degradation of methylene blue by using Ti-nickel and antimony doped tin oxide (Ti-NATO) electrodes. The electrodes were prepared by dip and dry method and characterized by various techniques. Th e electrical structure, oxidation state, and surface chemical composition were also revealed using XPS analysis. Electrochemical degradtion of Methylene blue has been reported with respect to voltage and flow rate ans tudied their rate consstt and degreadation efficiency etc. Degradation by-products were also identified using LC/MS/MS analysis and a plausible mechanism for the degradation of MB with Ti-NATO anode was suggested. The results of this study demonstrate that electrochemical oxidation of contaminants offers a sustainable route for pollution elimination from wastewaters.

Keywords: *Ti-NATO, methylene blue, electrochemical, oxidation*.

Graphic Abstract:



The spatial distribution, transport and deposition of microplastics in urban environment

Inês Amorim Leitão[1,2], Loes van Schaik[1], António Dinis Ferreira[2], Violette Geissen[1]

[1]*Soil Physics and Land Management Group (SLM), Wageningen University & Research, P.O. Box 47, 6700 AA, Wageningen, Netherlands*

[2]*Research Centre for Natural Resources, Environment and Society (CERNAS), Polytechnic Institute of Coimbra, Escola Superior Agrária de Coimbra, Bencanta, 3045-601 Coimbra, Portugal*

corresponding author: ines.amorimdovaleleitao@wur.nl

Abstract

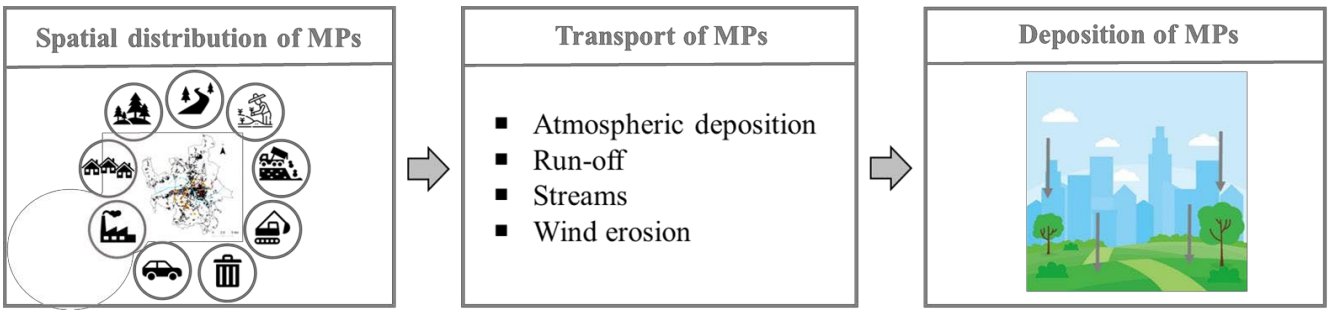
Plastic pollution is a growing concern worldwide: plastics are commercialized in large quantities (Geyer et al., 2017) and it takes a long time for them to degrade (Scalenghe, 2018; Qiu et al., 2020). When in the environment, plastic is fragmented into microplastics (<5mm), which have been found in all environmental compartments at different locations (Akdogan and Guven, 2019; Jenkins et al., 2022). Microplastics contribute to the environmental pollution in water, air and soil and seem to be linked to human health problems. The progressive increase of population living in cities led to the aggravation of the pollution problem worldwide, especially in urban environments (Dris et al., 2017). Urban areas represent a strong source of pollution, through the roads, industrial production, wastewater, landfills, etc (Leitão et al., 2023). It is expected that pollutants such as microplastics are transported diffusely from the sources through different pathways such as wind and rain. Therefore, it is very complex to quantify, control and treat these pollutants, designated current problematic issues by the European Commission (Costa et al., 2020). Green areas are pointed out by experts as natural filters for contaminants in cities, through their capacity of retention by vegetation (Leitão et al., 2019; Zhang et al., 2022). These spaces have thus the capacity to control the load of pollutants transported. Although many information is already known about the contamination of microplastics in the environment, there are still many issues that require further investigation, such as the contamination of microplastics in soil, their transport through different pathways and the role of vegetation filtering microplastics, especially in urban environment.This study investigates the spatial distribution of microplastics in urban soils of different land uses, their transport through atmospheric deposition, wind erosion, runoff and streams, as well as their deposition in vegetation like grass and tree leaves in urban environment. Coimbra, a medium large city located in the central Portugal, is the case-study. All the soil, sediments, water and vegetation samples were collected in Coimbra and were later analyzed in the Wageningen University & Research laboratory. Microplastics were extracted through the density separation using Sodium Phosphate as solution (~1.4 g cm−3) and filtration methods, visualized under a stereo microscope and identified using the u-FTIR method.

Microplastic particles were found in all the different samples. In terms of soils, higher concentrations of microplastics were found in green parks, followed by landfills and industrial places, and the lowest concentrations in forests and pasture land-uses (Leitão et al., 2023). Atmospheric deposition and streams after rainfall events seems to represent the strongest pathways of microplastics. Tree leaves can retain microplastics on their surfaces. Small leaves such as needle leaves seem to present higher amounts of microplastics per leaf area than bigger leaves. Rainfall episodes seem to reduce the concentration of microplastics on leaves surface, which suggests the wash of microplastics down to lower levels of the tree or to the soil. When in soil, different types of microplastics could be transported to the atmosphere through wind erosion. Grass seems to present high concentrations of microplastics, and the enlargement of the grass cover leads to a reduction of the amount of microplastics in soil, but also of the microplastics moved from the ground to the atmosphere by wind erosion.

This study proof that vegetation can help to control the transport and dispersion of microplastics. In order to control the entry and the concentration of microplastics in the environment, especially in cities, it is essential to defining and evaluating nature-based land-use scenarios, considering the role of green urban areas and different vegetation types in filtering small particles.

Keywords: *microplastics; cities; sources; pathways; vegetation*

Graphic Abstract



Quantification and characterization of low-density microplastics in farmland soil profiles: a case study from sri lanka

K.R.S.S. Kahandawa [1] *, W.L.D.M.P. Jayawardena[1], Champika V. Hettiarachchi[2], H.M.S.P. Madawala[1]

[1] *Department of Botany, Faculty of Science, University of Peradeniya, Sri Lanka*
[2]*Department of Chemistry, Faculty of Science, University of Peradeniya, Sri Lanka*
*Corresponding author : * sachinik@sci.pdn.ac.lk*

Abstract

In recent years, ubiquitous presence of microplastics (MPs) and their potential impacts have garnered increasing attention worldwide. Though more focus was placed on aquatic environments, less is known about their occurrence and behaviour in terrestrial ecosystems, particularly in farmland soils. Microplastics enter agricultural soils through mulching, tunnelling, fertilizer bags, water pipes etc., incurring harmful effects on crop growth and the soil biota. Understanding MP pollution and its vertical transport in farmland soils is crucial for assessing their potential risks to agricultural productivity, ecosystem health and human well-being. Thus, this study quantifies and characterizes low-density MPs in vegetable fields in Nuwara Eliya, one of the main vegetable-growing areas in Sri Lanka, with the aim of providing valuable insights into their accumulation, distribution and potential implications. Thirty-six soil samples from three different soil layers (0-10, 10-30, 30-50 cm) were collected from two farmer-managed vegetable plots in Nuwara Eliya. Air-dried soil samples were sieved through 5mm and 2mm mesh-sized metal sieves to extract plastic particles of different size categories. 50g of soil < than 2mm was used to extract MPs (density < 1.00 g/mL) by density separation following an optimized chemical digestion in 100 ml of acidified water containing 5 ml of 30% H_2O_2 at 60-70 ^oC. Extracted MPs were categorized by shape and colour under a stereomicroscope, and polymer types were confirmed by ATR-FTIR.

The results were analysed statistically using Minitab 18.0 software to compare the levels of MPs between sites and depths. The results showed that site-specific differences in the abundance of MPs ($p = 0.007$), with Site 2 exhibited significantly higher MP pollution (340.0±158.6 particles/kg) compared to Site 1 (246.7±162.8). This disparity may have been attributed to Site 2's close proximity to the city and its residential areas. In both sites, the MP abundance decreases from the upper soil layers to deeper layers. Furthermore, in both sites, MPs showed a notable tendency to transport beyond the plough layer, with 24.6 % and 34.3 % of the total MPs detected in the 30-50 cm soil layer, respectively. Fragments are the most abundant in all soil depths compared to fibres. MPs exhibit diverse colours including white,

colourless, blue, green, red, black and yellow, with white being the most prevalent colour observed at both study sites (64.4% and 72.7%, respectively). Polypropylene (PP), Nylon, Polyethylene were identified as the most dominant polymer types of MPs. The study concludes that site-specific MP pollution is prevalent in vegetable fields in Nuwara Eliya, suggesting that besides agriculture-related inputs, urban activities and human settlements are likely sources of MP contamination in soils. It also suggests that soil management practices like ploughing influence vertical transport of MPs through bioturbation and macropores. The tendency of MPs to migrate through the soil profile poses a potential risk of contaminating groundwater resources. These results underscore the importance of addressing urban waste management and implementing measures to mitigate MP pollution in agricultural fields to safeguard both soil health and water resources.

Keywords: *vertical distribution, agricultural soils, low density microplastics, atr-ftir, sri lanka*

Exposure assessment of micro/nano-plastics through vegetable, fruit, and grain products

Zhihao Yuan*, Rajat Nag, Enda Cummins

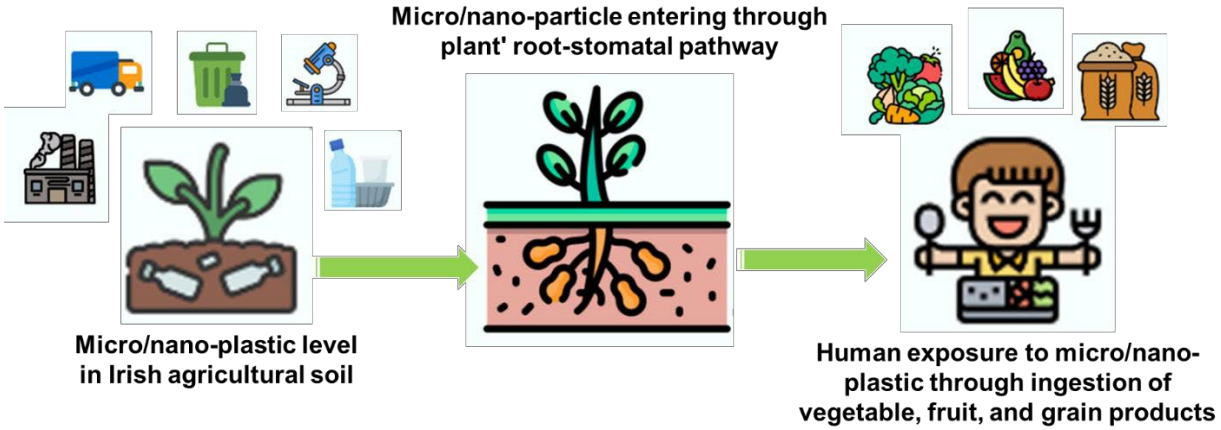
UCD School of Biosystems and Food Engineering, University College Dublin, Ireland
corresponding author: yuan.zhihao@ucdconnect.ie

Abstract

Human exposure to micro/nano-plastic (MN-P) through the food system leads to considerable uncertainty regarding the potential hazardous effects. MN-P has been detected in seafood, water, fruits, vegetables, grains, salt, milk, alcohol, sugar, and other foods; however, no unified exposure assessment model currently exists for vegetable, fruit, and grain products. This study conducted a probabilistic exposure assessment on the potential human exposure (HE) to MN-Ps through the ingestion of vegetable, fruit, and grain products. The HE model utilised the MN-P size vs. concentration relationships (linear regression model) and the bioaccumulation factor (BF). This study calculated the Estimated Daily Intake (EDI) of MN-P through potential internalisation in specified food products based on Irish food consumption survey data. This research found that there is a concern associated with the uptake of MN-P with a simulated mean (SM) diameter smaller than 620 nm through root systems. Where NP data is limited, bridging data using metal nanoparticles (MNP) was considered, yielding an overall MNP BF of 3.22 for the pooled group of vegetable, fruit, and grain products. The estimated abundance of MN-P in Irish agricultural soil was 6.05×10^4 n/kg (SM), and the overall SM MN-P levels in vegetables, fruits, and grains were 1.47×10^6 n/kg under conditions and assumption of the study. Consequently, the simulated EDI of MN-P through vegetable, fruit, and grain products was 1.62×10^3 n/kg bw/day. The contribution to MN-P exposure ranked in the order of vegetables > fruits > grains. Additionally, the sensitivity analysis indicated that the most influential parameters in the predictive modelling were MN-P abundance in soil, followed by the bioaccumulation factor, and then food consumption. Future research focusing on detecting and quantifying MN-Ps in a broader range of food products could enhance the accuracy of the model.

Keywords: *estimated daily intake; food safety; human health; plastic pollution; risk*

Graphical abstract



Detection and remediation of polystyrene microplastic from water

Priyanka Sehrawat, Abhishek Kumar Chaubey, Tej Pratap, Dinesh Mohan*
School of Environmental Sciences, Jawaharlal Nehru University, New Delhi-110067, India Presenting author – pssehrawat97@gmail.com
**Corresponding author - dm_1967@hotmail.com*

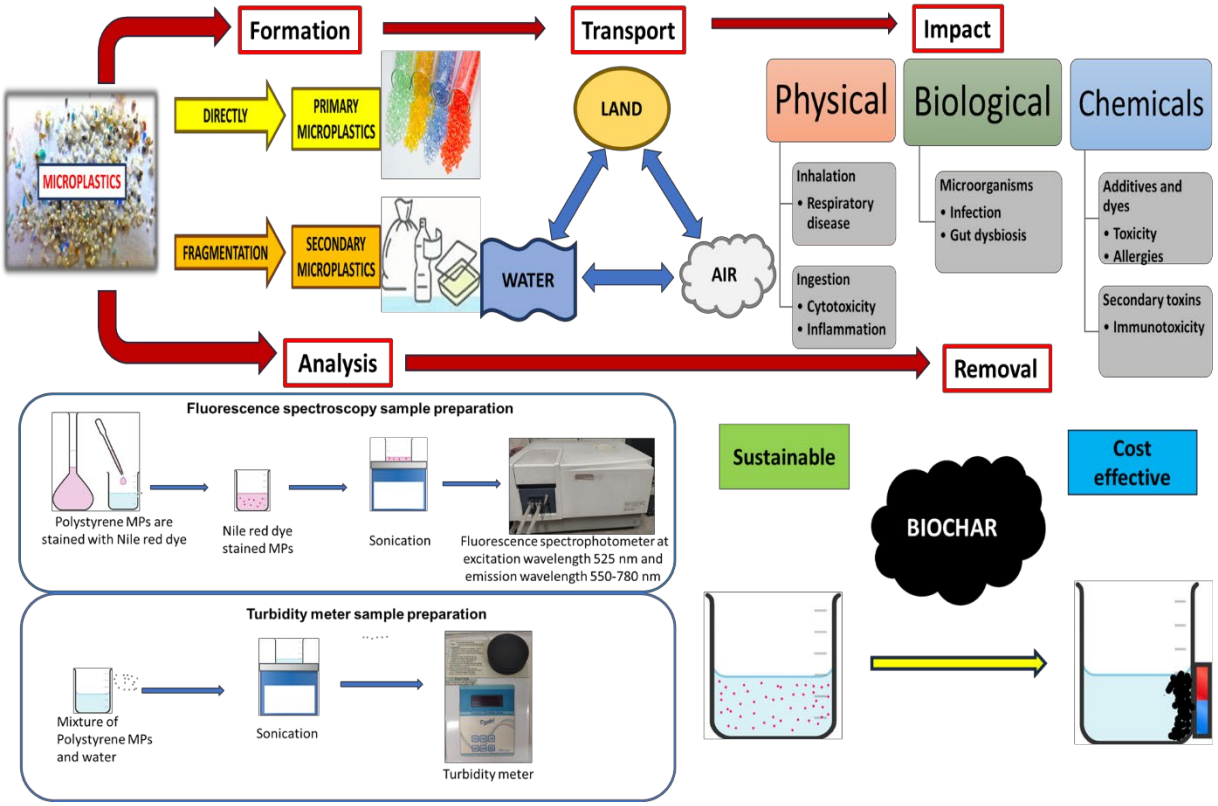
Abstract

Microplastics (MPs) are plastic particles <5 mm in size, originating from primary sources including microbeads and fibers, and secondary sources through the degradation of larger plastic materials such as food packaging and textiles. According to the UNEP report, 3 million tonnes of microplastics are released into the environment annually, primarily from city dust and tire abrasion [1]. MPs are detected in Chennai Red Hills Lake (5.9 items/L) [2], Odisha Mahanadi River (16.6 ± 5.2 items/L) [3] and Kanpur Ganga River (206 ± 31.9 particles m^{-3}) [4]. MPs absorb pathogens and toxic chemicals enabling bioaccumulation in higher trophic levels, serve as a substrate for microorganism growth which can affect various life forms [5]. Therefore, MPs monitoring is crucial for the assessment of water and sediment contamination. In our study, polystyrene, a most frequently detected MP, was chosen for analysis and remediation. Quantitative analysis of polystyrene (PS) was conducted using fluorescence spectrophotometry and turbidity measurement.

Each technique was evaluated for its effectiveness in providing rapid and accurate quantification of PS. Fluorescence spectrophotometry, by utilising the fluorescent properties of Nile red-stained microplastics, allowed for sensitive detection and quantification. Turbidity measurement offered a straightforward method to assess the presence of dispersed particles. A comparative evaluation of the techniques highlighted the strengths and limitations of both methods in different contexts. In the literature fluorescence spectrophotometry has been reported as one of the sensitive and specific technique for detecting low to higher concentrations of MPs, particularly in complex environmental samples [11]. Frequently employed techniques for MPs removal include filtration; coagulation; adsorption; membrane separation, and grit chamber [6,7]. Among these methods, adsorption stands out as the most frequently utilized technique due to its simplicity, sustainable and cost-effective nature. Biochar produced from lignocellulosic biomass is used as a material preventing MPs pollution. The coarse surface and porous nature of biochar facilitate the entrapment of MPs [8]. Incorporation of magnetic characteristics to biochar improves surface roughness, hydrophobic interactions, electrostatic attraction and separation of MPs [9,10]. These enhanced properties of biochar were harnessed to develop sustainable solution for effective polystyrene MPs removal.

Keywords: m*icroplastics, polystyrene, fluorescence, sustainable, biochar*

Graphical Abstract



Influence of biofilm formation and co-transport of fecal indicator bacteria on microplastic surfaces originating from wastewater discharges in a river system

Nefise Alyürük[1], Neval Baycan[1]*, Cumana Alpergün[1], Orhan Gündüz[2],
[1]*Environmental Engineering Department, Dokuz Eylul University, İzmir, Türkiye*
[2]*Environmental Engineering Department, Izmir Institute of Technology, İzmir, Türkiye*
*Corresponding author : *neval.baycan@deu.edu.tr*

Abstract

Biofilm formation on microplastics (MPs) was investigated using controlled experiments and real samples from a river receiving wastewater discharges. The main motivation for this study was to clarify whether there is a relationship between fecal indicator microorganisms (FIOs) and MPs discharged from the wastewater treatment plants (WWTP-Ds) that favors the survival and transport of these microorganisms. In controlled studies, the time required for biofilm formation on MPs was determined, while in studies with real samples, the abundance of FIOs in river water (RW) samples was investigated and biofilm formation on raw MPs was studied over a two-month period. Controlled studies were carried out with different types of MPs (PE, PP, PS, PET, PA, PVC, PBT, ABS, PC) in different size ranges (3-4. 5 mm; 2-3 mm; 0.5-1.5 mm) which were placed on a steel filter and incubated in a glass reactor for 3, 7, 10, 30 and 60 days. In the field, the amount of biofilm formed on the surface of MPs was determined on 2-3 mm samples placed in a stainless-steel cage at three stations along the river (RW, domestic WWTP-Ds and industrial WWTP-Ds). In controlled experiments, it was observed that a biofilm layer formed on the surfaces of microplastics of different sizes from day 3 onwards. The amount of biofilm formed on the surface of PP (for 30 and 60 days) was significantly higher ($p<0.05$) compared to PE and PS. The abundances of FIOs (log10 (cfu/100 ml)) in river water samples were in the range of 1.73 - 7.04 for coliforms, 0 - 5.04 for *E.coli,* 0 - 3.58 for *Enterococci*, 0 -2.61 for *Clostridia*. Although, there were no significant differences between the amount of biofilms formed on different types of MPs (PE, PE, PP), there was a significant difference between 3 different stations. Coliform and *E. coli* microorganisms were detected in all MP samples placed in all stations in the field. In conclusion, the results supported our hypothesis that MPs have a positive effect on the survival, attachment and transport of microorganisms from wastewater treatment plants.

Keywords: *microplastic, biofilm, indicator microorganisms, wastewater, river.*

Investigation of the concentration of microplastics transferred from ready to-eat food packaging to products

Miray Arabaci[1], Nursena Kara[1], Neval Baycan[1]

Dokuz Eylul University, Department of Environmental Engineering, Izmir, Türkiye
corresponding author: neval.baycan@deu.edu.tr
presenting author: mryarabaci@gmail.com

Abstract

Due to today's living conditions, there has been a significant increase in plastic usage in recent years. Microplastics pose a risk to humans by entering the food chain. People have started to prefer ready-to-eat cooked and packaged foods due to time constraints and ease of preparation. When examining the packaging of these ready meals, it was observed that the packaging materials are of plastic origin.

In this study, five different types of ready-to-eat meals (one meal and four soups) were selected to determine whether there is plastic transfer from the packaging to the food, and their microplastic contents were analyzed. For this purpose, the selected ready meals were first analyzed without heating and then heated as recommended (microwaved for two minutes), and the types and quantities of microplastics were determined.

For the characterization of microplastic types and quantities, pre-treatments such as phase separation and organic matter removal were applied, followed by physical and chemical characterizations using microscopy and FT-IR. According to the analysis results, the analyses conducted before heating showed results ranging from 15 to 50 microplastics per package (250 mL), while after heating, results varied between 8 and 57 microplastics per package.

In the examinations, the identified microplastics were found in particle and fiber forms, predominantly consisting of PET, PE, and PVC types.

Keywords: *microplastic pollution, convenience foods, environment and human health.*

Assessing the impact of chemicals in plastics on the immune system

Neema Negi, Dorte Herzke, Hege Hjertholm, Monica Andreassen, Berit Brunstad Granum, Igor Snapkow, Hubert Dirven*

Department of Chemical Toxicology, Division of Climate and Environmental Health. Norwegian Institute of Public Health (NIPH)

Corresponding author : Hubert.Dirven@fhi.no

Abstract

Chemicals in plastics encompass a diverse array of substances used in the manufacturing of plastic materials, contributing to their properties such as enhancing flexibility, durability, color, and resistance to heat and UV radiation. Common plastics like polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS), polyethylene terephthalate (PET), acrylonitrile butadiene styrene (ABS), and polycarbonate (PC) are ubiquitous in everyday products due to their versatility and affordability[1]. Over 16,000 chemicals have been identified that are potentially present in plastic materials, yet only 6% are currently regulated internationally[2]. These include flame retardants, UV stabilizers, per- and polyfluoroalkyl substances (PFASs), phthalates, bisphenols, alkylphenols and alkylphenol ethoxylates, biocides, certain metals, polycyclic aromatic hydrocarbons, and non-intentionally added substances (NIAS). Out of over 4,200 plastic chemicals of concern, approximately 3,600 are currently unregulated on a global scale[2]. These chemicals can leach under various conditions, potentially causing health issues[3]. In human biomonitoring studies in Norway as conducted at our institute widespread exposure to phthalates and phenols in children was demonstrated, suggesting that these chemicals can leach from plastics and are taken up from for example food and drinks and excreted in the urine.

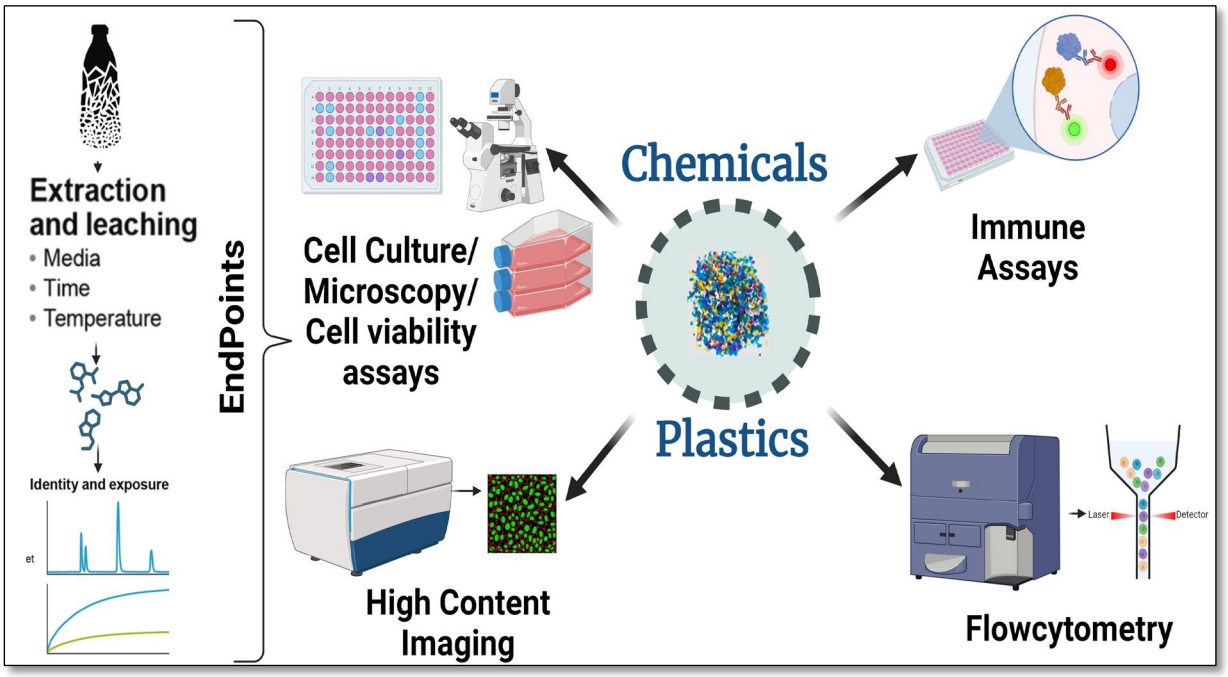
The Norwegian government is prioritizing this issue and may propose regulatory action in the EU through REACH. Immunotoxicity, the harmful effect of certain chemicals on the immune system, is a concern with plastics. Chemicals like BPA, phthalates, PBDEs, and styrene may impact immune function. The complexity of leaching chemicals from plastics, including mixture effects, requires urgent action to address related risks.

This project aims to explore the impact chemicals leaching from plastics, identified as significant concerns, utilizing both established cell lines and human primary cells. Our research plan will integrate a diverse array of methodologies, including cell culture techniques, cell viability assays, high-content imaging, flow cytometry as well as other immune assays. Through these methods, we seek to deepen our understanding of the potential immune- related implications associated with these chemicals in plastics. Statistical analyses for this study will be conducted using GraphPad Prism 9.0 and R programming language.

This project seeks to bridge the knowledge gap by delving into the extent of immunotoxicity associated with plastic chemicals, filling a critical knowledge gap for future policy and health considerations.

Keywords: *chemicals, plastics, immunotoxicity, reach, leaching*

Graphic Abstract



The abundance, characteristics and potential sources of microplastics in irish agricultural soils across different land-uses

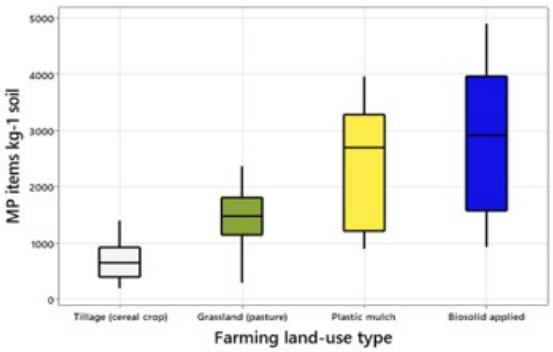
Clodagh D. King, Caroline Gilleran Stephens, Joseph P. Lynch, Siobhán N. Jordan
Centre for Freshwater and Environmental Studies, School of Health and Science, Dundalk Institute of Technology, Dundalk, Ireland
Corresponding Author: siobhan.jordan@dkit.ie

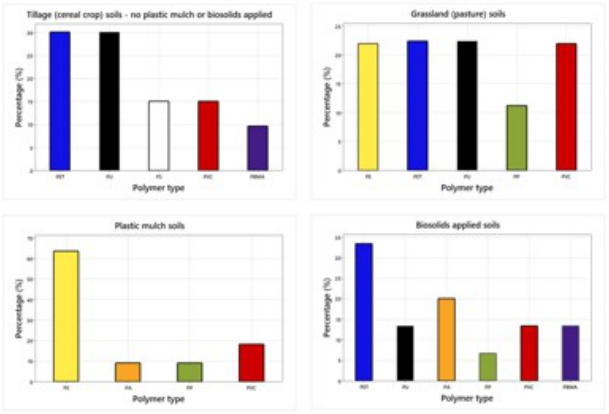
Abstract

Modern-day intensive agricultural production systems such as high grass and crop yielding systems in Ireland, rely heavily on plastic materials (Borreani and Tabacco, 2017; Hofmann et al., 2023). Consequently, these materials may act as entry routes for microplastics into agricultural soils and the wider environment (Cusworth et al., 2024; Harms et al., 2021; Qi et al., 2020). Prevention of microplastics from entering the human food chain is critical (Mamun et al., 2023). To tackle this, we must begin with the prevention and control of microplastics in agricultural food production systems, which requires an evaluation of microplastics in the core resources of primary production such as soil. In this study, soil samples were analysed from 24 agricultural fields across seven counties in Ireland. These fields were categorised into different land-uses based on their plastic pollution potential. A wet extraction technique was employed using density separation methods to extract microplastics from soils, and Raman spectroscopy was used to identify polymer classifications. Soils sampled from every field were found to be contaminated with microplastics, in concentrations ranging from 200 to 4899 MP items kg^{-1}. Significantly higher concentrations were found in soils treated with biosolids and plastic mulch films, than without these treatments, indicating that these amendments are contributors of microplastic pollution in Irish agricultural soils. The main findings from this study strongly suggest the need for urgent collective action to minimise the exposure risks of microplastics to soils. It is recommended that extensive monitoring of microplastics in agricultural soils be conducted and that regulations on biosolids and plastic mulch consider microplastic contamination. The study also calls for further research to be carried out on the lasting effects of both conventional and biodegradable plastic mulch films on agricultural soils.

Keywords: *microplastics, agricultural plastics, agricultural soils, biosolids, plastic mulch.*

Graphic Abstract





Degradation products of plastics are markers of microplastics

José P. Da Silva

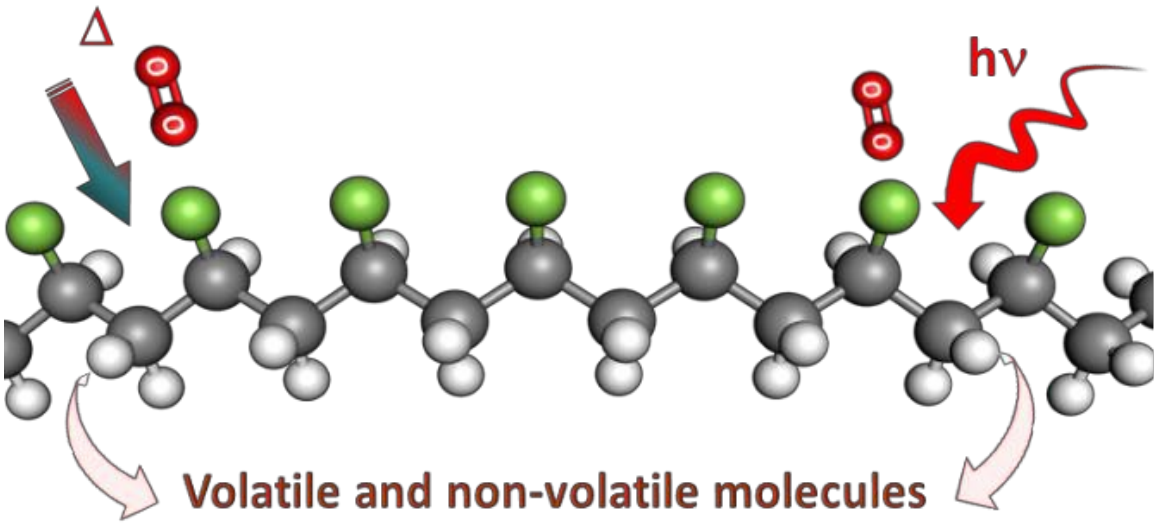
Centre of Marine Sciences (CCMAR/CIMAR LA), University of Algarve, 8005-139 Faro, Portugal
Correspoinding email: jpsilva@ualg.pt

Abstract

Plastics materials are known to undergo low reaction rates in environmental conditions. However, the large plastics surface areas exposed to chemical and photochemical degradation release particles and organic compounds, that lead to global contamination of all environmental compartments, including soil, water, air and organisms. While the release and contamination by plastic particles has been widely studied [1], the contamination by products resulting from the degradation of plastics materials has been overlooked [2]. In this presentation we will examine the main chemical and photochemical reaction pathways of polyethylene (PE), polystyrene (PS), polyvinyl chloride (PVC) and polyethylene terephthalate (PET) plastics and microplastics. The main degradation products identified by GC-MS and LC-HRMS will be discussed. The role of the environmental conditions as the presence of oxygen and natural surfaces on photoproduct distributions will be uncovered. The use of key degradation molecules uniquely related to polymer structure to estimate the contamination by micro and nanoplastics of environmental samples will be discussed.

Keywords: *polyethylene; polystyrene; polyvinyl chloride; polyethylene terephthalate; degradation products; lc-hrms*

Graphic Abstract



Sorghum tableware: A sustainable shift from single-use plastics in the beverage and snacking sectors

S.M. Devatha and PA. Raajeswari*

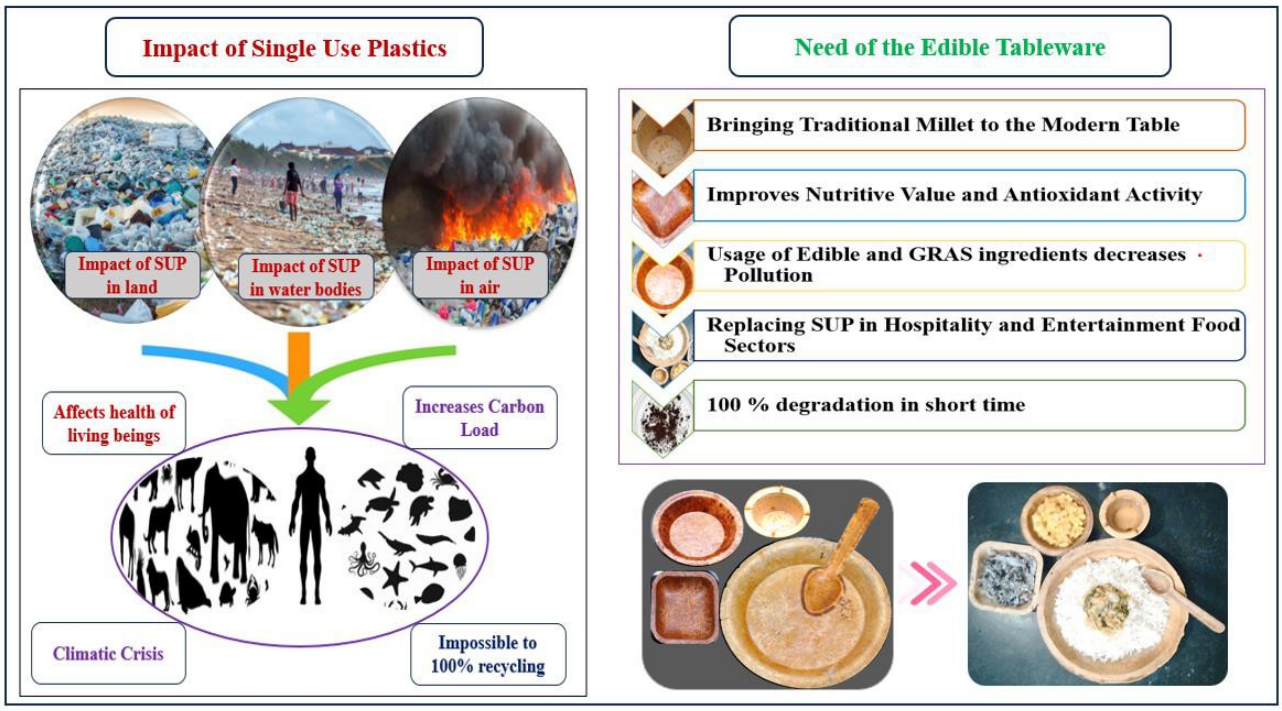
Department of Food Science and Nutrition Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu - 641 043
Corresponding author: raajeswari_fsn@avinuty.ac.in

Abstract

Plastic waste disposal is a major cause of concern all around the world. Among plastic usage, disposal of single use plastic utensils is significant and has a tremendous impact on the surrounding environment. The proposed study is a small footprint in the path of innovation with the following objectives to select, formulate, and standardize edible tableware from sorghum (*Sorghum bicolor (L.) Moench)* and to value add by incorporating micronutrient and antioxidant-rich flowers like rose (*Rosa damascene Herrm*.) and hibiscus (*Hibiscus rosa sinensis* L.) in standardised edible tableware and to analyse the physical and mechanical properties of standardized edible tableware. Edible tableware includes cups, bowls, katori, spoons, and quarter plates from sorghum is a great alternative as they are highly nutritious and cost-effective. Cup weigh 16g, bowl and katori weighs 22 g, spoon weighs 8 g and quarter plate weigh 42 g. Preliminary processing like germination and roasting significantly increased the nutritive value, sensory attributes and decreased the anti-nutritional factors of standardized sorghum tableware. Sensory attributes of the roasted and flowers powder incorporated sorghum tableware scored 8 points which is liked very much by sensory panellists. The incorporation of flower powder like rose (15.76 µl/ml) and hibiscus (54.92 µl/ml) increased the antioxidant activity than non-value added sorghum tableware (134.26 µl/ml). FTIR and TGA of tableware showed similar results and the processing doesn't affect the functional properties of tableware. Roasted tableware has better tensile strength than unprocessed and functionally-enhanced tableware. Standardized tableware with-stands for more than 40 minutes at ambient, hot, and cold medium foods and keeping quality were analysed for 120 days by total plate count ($>12x10^1$ cfu/g). It readily degrades within 12 days in wet topsoil. Edible tableware could be a potential source for the replacement of plastic utensils, thereby providing scope for environmental protection, and leading to sustainable development. This would be an effective way to reduce paper cup and non-biodegradable cutlery usage and sustainable zero waste management. Hospitality, entertainment, and food service centres may use this kind of cutlery and crockery.

Keywords: *Sorghum bowl, katori, Spoon, edible and ecofriendly, characterization*

Graphical Abstract



Millet medicinal herb soup mix in edible pouch: an alternative solution against single-use plastics

Dharani Priya S*, Dr. Raajeswari Paramasivam

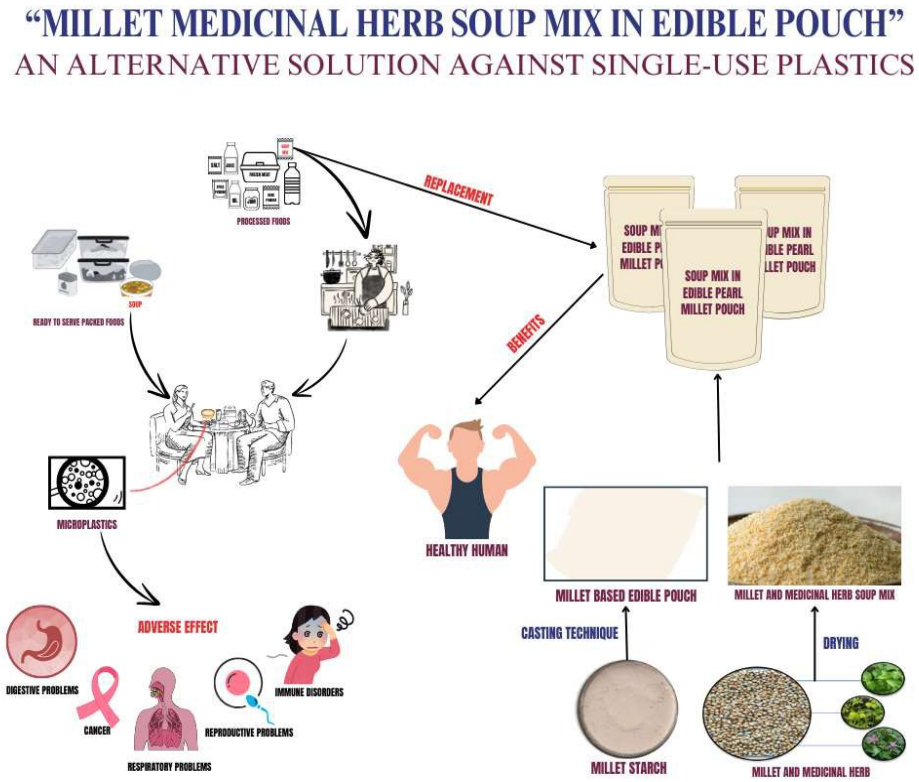
Department of Food Science and Nutrition, Avinashilingam Institute for Home Science & Higher Education for Women, Coimbatore, Tamil Nadu, India
Corresponding author: dharanipriya2030@gmail.com

Abstract

Single-use plastics in food packaging pose significant challenges due to microplastics that can contaminate food, potentially causing harmful effects on human health and pollution. Edible packaging provides a sustainable alternative for single-use plastics in instant soup mixes. The millet-based edible pouch packed with a millet medicinal herb soup mix can enhance nutrient bioavailability and immunity. The edible pouch is developed with millet starch using the casting technique. The pearl millet undergoes germination, wet milling, purification, and drying in order to obtain starch. The soup mix was formulated and standardized with three medicinal herbs: *Cardiospermum halicacabum, Solanum trilobatum* and *Coleus ambionicus*. Edible pouches with varying glycerol concentrations were formulated, with lower glycerol concentrations having a quicker dissolving time in boiling water. Sensory evaluations resulted in high acceptability for soup mixes in edible pouches. Edible pouches demonstrated a good tensile strength of 0.92 MPa, a thickness of 0.15 mm, and a moisture permeability of 0.92%. Nutrient analysis of the pouches with a soup mix containing various medicinal herbs revealed energy content between 243.81 and 267.90 kcal and protein content from 8.23 to 9.64 grams. Shelf-life analysis indicated stable microbial loads, with total plate counts and yeast/mold counts remaining relatively stable over 30 days. A pilot study was conducted with 150 respondents, and 92.7% consumed soup, with 64% using pre-packaged commercially available mixes. The study highlights the popularity of soup mixes, emphasizing the need to address single-use plastic pouches. The millet medicinal herb soup mix in an edible pouch is an initial step to replace single use plastic pouches while also providing convenience and health benefits.

Keywords: *edible packaging, single-use plastics, microplastics, soup pouch, pearl millet*

Graphical abstract



Comparing the toxicity of polystyrene microplastic and diclofenac individually and mixed on neonate and adult Daphnia magna: immobilisation and oxidative stress status

Maranda Esterhuizen[1,2,3]

1. University of Helsinki, Ecosystems and Environment Research Programme, Faculty of Biological and Environmental Sciences, Niemenkatu 73, 15140 Lahti, Finland.
2. Helsinki Institute of Sustainability Science (HELSUS), Fabianinkatu 33, 00014 Helsinki, Finland.
3. University of Manitoba, Clayton H. Riddell Faculty of Environment, Earth, and Resources, Wallace Building, 125 Dysart Road, Winnipeg, MB R3T 2N2, Canada.
Email address of corresponding author: maranda.esterhuizen@helsinki.fi

Abstract

Research has underscored the global ubiquity of microplastics (MPs) in various environments1. However, the presence of multiple stressors in these environments, such as co-occurrence with pharmaceuticals and personal care products (PPCPs), adds complexity to the assessment of MP toxicity2 and could potentially alter the overall adverse effects upon exposure. The combined effect of MPs and PPCPs can potentially be additive, synergistic or antagonistic3. This study aimed to investigate the effects of polystyrene (PS) MP (fragments: 45-63 µm diameter) and diclofenac (DCF), two commonly occurring aquatic pollutants, on the model bioindicator organism Daphnia magna. In addition to mobility, oxidative stress status was used as an indicator of toxicity in response to exposure to these toxicants individually and combined at various environmentally representative concentrations (0.01, 0.1, 1.0, 10, 50, and 100 mg/L), for 24 and 48 h periods. The exposures were conducted in the dark to avoid photodegradation. Immobilisation was assessed according to the OECD guidelines4, and live neonates were collected to measure reactive oxygen species (ROS) to assess oxidative stress. The lethal dose 50 values (LD50) and the no and lowest observed effect levels (NOEAL and LOEAL) were calculated to determine whether combined exposure altered toxicity, i.e., additive, synergistic, or antagonistic effects. PS and DCF individually at concentrations of 50 mg/L and higher caused significant immobilisation in neonates, but not adults, only after 48 h of exposure. In combination, adverse effects were observed after 24 h of exposure to 50 mg/L each. In neonates, ROS increased with all PS exposure concentrations, up to 2.4 times with the highest exposure concentration, and with adults on average 1.6 times. On the other hand, DCF did not have a significant effect. However, when combined, the LD50 of the individual compounds (21.4 mg/L for PS and 19.5 mg/L for DCF) decreased 1.6-fold for neonates. Similarly, the NOEAL decreased by 5-fold and the LOAEL by 2.5, indicating a synergistic effect. This reduction in dose descriptors highlights the risk of enhanced toxicity due to pollutant interactions, an issue of concern in environments where multiple contaminants coexist. This research underscores the importance of evaluating the combined effects of different pollutants to better appreciate the potential environmental risks. These findings highlight the need for regulatory frameworks to consider complex mixtures of pollutants, as these can pose greater risks than the sum of their parts. Further studies should focus on elucidating the interaction mechanisms between these and other contaminants to inform more effective environmental protection and pollution mitigation strategies.

Keywords: *mixed toxicity, polystyrene, microplastic, diclofenac, daphnia magna*

Short-term exposure to polystyrene micro- and nanoplastic – in vivo uptake and effects in a colitis mouse model

Verena Kopatz[1,2,3,4], Angela Horvath[3,5], Bernadette Mödl[6], Gerald Timelthaler[6], Julia Wallner[1], Zeynab Mirzaei[7,8], Saule Bertalyte[1], Michaela Schlederer[1], Martin, Raigel[1,9] Joachim Widder[2,4], Wolfgang Wadsak[3], George Sarau[7,8], Silke Christiansen[7,8], Robert Eferl[6], Vanessa Stadlbauer-Köllner[3,5],Verena Pichler[3,10] and Lukas Kenner[1,3,4,9]

1. Medical University of Vienna, Department of Pathology, Vienna, Austria,
2. Medical University of Vienna, Department for Radiation Oncology, Vienna, Austria,
3. CBmed GmbH – Center for Biomarker Research in Medicine, Graz, Styria, Austria,
4. CCC – Comprehensive Cancer Center, Vienna, Austria,
5. Department of Gastroenterology and Hepatology, Medical University of Graz, Graz, Austria,
6. Medical University of Vienna, Center for Cancer Research, Vienna, Austria,
7. Fraunhofer Institute for Ceramic Technologies and Systems IKTS, Correlative Microscopy and Materials Data, Forchheim, Germany,
8. Institute for Nanotechnology and Correlative Microscopy eV INAM, Forchheim, Germany,
9. University of Veterinary Medicine, Unit of Laboratory Animal Pathology, Vienna, Austria,
10. University Vienna, Department of Pharmaceutical Sciences, Division of Pharmaceutical Chemistry, Vienna, Austria
corresponding author: verena.kopatz@meduniwien.ac.at

Abstract

Micro- and nanoplastic particles (MNP) have been found in recent years in all parts of the world, in various organisms, and also in the human body (e.g. in stool, blood, placenta, kidney, or lungs).1,2 Until now, the health effects of this exposure to MNP are almost completely unexplored. For the gastrointestinal (GI) tract, MNP-related changes to the gut microbiome and inflammatory processes have been described for healthy individuals.3 Thus, MNP exposure in patients with GI diseases (e.g. colitis, inflammatory bowel disease, colorectal cancer) might pose additional health risks. Methodology: To better understand the effects of MNP exposure in a colitis models - mimicking an inflammatory environment with a defective intestinal barrier - we induced colitis by dextran sodium sulfate (DSS) and orally administered a polystyrene (PS) MNP solution, comprising three different particle sizes (10, 1, and 0.29 µm). MNP biodistribution, macrophage response, and gut microbiome alterations were evaluated. Results: Uptake of specifically nanosized PS particles was observed in the bloodstream and excretory organs, with more pronounced effects in the colitis model compared to healthy mice. Macrophages infiltrating the colon tissue of MNP-treated mice exhibited a shift towards a more pro-inflammatory phenotype. MNP application in colitis mice showed to decrease the evenness of the intestinal microbiome and increase potentially pathogenic bacterial populations. Conclusion: These findings suggest a complex interplay of MNP toxicokinetic, inflammation, and microbiome alterations, potentially contributing to the exacerbation of colitis. Effects of PS MNPs in a colitis mouse model The inevitable and increasing exposure to MNPs due to human lifestyle has been shown to influence microbiome and inflammatory processes not only in healthy individuals, but might also pose a significant risk of interfering with various diseases. Thus, highlighting an urgent need for comprehensive strategies to mitigate MNP pollution and its potential impacts on public health and disease dynamics.

Keywords: *Polystyrene, micro- and nanoplastics, colitis, mouse model*

Polystyrene Microplastics effects on human gingival fibroblasts

Federica Di Cintio[1,2], Anna Giulia Ruggieri[2,3], Maurizio Ronci1, Piero Di Carlo[2,3], Vittoria Perrotti[3] and Michele Sallese[2,3]

1. Department of Oral, Medical and Biotechnological Sciences, University "G. d'Annunzio" of Chieti-Pescara, Chieti, Italy.
2. Center for Advanced Studies and Technology (CAST), University "G. d'Annunzio" of Chieti-Pescara, Chieti, Italy.
3. Department of Innovative Technologies in Medicine & Dentistry, University "G. d'Annunzio" of Chieti Pescara, Chieti, Italy. federica.dicintio@unich.it

Abstract

Plastics have been recognized as a global danger to the ecosystem due to their buildup and impact on humans [1]. The breakdown of plastics produces small particles <5 mm called microplastics (MPs) [2] released into the environment [3]. The main chemical component of plastic is polystyrene (PS) [4]. The exposure of PS-MPs causes inflammation [5], cytotoxicity [6], and dysregulated proteins on cancer-related signaling pathways [7]. The study aimed to examine the potential toxicological effects of 1µm PS-MPs on human gingival fibroblast cells (hGF).

To test the toxicity of the PS-MP, MTT assay was performed. Cell cycle was quantitatively analyzed by flow cytometry after 50µg/mL PS-MPs treatment of hGF cells. The PS- MPs internalization was studied by confocal fluorescence microscopy, transmission electron microscopy (TEM), and flow cytometry at 48 and 72 h of treatment. In addition, the altered signaling pathways as well as the differentially expressed protein levels were assessed by label-free shotgun proteomics. These data were validated by wound healing and proliferation assays.

PS-MPs did not show toxicity at the tested concentrations and time points. Confocal fluorescent microscopy and TEM showed the uptake of 1 µm PS-MPs in the hGF cell line while flow cytometry proved that 10% of cells internalized the particles at all timepoint exposure. Additionally, after the treatment an enrichment of several Hallmark Gene Set was observed. Among others, Myogenesis, EMT, p53 pathway, and Fatty Acid Metabolism resulted activated at 48 h, while Myc signaling pathways and E2F targets resulted inhibited at 72 h. The cell motility significantly increased from 3 to 36 h after treatment with PS-MPs compared to control cells, with a slight decrease in proliferation at 48 and 72 h compared to untreated cells. By investigating the effects of PS-MPs on hGF, the present study suggests these pollutants negatively impact on human health by modulating pathways associated with cell growth, motility, and cell survival

Keywords : *human gingival fibroblast, miscroplastics, polystyrene*

Interaction of nano and microplastics (MNPs) with stored products and pests

Sakhawat Shah, Fenglian Yang*

Hubei Insect Resources Utilization and Sustainable Pest Management Key Laboratory, College of Plant Science and Technology, Huazhong Agricultural University, 430070 Wuhan, Hubei, People's Republic of China
Corresponding author: yangfenglian@mail.hzau.edu.cn

Abstract

Micro and nanoplastics (MNPs) pose significant environmental concerns with widespread implications for ecosystems and human health. Despite advancements in understanding MNP pollution, their interactions with stored agricultural products and pests are not well-studied, revealing a critical research gap. This study explores potential contamination pathways of MNPs in stored products, such as wheat grains and rice, and examines how these particles affect pest behavior and grain quality. MNPs can infiltrate stored agricultural products via various routes, including atmospheric deposition, direct introduction from plastic production, plastic mulching, and riverine transport. Additionally, MNPs enter agricultural soils through contaminated organic amendments like biosolids, composts, and food wastes, ultimately leading to contamination during the cultivation and processing of stored products. The presence of MNPs in stored grains can compromise their nutritional quality by altering the uptake of essential nutrients, which affects mineral content, protein composition, and overall nutritional value, including amylose content and starch synthesis. Moreover, the interaction of MNPs with pests in stored products can influence pest behavior, including feeding patterns, cognitive functions, and developmental processes. Understanding these interactions is vital for developing effective strategies to mitigate the impacts of MNP pollution on pest populations and agricultural ecosystems. Our findings highlight the urgent need for comprehensive research to address this knowledge gap and to inform sustainable agricultural practices and pest management strategies in the face of rising microplastic pollution.

Keywords: *Microplastics contamination, agricultural products, pest behavior, nutritional quality, environmental impact*

Leafy treat: Crafting edible films from jamun leaves extract to replace single use plastic

Divya[1], Dr. Paramasivam Raajeswari[2]

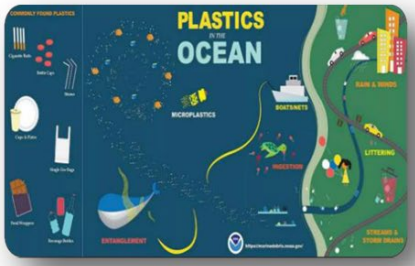
[1]II PG Student, [2]Professor,
Corresponding author: divyalakshmanan65@gmail.com

Abstract

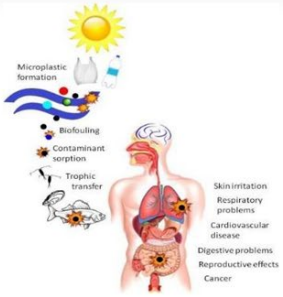
Plastics, a polymer either natural or synthetic can be made into different shapes and sizes, for making cutleries, plates, containers due to their unique characteristics. Microplastics on entering the body via ingestion gets accumulated in the organs and tissues interfering with biological process, leading to chronic inflammation. On the other hand, recycled plastics often contain higher levels of chemicals including toxic flame retardants, benzene, carcinogens, brominated and chlorinated dioxins, etc. Environmental concerns lead to the creation of edible films offering the important advantage of being biodegradable and environmental friendly. Capability to improve food preservation and processing techniques and to be effective carrier for bioactive compounds can be met by incorporating jamun (black berry) leaves. Jamun is used as a medication to treat various metabolic issues including diabetes, hyperlipidemia, hypertension, obesity, etc. Jamun leaves is selected for its bioactive compound, antimicrobial property and easy availability. The main bioactive compound includes phenolic acids, esters, flavanols, anthocyanins, and procyanidins and is the richest sources of chlorogenic acid. Combining tapioca with jamun leaves extract can enhance the nutritional content of edible films. It helps in improving digestion, regulating blood sugar levels, and reducing inflammation. The nutritional compounds in the leaf extract can be transferred to the food they wrap, providing additional health benefits. Products packaged with health-promoting materials like edible starch film containing jamun leaf extract can have strong marketing appeal, attracting environmentally conscious consumers seeking healthier and more sustainable food options. Overall, incorporating jamun leaf extract into edible starch film presents a promising opportunity to develop functional and sustainable packaging solutions that offer both nutritional benefits and extended shelf life for packaged food products.

Keywords: *microplastics, bioactive compounds, antimicrobial property, Jamun leaves*

Graphic Abstract



TROPHIC TRANSFER



Spatio-temporal trends and characteristics of microplastic contamination in a large Karnaphuli river-dominated estuary

Md. Refat Jahan Rakib [1,*], Sultan Al Nahian [2], Reyhane Madadi [3], Sayeed Mahmood Belal Haider [4], Gabriel Enrique De-la-Torre [5], Tony R. Walker [6], M. P. Jonathan [7], Win Cowger [8,9], Mayeen Uddin Khandaker [10,11]

1. *Department of Fisheries and Marine Science, Faculty of Science, Noakhali Science and Technology University, Noakhali, Bangladesh*
2. *Bangladesh Oceanographic Research Institute, Ramu, Cox's Bazar, Bangladesh*
3. *Environmental research laboratory, School of Civil Engineering, Iran University of Science and Technology, Tehran, Iran*
4. *Grupo de Investigación de Biodiversidad, Medio Ambiente y Sociedad, Universidad San Ignacio de Loyola, Lima, Peru*
5. *School for Resource and Environmental Studies, Dalhousie University, Halifax, Nova Scotia, Canada*
6. *Centro Interdisciplinario de Investigaciones y Estudios sobre Medio Ambiente y Desarrollo (CIIEMAD), Instituto Politécnico Nacional (IPN), Calle 30 de junio de 1520, Barrio la Laguna Ticomán, Del. Gustavo A. Madero, C.P. 07340, Ciudad de México, México*
7. *[g] Moore Institute for Plastic Pollution Research, Long Beach, California, USA*
8. *[h] University of California, Riverside, Riverside, California, USA*
9. *Centre for Applied Physics and Radiation Technologies, School of Engineering and Technology, Sunway University, 47500 Bandar Sunway, Selangor, Malaysia*
10. *Department of General Educational Development, Faculty of Science and Information Technology, Daffodil International University, DIU Rd, Dhaka 1341, Bangladesh*

** Corresponding author: rifatjahanrakib@gmail.com*

Abstract

Microplastic (MP) pollution is a major global issue that poses serious threats to aquatic organisms. Although research on MP pollution has been extensive, the relationship between MPs and water quality parameters in estuarine water systems is unclear. This work studied the spatiotemporal distribution and characteristics of MPs in the Karnaphuli River estuary, Bangladesh. MP abundance was calculated by towing with a plankton net (300 µm mesh size) at three river gradients (up-, mid- and downstream) and the association between physicochemical parameters of water and MP distribution patterns was also investigated. Mean MP abundance in water was higher during the wet season/April (4.33 items/m^3) compared to the dry season/September (3.65 items/m^3). In descending order, the highest MP abundance was observed downstream (6.60 items/m^3) > midstream (3.15 items/m^3) > upstream (2.22 items/m^3). pH during the wet season and temperature during the dry season were key physicochemical parameters that correlated with river MP abundance (r^2 = -0.74 and 0.74 respectively). Most particles were film-shaped, white in color, and 1-5 mm in size. Of the six polymers detected, PP, PS, PET, and cellulose were predominant, comprising roughly 17-19% each. These results can be used to model MP transport in the freshwater ecosystem of Karnaphuli River estuary in Bangladesh to help develop future mitigation strategies.

Keywords: *contamination; microplastics (MPs); seasonal variation; surface water; polymer risk assessment; karnaphuli river estuary*

Current status and trends of research on microplastics in groundwater

Ben Ma[1], Dong Li[2*], Yuliang Zhu[a], Jie Zhang[1,2]

1. Key Laboratory of Water Science and Water Environment Recovery Engineering, Beijing University of Technology, Beijing 100124, China
2. State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, Harbin 150090, China
Corresponding author: leebjut326@163.com

Abstract

In recent years, microplastics have been frequently detected in drinking water and drinking water sources around the world. Microplastics are an emerging class of emerging pollutants with a global reach. However, current research has focused on surface runoff and oceans, and relatively little research has been conducted on microplastics in groundwater[1-3]. Due to the hidden nature of groundwater systems and limitations in sampling techniques, there is very little literature on microplastics in groundwater, and their impact on these systems is almost unknown. However, approximately 10% of the world's freshwater supply comes from groundwater, accounting for 25% of the global drinking water supply[4], Furthermore, once groundwater is contaminated, it is tough to remediate. Microplastics in the form offragments, fibers, and particles similar to those found in surface waters have also been found in groundwater in recent years, including the common polyamide (PA), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) and polystyrene (PS)[5]. Microplastics have been shown to have potential side effects on animals, plants, microbiota, soil function and structure, and even humans. However, the literature on microplastic contamination of groundwater is limited in explaining the sources and pathways of exposure of groundwater to microplastics, and existing knowledge does not explain the transport transformations and impacts of microplastics once they enter the subsurface environment. In addition, there is still a lack of systematic introduction of microplastic removal methods in groundwater. This paper reviews and summarises the progress of research on microplastics in groundwater systems, introduces the sources of microplastics in groundwater, their detection methods, and their removal methods in a comprehensive aspect, and gives prospects for future research directions and development trends, intending to provide references for subsequent research and risk prevention on microplastic-containing groundwater.

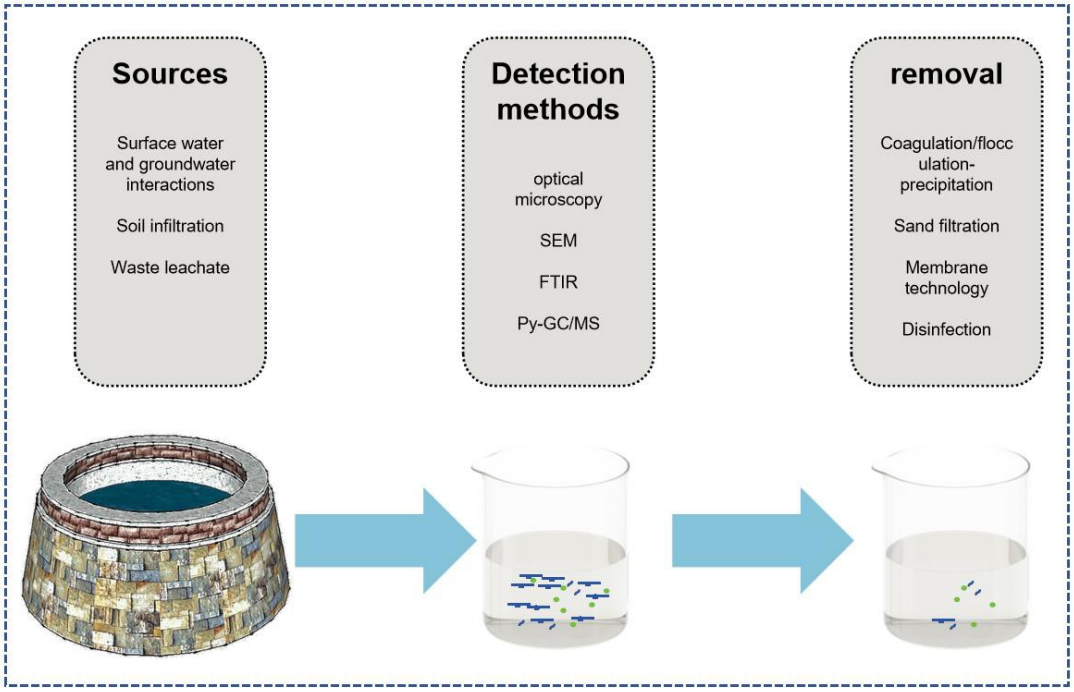
Through the Web of Science core collection search related research literature, based on a large number of literature research and analysis, this paper analyses the research progress of microplastics in groundwater from the source of microplastics in groundwater, detection, and removal methods, to provide a reference for the follow-up research and risk prevention of microplastic-containing groundwater. Groundwater also participates in the Earth's water cycle and is part of the Earth's water cycle. Therefore, microplastics in groundwater could originate from the Earth's water cycle. Microplastics in surface water may be carried into the groundwater system when surface water is the source of groundwater recharge. Detection methods for microplastics in groundwater are similar to those for surface water bodies and generally use optical microscopy, Scanning Electron Microscope (SEM), Fourier Transform Infrared Spectrometer (FTIR), Raman spectra, and pyrolysis GC-MS (Py-GC/MS). However, groundwater sampling is more difficult compared to surface water, when there is a well at the sampling site it can be taken directly from the well, if there is no well at the sampling site it is necessary to drill a borehole to take water. Coagulation/flocculation-precipitation has a good effect on microplastics, and the removal effect of different coagulants for different types of microplastics varies. Sand filtration is a common treatment process, which has some effect on

the retention of microplastics. Membrane technology is widely used in water supply and sewage treatment using membrane selective permeability to achieve the depth of pollutant treatment technology, has a good effect on the treatment of microplastics, is to prevent micropollutants into the drinking water supply of an important barrier. Disinfection is aimed at the microorganisms in the water, however, it has been found that disinfection also appears to reduce the abundance of microplastics to a degree.

This paper systematically reviews the sources, detection methods, and treatments of microplastics in groundwater and explores future trends in the field. Although various countries have taken certain measures to control the use of plastics, the massive use of plastics over the past 70 years has made microplastic pollution common in natural ecosystems around the world, and microplastic pollution will continue for a long time in the future. Microplastics are not yet included in water quality testing indicators in most countries, despite their enormous potential harm to the environment and human health. The detection methods for microplastics in the studies that have been reported are not uniform, and the detection limits and detection errors of different methods vary. Therefore, it is necessary to establish standardized sampling and detection methods for microplastics.

Keywords: *microplastics; groundwater; source of pollution; detection methods; removal methods*

Graphical abstract



The threat of microplastics and nanoplastics to biological nitrogen removal processes

Yuliang Zhu[1], Dong Li[1*], Ben Ma[a], Jie Zhang[1,2]

1. Key Laboratory of Water Science and Water Environment Recovery Engineering, Beijing University of Technology, Beijing 100124, China
2. State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, Harbin 150090, China
**Corresponding author: leebjut326@163.com (D. Li).*

Abstract

Due to the advantages of plastic products, such as low cost and high durability, they are widely used in various sectors of society (Meng et al., 2020). However, the degradation and mineralization rates of plastics are extremely low, leading to their gradual accumulation in the environment in the form of microplastics or nanoplastics. Research has shown the presence of microplastics/nanoplastics in the air, soil, freshwater, and oceans (Huerta Lwanga et al., 2016; Wang et al., 2021). The improper disposal of plastic products results in large quantities of microplastics/nanoplastics entering wastewater treatment plants (WWTPs) along with wastewater, making these plants reservoirs of microplastics/nanoplastics and posing serious threats to human and environmental health (Zhou et al., 2022). Polyethylene (PE), polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC) are the most widely used plastic products and are commonly found in WWTPs (Andrady, 2011; Gatidou et al., 2019). Biological treatment processes are the core technology in most WWTPs because they can effectively remove pollutants from wastewater, with the removal of nutrients such as nitrogen and phosphorus being particularly important. Although numerous studies have shown that the presence of microplastics/nanoplastics can affect biological nitrogen removal processes, these studies have significant contradictions and do not explain the mechanisms by which different microplastics/nanoplastics influence the nitrogen removal process. Therefore, it is necessary to investigate the risks of different types of microplastics/nanoplastics to biological nitrogen removal processes to guide the application of biological nitrogen removal technologies.

Protein molecular docking was performed using the SailVina final v1.0 software. The 2D structures of micro/nanoplastic monomers were downloaded from the PubChem database (https://pubchem.ncbi.nlm.nih.gov/). Representative protein structures related to the biological nitrogen cycle (ID: 6eu6, 8sr1, 1fgj, 7b04, 1r27, 3ml1, 6tpo, 4xyd, and 1fwx) were obtained from the PDB database (https://www.rcsb.org/). PyMOL software was used to remove water molecules and native ligands, and to visualize the molecular docking.

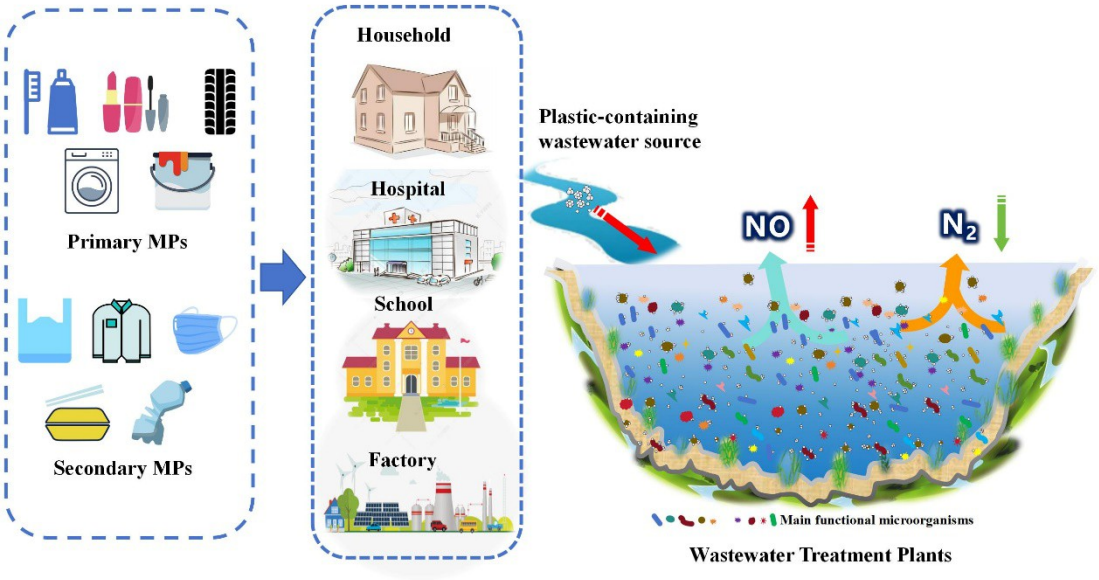
The docking interactions between monomer structures of four common microplastics/nanoplastics (PE, PP, PS, and PVC) and functional proteins involved in the biological nitrogen removal process were analyzed. PS exhibits the highest binding energy with functional proteins, suggesting that PS is more likely to attach to nitrogen-removal-related microorganisms compared to other microplastics/nanoplastics, thereby disrupting their normal biological activities. This finding is corroborated by studies conducted by Huang et al. (2023) and Ma et al. (2022) which also demonstrated the significant inhibitory effect of PS on the biological nitrogen removal process (Huang et al., 2023; Ma et al., 2022). Furthermore, for the nor functional protein, the binding energies with microplastics/nanoplastics are higher than those of other functional proteins. Nor is a key functional protein in the denitrification process,

responsible for converting NO to N_2O, indicating that the denitrification process is more sensitive to different types of microplastics/nanoplastics and may lead to NO accumulation.

The presence of microplastics/nanoplastics in wastewater treatment plants can adversely affect the normal biological activities of nitrogen-removing microorganism leading to reduced nitrogen removal efficiency. Among these, PS has a higher affinity for key functional proteins, making nitrogen removal more susceptible to inhibition. Furthermore, nor proteins exhibit high affinity with various types of microplastics/nanoplastics, suggesting that the reduction process of NO in biological nitrogen removal might be the first to be inhibited by microplastics/nanoplastics, resulting in NO accumulation and increased greenhouse effect. These findings contribute to a deeper understanding of the risk assessment and environmental management of microplastics/nanoplastics in biological nitrogen removal systems, providing a theoretical baseline for understanding the ecological roles of microplastics/nanoplastics in engineered ecosystems.

Keywords: *microplastics/nanoplastics; biological nitrogen removal; functional proteins; protein molecular docking; greenhouse effect*

Graphical abstract



Polycyclic Aromatic Hydrocarbons Profile of Microplastics Contaminated Smoked Bali Sardinella, *Sardinella lemuru* (Bleeker, 1853), and the Potential Food Safety Risk

Rowelyn M. Sargadillos1,3, Leonilo F. Endoma, Jr.1, Mae Grace G. Nillos2, *Encarnacion Emilia S. Yap1

1.Institute of Fish Processing Technology, College of Fisheries and Ocean Sciences, University of the Philippines Visayas, Miagao 5023, Iloilo, Philippines,
2. Institute of Aquaculture, College of Fisheries and Ocean Sciences, University of the Philippines Visayas, Miagao 5023, Iloilo, Philippines,
3.Fish Processing and Marine Biology Department, College of Fisheries, Mindanao State University – General Santos, Fatima, General Santos City 9500, South Cotabato, Philippines
**Corresponding Author: esyap@up.edu .ph*

Abstract

The presence of MPs in aquatic products may enhance the PAH contamination levels, particularly in smoked fish, where the process is known to introduce PAHs thus, raises a bigger food safety concern. However, limited literature reported the possible changes in PAHs levels on smoked fish contaminated with MPs. In this study, the level of PAHs in raw, brined, smoked, and plastics-spiked smoked sardines (*Sardinella lemuru*) were determined, and the potential food safety risk of contamination was assessed. No detectable levels of benzo (a) pyrene were detected however, this study highlights the presence of naphthalene from plastics-spiked smoked sardines which indicate the potential effect of smoking process on the release of hazardous compound thus, could potentially increase the PAH level at higher concentration of microplastic contamination. Moreover, risk assessment revealed that raw, brined, smoked, and plastics-spiked smoked sardines have low or minimal health risks. This study bridged the knowledge gap on the potential increase of PAHs in smoked fish contaminated with MPs and the potential risk providing information on aquatic food safety.

Keywords: *benzo (a) pyrene, cancer risk, hazardous compounds, naphthalene, pyrogenic*

Microwave-assisted hydrogen peroxide degradation of polystyrene microplastics

Natalia Hernandez-Montero[1,*], *Esteban Duran Herrera*[1]
[1] *Chemical Engineering Department, University of Costa Rica (UCR) - University of Costa Rica (UCR) – 11501-2060, San José, Costa Rica*
corresponding author: natalia.hernandezmontero@ucr.ac.cr

Abstract

The polystyrene (PS) polymer is widely used in various industries, including packaging, construction, and electronics. However, the accumulation of PS waste generates significant environmental and health concerns due to its non-biodegradable nature. It is essential to develop effective and eco-friendly techniques for degrading PS. Microwave-assisted polymer degradation has emerged as a promising strategy due to its high energy efficiency and rapid heating (Xia et al., 2022). Previous studies have examined PS degradation under various conditions, such as thermal degradation, photodegradation, and chemical degradation. However, research on microwave- assisted PS degradation has been limited, especially in peroxidative-nitric solution. Understanding the kinetics of PS degradation under microwave conditions is crucial for optimizing the degradation process and creating industrial applications (Schrank et al., 2022).

The aim of this study is to investigate the degradation behavior of PS microplastics and its preliminary kinetics when exposed to microwaves at 220°C in a peroxidative-nitric solution. The study seeks to provide preliminary insights into the degradation mechanism of microplastics for potential industrial applications. The theoretical framework of this study is based on the understanding of microwave-assisted polymer degradation, which involves the absorption of microwave energy by the polymers, leading to the breakage of chemical bonds and material degradation. The peroxidative-nitric solution is used to promote the chemical degradation of PS. It is expected that the interaction between microwave irradiation and peroxidative-nitric solution will generate a synergistic effect on PS degradation (Mdluli et al., 2024).

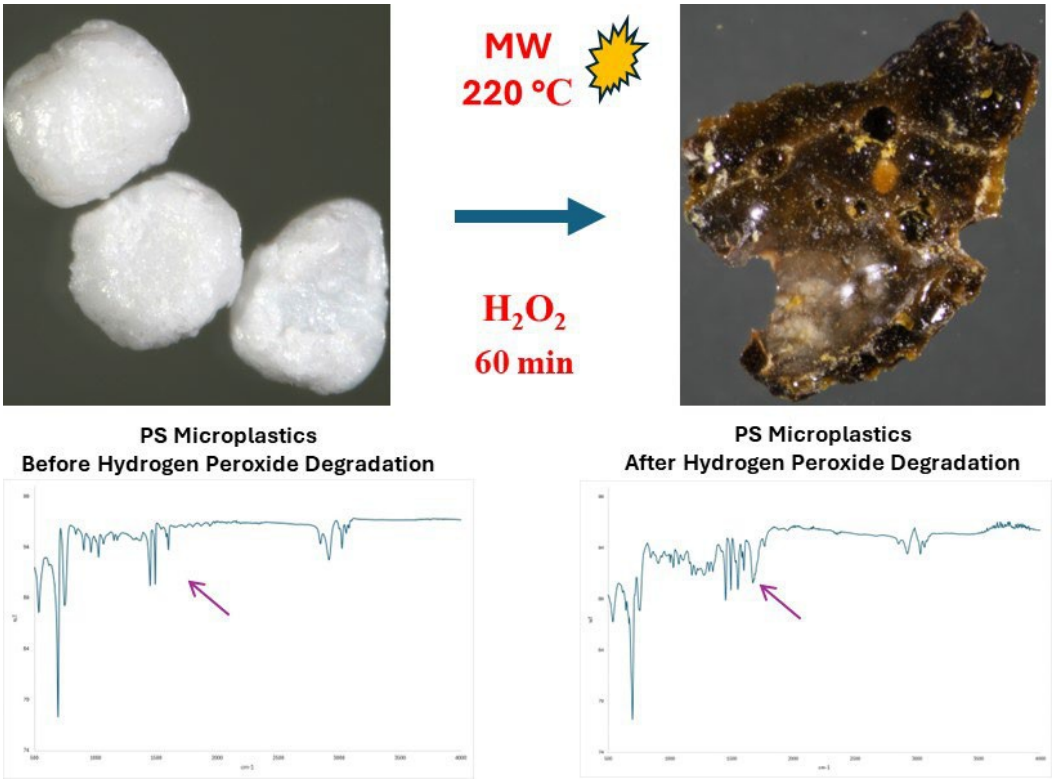
Polystyrene particles were produced by crushing plastic pieces and sieving them through Retsch filters to achieve particle sizes between 850 µm to 1 mm. The particle size confirmation was conducted by scanning electron microscopic (SEM) Jeol JSM-IT500, being the average particle size value of 1,1 mm. For the degradation study, the PS samples were dried to a constant weight and approximately 0.4000 g of PS was weighed. A solution composed of 4 ml of hydrogen peroxide 30%, 1 ml of concentrated nitric acid, and 5 ml of ultrapure MiliQ water was then added to the PS. This solution was exposed to microwave radiation using a Speed Xpert Berghof D-72800 Eningen microwave oven to study its decomposition. The procedure was replicated for time intervals of 0, 15, 30, and 60 min. The recovered PS was dried to a constant weight, and the mass loss data were recorded. The mass loss data were fitted to the Korsmeyer-Peppas model (Korsmeyer et al., 1983) to mathematically describe the degradation process (kinetics) and to gain insight into the mass loss mechanism. This model relates material degradation with retention time as a power law where m is the sample mass at time t, m_0 is the sample mass at time t=0, k is a kinetic constant,

and *n* is an exponent that characterizes the mechanism of degradation (release) of material. Non-linear regression analysis of the data was performed using Polymath software.

Furthermore, an IR spectra study was used to analyze possible degradation bands. A Perkin Elmer FT-IR spectrometer and Pike GladiATR were employed for the analysis. The appearance of bands around wave numbers associated with the degree of oxidation 1710 cm^{-1} (carbonyl, C=O) (Rojas- Guerrero et al., 2023) along the treatment confirmed the degradation of the PS particles. This preliminary study gives important input on how PS microplastics degrade when exposed to microwaves in the presence of a peroxidative-nitric solution. It is believed that microwave exposure at 220°C for various time intervals can significantly promote PS degradation, which will be reflected in changes in morphology, loss of mass, and chemical structure of the samples. The consequences of this study could be highly relevant for creating effective techniques for degrading PS and other plastics.

Keywords: microplastics, microwave-assisted advanced oxidation, polystyrene, degradation, kinetics

Graphical abstract



Microplastics in Pearl River Networks: Source, transport, and risk assessment

Huan Wang[1], Tingting Zhu[2], Jun Wang[3], Yi Liu[1,*]

1. Earth, Ocean and Atmospheric Sciences (EOAS) Thrust, Function Hub, The Hong Kong University of Science and Technology (Guangzhou)
2. Shenzhen Research Academy of Environmental Sciences
3. Advanced Materials Thrust (AMAT), Function Hub, The Hong Kong University of Science and Technology (Guangzhou)
**Corresponding author, Email: yiliuyl@hkust-gz.edu.cn*

Abstract

Microplastics (MPs) pollution has become a global environmental problem with profound impacts on aquatic ecosystems. Currently, despite the growing interest in MPs in aquatic systems, investigation into MP pollution in large watersheds is limited. Here, we conducted a field survey across the Pearl River Basin and characterized the spatial distribution of MPs by using a Laser Direct Infrared chemical imaging system (LDIR). The results showed that MPs were detected in all samples with an average abundance of 1092.86 items/L, in which polyamide, polyurethane, and polyvinyl chloride are the main types, and further analysis revealed a significant correlation between MPs concentrations and land use patterns. As the intensity of land use increases, transitioning from forested area to agricultural area, and eventually to urban area, there is a gradual rise in microplastic concentration. The results of the MPs pollution load index (PLI>1) and the hazard ranking of MPs (= 212.49) yielded a hazard class III for MPs pollution in PRB, the combined pollution risk index (= 2784.40) stated clearly the very high ecological risk. The Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis revealed that population density has been recognized as a primary factor influencing the sources of riverine MPs, and precipitation-induced surface runoff is a major pathway for MPs transferring from land to rivers. River dynamics were analyzed due to their influence on the removal of MPs during transport in the river channel. The smooth state (low Froude number) can promote but the rough state (high Froude number) can inhibit the deposition of MPs from water column to sediments. This study provides the first-hand MP pollution status in the Pearl River Networks and provide theoretical bases (spatial distribution characteristics, transmission mechanism, source of MPs) and experimental references for scientific community, help water quality management governor and stakeholders develop policy and management.

Keywords: microplastics; LDIR; pearl river basin; PLS-SE

Bio-based plastics: Unexpected hotspots for antibiotic resistance gene transfer

Yousuf Dar Jaffer[1,2], Fazel Abdolahpur Monikh[1,3,4], Uli Klümper[5], Nhung H.A. Nguyen[4], Alena Sevcu[4], Alberto Katsumiti[6], Ainhoa Bilbao[6], Hans-Peter Grossart[1,7*]

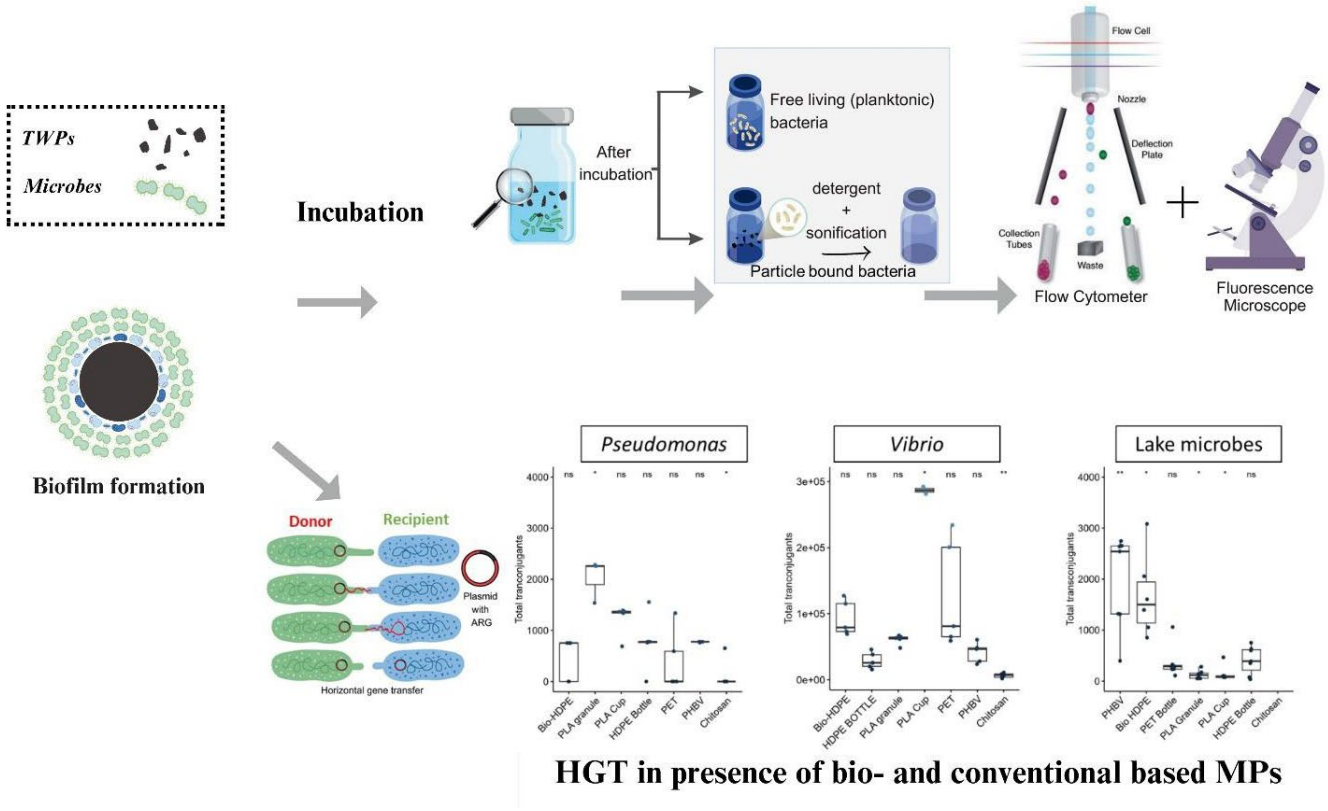
1 Department of Experimental Limnology, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany
2 ICAR-Central Soil Salinity Research Institute, Karnal India
3 Department of Chemical Sciences, University of Padua, Padua, Italy.
4 Institute for Nanomaterials, Advanced Technologies, and Innovation, Technical University of Liberec Bendlova 1409/7, 460 01, Liberec, Czech Republic
5 Institute for Hydrobiology, TU Dresden, Zellescher Weg 40, Dresden 01217, Germany
6 GAIKER Technology Centre, Basque Research and Technology Alliance (BRTA), Zamudio, Spain
7Institute for Biochemistry and Biology, Potsdam University, Potsdam, Germany

Abstract

Microplastics (MPs) from conventional plastics have been known to facilitate horizontal gene transfer (HGT) of antibiotic resistance genes (ARG)1. This study explores if bio-based plastic particles cause similar effects by comparing four bio-based MPs (PLA granules, HDPE granules, PHBV granules, and commercial PLA) with two conventional MPs (PET and HDPE from bottles). We used Escherichia coli strain resistant to trimethoprim and hosting the gfp- tagged plasmid pKJK5 as the donor, and Pseudomonas sp., Vibrio parahaemolyticus, or a natural lake microbial community as recipients. The gene transfer frequency was evaluated both on the surface of MPs and in the liquid suspension phases by flow cytometry. Across all recipient setups, higher rates of HGT were detected on bio-based MPs compared to conventional MPs. Treatments with PLA granules, commercial PLA, and PHBV exhibited the highest HGT frequency. Hence, bio-based MPs may further enhance HGT of ARGs, which requires risk assessments prior to consumer integration.

Keywords: *microplastics, antibiotic resistance gene, bio-plastics, health risk, conventional plastics*

Graphical abstract



HGT in presence of bio- and conventional based MPs

Polypropylene microplastics impacts the digestion of cow's milk proteins in infants

Tafadzwa Kaseke[1*], Vesna Jovanovic[1], Lukas Wimmer[3], Tamara Vasovic[1], Jelena Acimovic[1], Lea Ann Dailey[3] and Tanja Cirkovic Velickovic[1,2]

[1]*Center of Excellence for Molecular Food Sciences and Department of Biochemistry, University of Belgrade, Studentski trg 16,11000 Belgrade, Serbia*

[2]*Serbian Academy of Sciences and Arts, Knez Mihajlova 35, Belgrade, Serbia*

[3]*Department of Pharmaceutical Sciences, University of Vienna, Vienna, Austria*

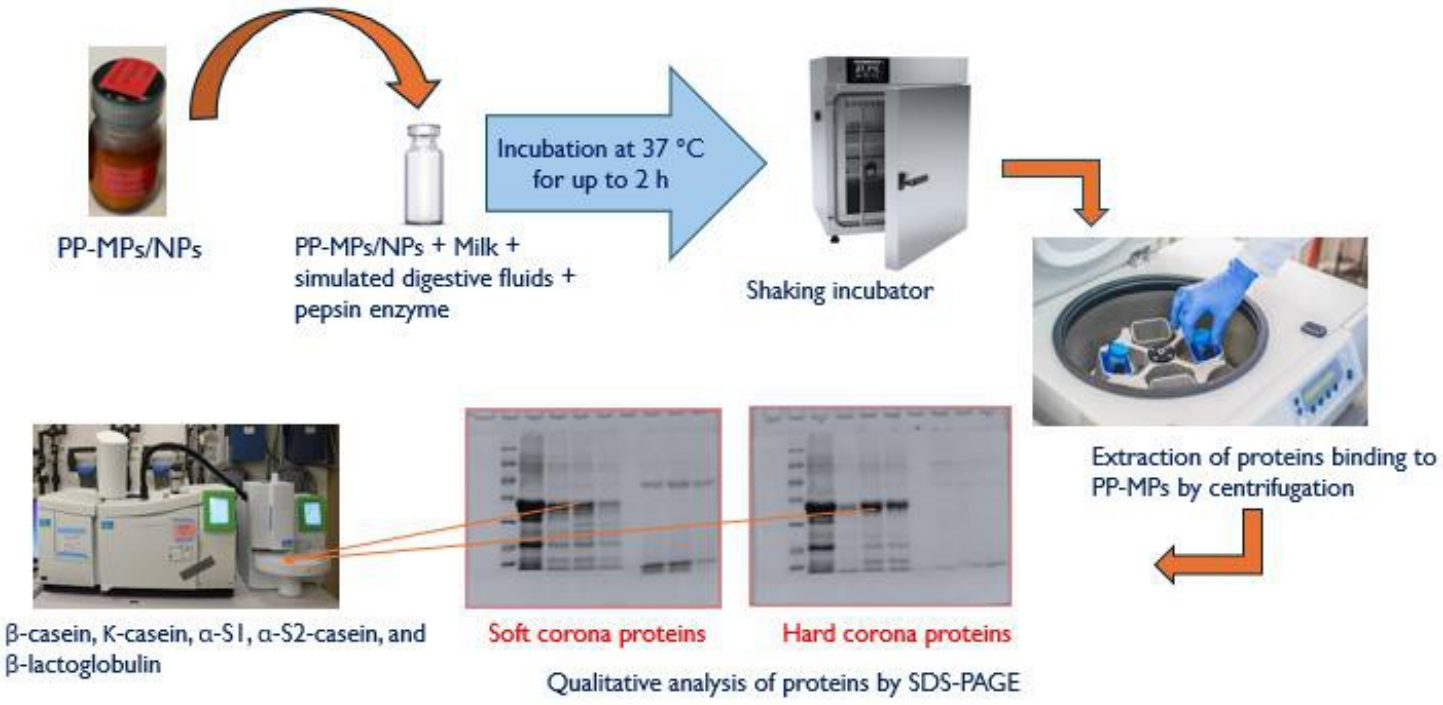
Email address: tafakaseqe@gmail.com

Abstract

Cow's milk forms an essential part of the diet of infants as a source of protein and other nutrients[1]. Microplastics (MPs) and nanoplastics (NPs) have been found in milk products including infant formula. Despite overwhelming evidence that MPs and NPs are detrimental to human health, their impact on the digestion of proteins in infants is not known[2]. To address this research gap, the current study investigated the *in vitro* digestion of cow's milk proteins in the presence of polypropylene (PP) MPs and NPs in simulated gastric fluids (SGF) using an infant digestion model (pH = 5.0; pepsin activity = 268 U/mL). The simulated *in vitro* digestion of skimmed (<1% fat) cow's milk proteins in infants in the presence of PP-MPs (63–180 µm in size; 20 mg/mL) was performed for 5, 30, and 120 min at 37 °C. For comparison purposes, the same experiment was performed using simulated gastrointestinal digestion conditions in adults (pH=3.0; pepsin activity=2000 U/mL). The *in vitro* digestion experiment was repeated in infants with different concentrations of PP-NPs (10, 50, and 100 µg/mL) for 30 min. The final concentration of the cow's milk protein in the digestion mixture was 1 mg/mL. Soft corona and hard corona proteins binding to PP-MPs were extracted by centrifugation, and profiles from protein hydrolysis were analyzed using SDS-PAGE. Selected bands of proteins were then excised from the gels and analyzed using the LC–MS/MS technique. The results revealed that both MPs and NPs had a negative influence on the process of protein digestion in infants. In addition, binding of proteins that included β-casein, Ƙ-casein, α-S1, α-S2-casein, and β-lactoglobulin in the soft and hard corona was observed, and this differed with digestion time. These results suggest possible interference of MPs and NPs with the utilization of proteins in infants, which could have detrimental health effects. Future experiments will focus on investigating the effect of MPs and NPs on protein digestion in infants using infant formula.

Keywords: *cow's milk proteins, polypropylene, simulated gastric protein digestion, soft and hard corona proteins, caseins*

Graphic abstract



Finite difference scheme for solving the waste plastic management model in the ocean system: codes Matlab

Dalah Mohamed

Affiliations: Department of Mathematics, University Constantine 1

Email address of corresponding author: dalah.mohamed@umc.edu.dz

Abstract

In this paper we establish the difference formula (forward operator) and we give the discretization of waste plastic management model in the ocean system [5] and [6]. Next, we propose the fully discrete finite difference method and we construct the numerical scheme. Finally, some numerical experiments are provided to test the effectiveness of the proposed difference formula and fully discrete method.

Keywords: *finite difference scheme, discretization, numerical scheme, initial conditions, Matlab.*

Assessment of the Genotoxic and Carcinogenic Potential of Laboratory-Aged secondary Polyethylene Terephthalate Nanoplastics

Mari Venäläinen[1,*], Hanna Pulli[1], Kirsi Siivola[1], Guyu Peng[2], Laura Rubio[3], Thorsten Reemtsma[2], Ricard Marcos[3], Alba Hernández[3], Marie Carrière[4], Julia Catalán[1]

1. The Finnish Institute of Occupational Health, Topeliuksenkatu 41 b, 00250 Helsinki, Finland
2. Helmholtz Centre for Environmental Research GmbH – UFZ, Permoserstraße 15, 04318 Leipzig, Germany
3. Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Barcelona, Spain
4. Univ. Grenoble-Alpes, CEA, CNRS, SyMMES-CIBEST, 38000 Grenoble, France
*Email address of corresponding author: *mari.venalainen@ttl.fi*

Abstract

Micro- and nanoplastics (MNPLs) in our environment go through a natural aging process that changes their physical and chemical properties. Continued exposure to these particles can lead to their accumulation in human tissues and concern for human health. This study assessed the genotoxic and carcinogenic potential of laboratory-aged secondary polyethylene terephthalate (PET) MNPLs that were obtained through sanding commercial water bottles.

The micronucleus (MN) assay is a validated method for assessing genotoxic carcinogens that act as tumor initiators. However, these short-term genotoxic assays cannot model the promotion and progression of carcinogenesis. The Bhas 42 cell transformation assay (CTA) is an OECD-validated *in vitro* assay that facilitates simulating the initiation and promotion stages of carcinogenesis and identifying a wider range of carcinogens.

The aging of the PET particles was performed with Q Sun Xe-1 solar simulator for 192 h, which equals to approx. 71 sunny days. Carcinogenic potential of the aged MNPLs was evaluated with the Bhas 42 CTA, following the OECD guidance. In brief, Bhas 42 cells were exposed to aged PET (6.25–200 µg/mL) from day 1 to 4 in the initiation, and from day 4 to 14 in the promotion assay. The cells were fixed on day 21 and the transformed foci were scored manually. Cellular internalization of the MNPLs was studied via transmission electron microscopy. In addition, human B lymphoblastoid TK6 cells were treated with aged PET (0.62–50 µg/mL) for 21 h (1.5 cell cycles) to assess MN induction. Afterwards, the cells were incubated with cytochalasin B for further 21 h before being fixed and analyzed with fluorescence microscopy.

Preliminary results showed cell-transforming effects of aged PET at the highest concentrations in the promotion assay. However, similar effect was not observed in the initiation assay. Agreeingly, neither did aged PET increase the MN frequency in TK6 cells. Internalization analyses are still in process

Keywords: *polyethylene terephthalate, nanoplastics, aged particles, cell transformation, genotoxicity*

Adsorption of Cu on post-consumer microplastics

A. Pacyna-Kuchta*[1], Z. Frankowska[2], M. Frankowski[2]

1. Gdańsk University of Technology, Faculty of Chemistry, Department of Biotechnology and Microbiology, 11/12 Narutowicza Street, 80-233 Gdańsk, Poland
2. Adam Mickiewicz University in Poznań, Faculty of Chemistry, Department of Analytical and Environmental Chemistry, Uniwersytetu Poznańskiego 8, 61-614 Poznań, Poland
corresponding author: aneta.kuchta@pg.edu.pl

Abstract

Microplastics (MPs) found in the marine environment can have a high affinity for metal ions and thus increase their bioavailability to biota. Port areas are affected by intense anthropogenic activities, and coastal pollution, and are therefore potential hotspot areas for pollutants such as trace elements and organic contaminants. They may also be hot-spots for Cu contamination, due to the use of anti-fouling paints and ship scrubbers and MPs. The main goal of this study was to better understand how microplastic particles can act as a contaminant vector, with a particular focus on copper. We used spherical microbeads and post-consumer plastic (micro- and mesofraction of irregular size created from post-consumer items such as bottle caps, coffee cups, foil etc). For the adsorption batch experiments we used both artificial seawater and freshly collected Baltic water affected in a smaller or bigger scale with shipping activity. We compared the adsorption results of different polymers to evaluate how particle size, polymer form and low-salinity seawater affect the adsorption of Cu. Studies were designed to mimic the relevant conditions in the environment.

Keywords: *microplastics (MPs)*

Microplastics in the river Yamuna, India: unseen threats to riverine ecosystems

Sneha Siwach and Ram Krishan Negi*

Fish Molecular Biology Laboratory, Department of Zoology, University of Delhi, Delhi-110007, India

Corresponding Author: negigurukul@gmail.com

Abstract

Plastic and microplastic pollution are a pervasive and global concern, with only a small fraction of produced plastics being recycled, while the remainder accumulates in the environment. Rivers are crucial ecosystems, supporting diverse plant and animal life, and providing essential water resources for drinking, agriculture, and industrial uses. However, the infiltration of plastic and microplastics into river systems poses a significant threat to these ecosystems. Recent research underscores the importance of freshwater resources, particularly rivers, as major conduits for microplastic dispersion. This study documents the presence of microplastics at various sites along the Yamuna River in Haryana and Delhi, India. Water samples, each 1 litre in volume, were collected from the surface and at a depth of 50 cm from eight different locations along the Yamuna River and analyzed in the laboratory. The highest concentration of microplastics detected was 433 microplastics per litre (mps/L) at the surface of Sonia Vihar, Delhi. At a depth of 50 cm, the highest concentration was 395 mps/L at Kalindi Kunj Barrage, Delhi. Preliminary investigations into the presence of microplastics in the organs of fish species (*Oreochromis niloticus*, *Salmostoma phulo*, *Labeo rohita*) revealed fibers and fragments of microplastics in nearly all organs examined. The predominant types of microplastics identified were polyethylene (PE), polystyrene (PS), polypropylene (PP) and polyethylene terephthalate (PET), confirmed through FTIR spectroscopy.

Keywords: *microplastics, plastic pollution, ftir spectroscopy, Yamuna, freshwater environment*

Method development for extracting microplastics from high organic matter matrices

Sheharyaar Farid [1], Ana R. Marques Mendes [1], Mark Gerard Healy [2], Liam Morrision [1]

1. *Earth and Ocean Sciences, School of Natural Sciences and Ryan Institute, National University of Ireland, Galway, Ireland*
2. *Civil Engineering and Ryan Institute, College of Science and Engineering, University of Galway, Ireland*

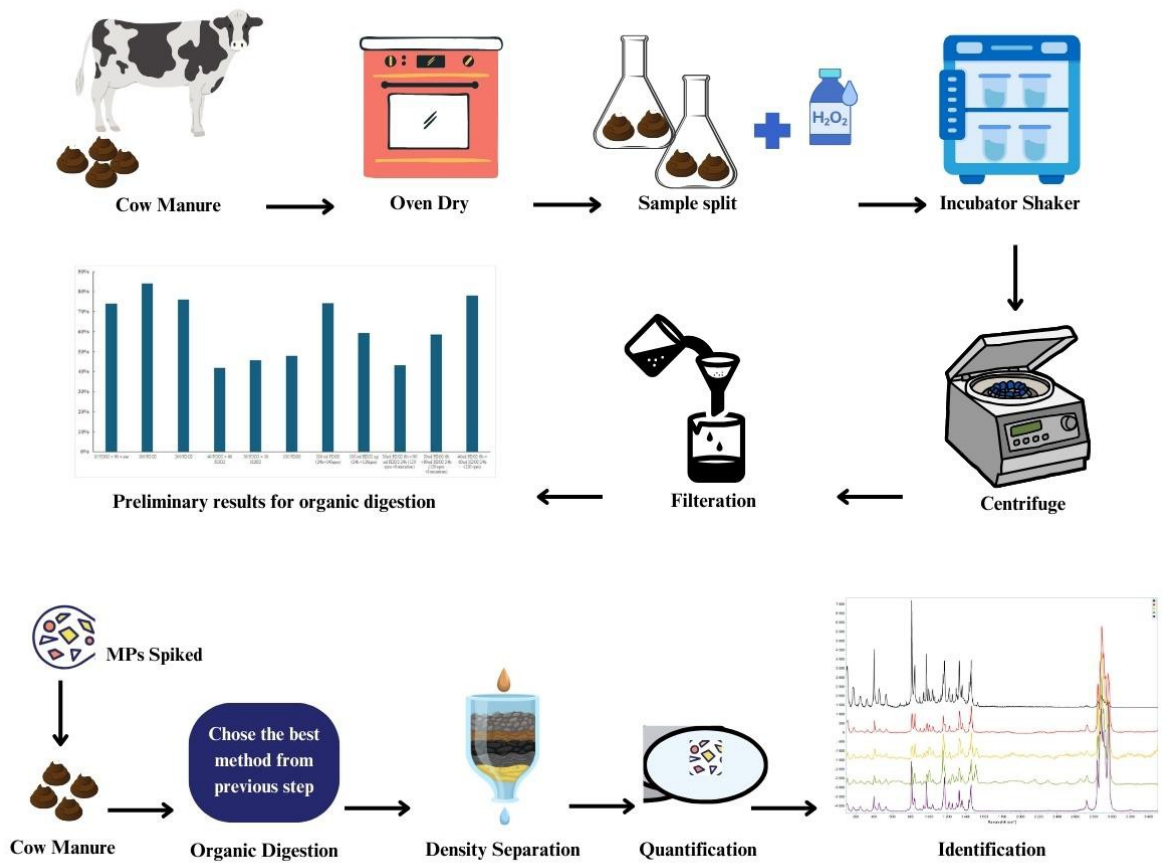
Email Address: S.farid1@universityofgalway.ie

Abstract

Animal manure is widely used as organic fertilizer for sustainable agriculture. The application of animal manure increases the quality and productivity of crops by improving the physiochemical properties of soil. The overall production of manure from cattle, chickens, and pigs in the EU-27 and the UK between 2016 and 2019 was approximately 1.4 billion tons per year of which 90% was applied to soil [1]. Previous studies have indicated the presence of microplastics (MPs) in animal manure which could lead to MPs pollution in soil [2, 3]. Microplastics research in manure is still on the early stages development and there is no standard method for organic digestion and extraction [3]. The extraction of MPs from organic materials can be improved and streamlined through optimising variables such as the reagents used in the organic matter digestion , concentration, time and temperature involved [4]. Previous research compared the impact of different reagents such as 30% H_2O_2 [2], Fenton's reagent (H_2O_2 + $FeSO_4$) [5], NaOH [6], and HNO_3 [7] at a range concentrations for organic digestion to extract MPs. Although 30% H_2O_2 removes more organic matter from the high organic content matrix than Fenton's reagent and KOH [8], temperature is crucial for material breakdown. Oxidants like H_2O_2 minimally affecting synthetic polymers' weight and size at room temperature, although polyamide (PA) fibres and poly(methyl methacrylate) (PMMA) particles at 70 – 100°C will disappear [4, 9]. The temperature increases between 40 – 50°C increase the organic matter removal for MPs extraction but no significant differences has been observed for organic matter reduction at 60 – 70°C [10]. The present study aims to optimize the extraction process of MPs from high organic matter matrices such as manure without effecting the polymers in a shorten amount of time. The preliminary results indicate that 40 – 75% of organic matter is reduced in animal manure at 40°C in 24h during the extraction of MPs. This research will contribute to develop method for MPs extraction from high organic materials at low temperature.

Keywords: *microplastics, manure, organic digestion, extraction method*

Graphical Abstract



Chickpea edible cups: fun and sustainale sips for kids

Amulyha B, Dr. Paramasivam Raajeswari*
Corresponding author: ammubhaskar25@gmail.com

Abstract

Child growth and development is a multifaceted process that commences in utero and continues till adulthood. Nutrition plays a vital role in the growth and development of children. On the other hand, there is an increased disposal of single-use plastics. To address this issue, chickpea edible cup is formulated to bridge the gap between nutrition and sustainability. Chickpea (*Cicer arietinum* L.) annual plant of the family Fabaceae is mainly grown in semiarid and temperate regions. Chickpeas are a type of pulse that are grown worldwide and are regarded as an affordable, high-protein food. Therefore, chickpea is incorporated in an edible cup for the ease of nutritional intake as well as on the notes of sustainability. Edible cups are a unique and environmentally friendly solution to the problem of waste generated by disposable cups. This edible cup was composed of chickpea flour, jaggery and dates powder in the ratio of 2:1:0.5. It had a firm appearance with mild brown color providing a nutty flavor and a sweet taste. A nutrient analysis and microbial analysis were conducted for chickpea edible cups. Chickpea cup yields

76.53 kcal of energy along with 1.44g of protein, 0.87g of fat and 15.72g of carbohydrates. Microbial analysis ensured no contamination by raw materials utilized to prepare the cups. FTIR, texture analysis, antioxidant activity and brine shrimp assay were also conducted to examine the quality and durability of the edible cups. These edible cups are enticing for children which is packed with nutrition. The use of edible cups also addresses the concept of sustainability at a young age. This initiative will aid for raising a responsible youngster for the future generation. Thus, chickpea edible cup is a commixture of healthy snack for children and a sustainable product for the environment.

Keywords : *Growth and development, nutrition, chickpeas, sustainability*

Graphic Abstract

Temporal evaluation of atmospheric microplastics deposition with rainwater on different landscapes

Zulakha Rasheed, Prof. Kazimierz Bęcek*

Corresponding author: kazimierz.becek@pwr.edu.pl

Abstract

Microplastics have been identified almost everywhere on the earth including remote areas. Few studies have shown the wet deposition of atmospheric microplastics but still there is not much evidence available about the transportation flux of these tiny particles. Atmospheric washout with rain could be a potential source of microplastics deposition on different kinds of landscapes. The current research study focuses on the presence, characteristics and quantification of atmospheric microplastics in agricultural and urban areas of Wroclaw, Poland. The aim of this study is to assess the wet deposition of microplastics on different landscapes including agricultural residential, and traffic areas of Poland. The novel methodology has been used in this research combined with using few sample collection protocols designed my NOAA and PCT/IB 2019 /051,838 of March 7, 2019, that is the code of the submitted request granted an international patent extension in several countries worldwide, together with the accepted Italian patent number 102,018,000,003,337 on March 7, 2018. The sampling duration was 6 months from October 2023 to March 2024. Initial lab experiments including sample preparation, digestion, vacuum filtration and extraction on membrane filter were done in the mineral processing laboratory of Geoengineering, Mining, and Geology faculty. Results shows high concentration of microplastics in rainwater samples from each location with majority in agricultural and residential area. The data was presented using Screening Electron Microscope (SEM). The results were categorized according to the identified particle sizes, colors, and shapes. This study provides valuable information on the extent and severity of wet deposition of microplastics on different landscapes of Poland, which will help to design policies and strategies to reduce microplastics pollution, promote sustainable development, and protect public health. This research study has linkage with SDG 15 and 3. The methodology and findings of this research can be used to assess microplastics impacts on livelihood, ocean and mountains worldwide and will help to plan strategy to achieve sustainable development goals.

Keywords: *microplastics, food chain, landscapes, wet deposition, rainwater*

Silver Nanoparticle Edible Films for Sustainable Packaging

* M.Haritha, Research Scholar, Raajeswari Paramasivam, Professor

Department Food Science and Nutrition, Avinashilingam Institute for Home Science & Higher Education for Women, Coimbatore, Tamil Nadu, India

corresponding author : haritha123789@gmail.com

Abstract

The intensifying environmental concerns with plastic packaging have driven the demand for sustainable alternatives. Traditional plastic packaging poses significant environmental hazards due to its non-biodegradability and the production of microplastics. All living organisms now consume microplastics, and these particles are deposited in ecosystems globally, affecting all living beings. This widespread contamination poses severe ecological and health risks. This study investigates whether tapioca starch films can be substantially enhanced by introducing specific herbs. The goal is to create a biodegradable and edible packaging material that is both sustainable and practical, offering a feasible alternative to current plastic packaging materials. The study involves a comprehensive review of existing literature, focusing on the formulation techniques, film-forming materials, and the role of plasticizers in improving film flexibility. Casting and extrusion methods are examined, along with the use of plasticizers such as glycerol and sorbitol. Additionally, the incorporation of natural extracts from plants, spices, and herbs into edible films is studied to evaluate their characterisation, antioxidant and antimicrobial effects. The films with 5 ml of silver nanoparticle extract demonstrated a tensile strength of 2.30 ± 0.15 N/mm², while those with 10 ml showed 1.95 ± 0.12 N/mm², compared to 4.20 ±0.20 N/mm² in the control films. Elongation at break was reduced to 11.2 ± 0.8% and 9.13 ±0.6% for the 5 ml and 10 ml nanoparticle films, respectively, from 15.5 ± 1.0% in controls. Furthermore, these films exhibited reduced moisture permeability and lower microbial contamination (20 ± 2 CFU/cm² and 18 ± 2 CFU/cm² for 5 ml and 10 ml, respectively, compared to 45 ± 5 CFU/cm² in controls). The incorporation of silver nanoparticles derived from antimicrobial herbs, particularly betel leaves, into tapioca starch-based edible films improves mechanical strength, antimicrobial characteristics, and moisture resistance with decrease in flexibility. These observations reveal that such films have a high potential application in sustainable food packaging, providing a sustainable alternative to conventional plastic packaging with enhanced food safety. Future research ought to focus on optimising nanoparticle concentrations and maintaining regulatory compliance in order to enable greater application in the food companies.

Keywords: *tapioca starch films, silver nanoparticles, antimicrobial herbs, sustainable packaging, antimicrobial properties*

Graphical Abstract:

Microplastic accumulation in estuarine mussels: insights from literature review and dynamic modelling

Ahinara Francisco López, Vaisakh Yesodharan and Pastora M. Bello Bugallo*

TECH-NASE Research Group, Department of Chemical Engineering, Universidade de Santiago de Compostela, Av. Lope Gómez de Marzoa, s/n, E-15782, Santiago de Compostela, Spain
**Correspondence: pastora.bello.bugallo@usc.es*

Abstract

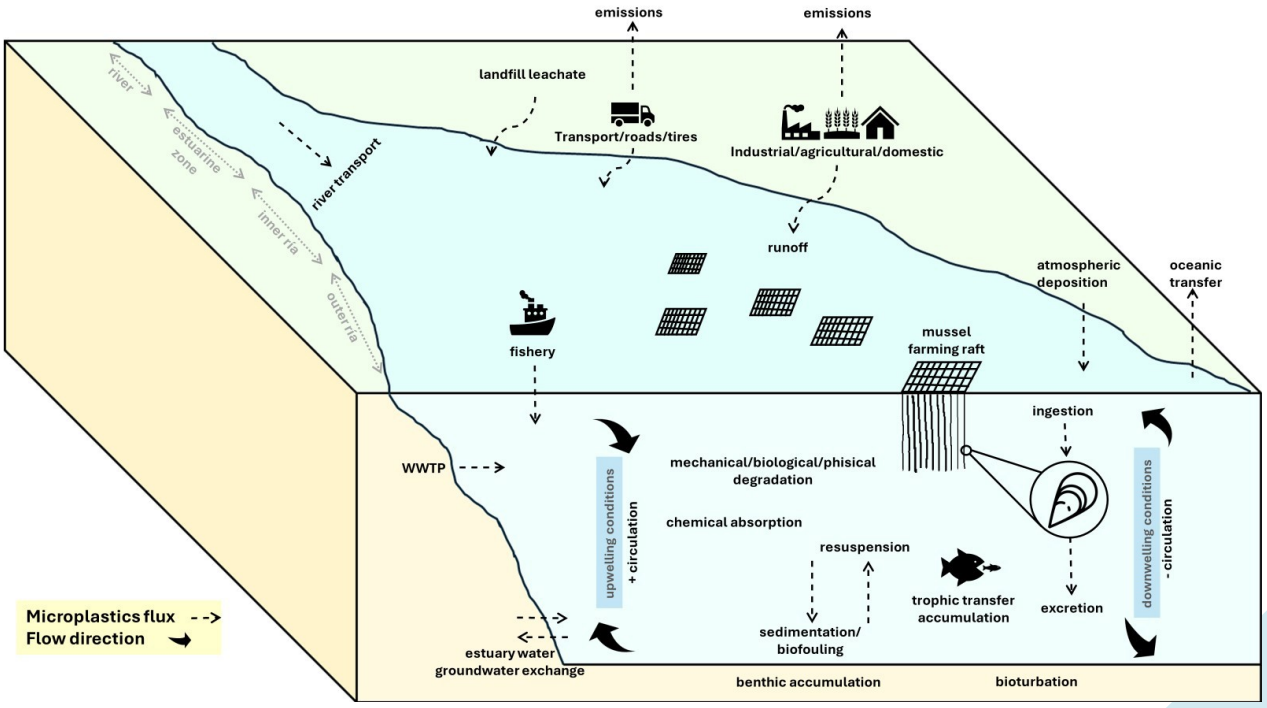
In the coming decades, an increase in annual plastic waste entering aquatic ecosystems is expected [1], with a concurrent increase in the transfer of microplastics to the biota [2]. Microplastics (MPs) have become ubiquitous in oceans, infiltrating the food chain of marine species and potentially reaching humans [3]. In estuarine environments, where urban and industrial activities interfere with mussel aquaculture, mussels potentially undergo significant anthropogenic pressures and freshwater inflows [4]. The dynamics of MPs in these areas are influenced by tidal flows, oceanic wind patterns, and runoff from urban areas, which are primary pathways for plastic debris entering estuaries [5]. Due to their transitional nature, estuaries play a significant role in the concentration and transport of microplastics, distinct from other water bodies. Furthermore, knowledge of estuarine behavior is necessary for understanding and quantifying the transport of MPs from land to ocean [6]. Understanding these processes is valuable for developing dynamic models that describe environmental systems and can be generalized for further studies under comparable conditions [7]. This research comprehensively analyzes microplastic behavior across the trophic chain in estuarine environments, considering interactions between microplastics and mussels. This study aims to investigate the accumulation of microplastics in mussels through dynamic modelling, while also exploring how environmental factors, including seasonal fluctuations and estuarine dynamics such as upwelling and downwelling, influence this accumulation process within a specific study area.

The study analyzes the prevalence of microplastics in estuarine environments, with a specific focus on the case study "Ría of Vigo" and their accumulation in mussels. The methodology begins with a comprehensive review of existing literature and study of the real system using system dynamics, providing a foundational understanding for model development. Numerical data derived from studies on microplastics in mussels are utilized to construct a dynamic model using Vensim PLE software. The model is built in a step-by-step manner using flows and stocks diagrams, integrating optimized data and equations to simulate the mobilization and accumulation of microplastics in mussels of the Ría of Vigo. The software facilitates the execution and refinement of these models, ensuring robust

analysis of microplastic dynamics in estuarine environments.This work expands current knowledge about microplastics in mussels and offers novel results through modelling. More than 120 articles have been reviewed and analysed to study the origin, sources and sinks of microplastics in estuaries. The model validates that mussels can remove and reintroduce significant quantities of microplastics into the water column, thereby influencing the transport dynamics of these particles in estuaries. Furthermore, it evaluates the estuaries' capacity to retain microplastics compared to adjacent water bodies. Estuaries emerge as pivotal zones for potential cleanup initiatives due to their unique environmental characteristics. However, addressing microplastic pollution remains challenging, primarily due to the inadequate availability of quantitative data, which complicates meaningful comparisons across different regions. Standardization in microplastic definitions and assessment methodologies is key to mitigate anthropogenic impacts effectively. The integration of modeling techniques proves valuable in complementing experimental findings, identifying areas prone to plastic accumulation, and guiding policymakers in implementing targeted interventions within estuarine ecosystems.

Keywords: *microplastics; modelling; food chain; urban estuaries; bioaccumulation*

Graphic Abstract



Analysis and characterization of microplastics in environmental samples using a custom micro-Raman spectroscopy setup

Megha Sunil[1], Mithun N.[2], Anu Gopinath[3], Santhosh Chidangil[2], Satheesh Kumar[1], Jijo Lukose[1*]

[1]*Department of Atomic and Molecular Physics, Manipal Academy of Higher Education, Manipal, Karnataka, India-576104*

[2]*Centre of Excellence for Biophotonics, Department of Atomic and Molecular Physics, Manipal Academy of Higher Education, Manipal, Karnataka, India-576104*

[3]*Department of Aquatic Environment Management, Kerala University of Fisheries and Ocean Studies, Kochi, Kerala, India-682506*

Abstract

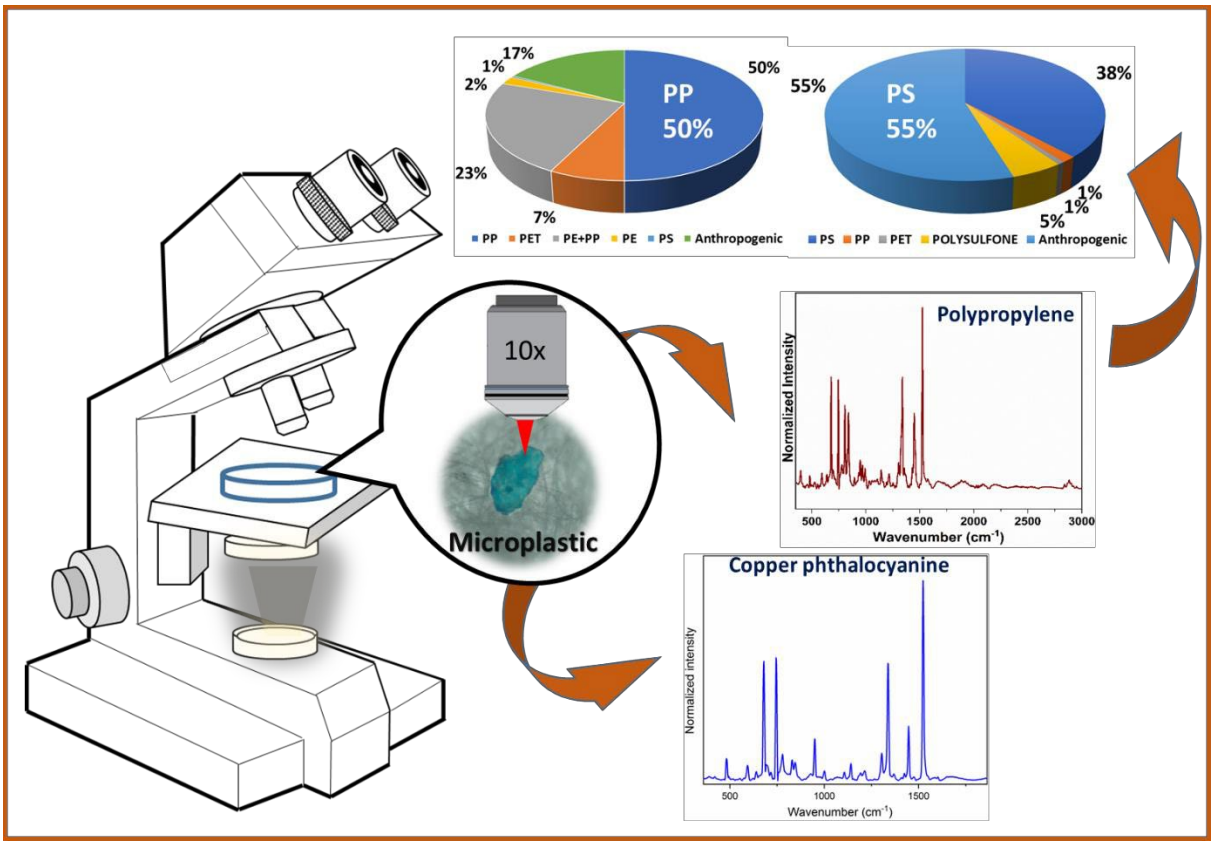
Plastics have become indispensable in modern society, finding extensive applications across various industries. However, their widespread usage and improper disposal have led to a pressing environmental issue known as plastic pollution [1]. Measuring less than 5 millimeters, microplastics have emerged as a significant global issue. These tiny particles are generated through the process of weathering and the breakdown of larger plastic debris. [2]. Microplastics in aquatic environments present significant risks to both marine organisms and human health as they continue to accumulate over time.

Micro-Raman Spectroscopy, due to its non-invasive characteristics, has emerged as a valuable technique for precisely identifying microplastics in water samples. This method offers exceptional sensitivity and minimal disruption, making it highly effective in detecting microplastics within aquatic environments. [3]. This investigation highlights a cost-efficient and highly sensitive micro-Raman spectroscopy setup, developed in-house, which proved successful in visualising, identifying, and characterizing microplastics within environmental samples. The analysis focused on water samples collected from groundwater sources in industrial zones located in southwest India, as well as from the Azhikkal Estuary in Kannur, India situated along the Arabian Sea coastline. copolymer, polyethylene terephthalate, polyethylene, and polystyrene also present. Furthermore, similar anthropogenic particles were also observed in the groundwater.

The primary focus of this study is to consistently examine the escalating occurrence of microplastics in aquatic environments, shedding light on this concern and establishing the necessary foundation for continuous monitoring endeavours. Furthermore, it emphasises the significance of analysing fluctuations in microplastic levels within marine environments in order to comprehend shifts in oceanic processes in the face of climate change. Subsequent research on microplastics in aquatic systems may shed light on the looming public health emergency arising from the capacity of biofilms to host viruses. Moreover, evaluating the harmful effects of microplastics on human health is imperative, considering their detection in diverse human specimens such as placental tissue [4] and breast milk [5]. Acknowledging the health risks associated with microplastics is quite crucial for formulating efficient strategies to address this issue.

Keywords: *microplastics, micro-raman spectroscopy, polystyrene, polypropylene*

Graphical Abstract



Unveiling pharmacokinetic potential: papaya leaf extract in oral dissolving strips

R. Jeevitha, Dr. Paramasivam Raajeswari,
Corresponding author:jeevithar2706@gmail.com

Abstract:

Oral Dissolving Strips (ODS) are an innovative drug delivery system designed for rapid disintegration in the oral cavity, offering an alternative to conventional dosage forms such as tablets and capsules. This study focuses on the development and evaluation of ODS using papaya leaf extract, known for its therapeutic properties, particularly in boosting platelet counts and possessing anti-inflammatory and immunomodulatory effects. In recent years, oral dissolving strips (ODS) have drawn a lot of attention as a new dosage form that has several benefits over conventional oral drugs. A combination of polymers was used to improve the formulation in order to provide the desired mechanical qualities and fast disintegration. The presence of dissolving agents and the selection of polymers enabled the formulated ODS to rapidly disintegrate on the tongue in a matter of seconds. Because papaya leaf extract contains phytochemicals, it boosted bioavailability without substantially affecting the strips mechanical integrity. All things considered, ODS derived from papaya leaf extract offer a viable method of delivering bioactive substances in a dosage form that is simple to administer, with potential uses in the pharmaceutical and nutraceutical sectors. ODS of papaya leaf extract present a promising delivery system that combines the medical benefits of the extract with the convenience and efficiency of orally dissolving strips, potentially enhancing patient compliance and therapeutic outcomes in conditions like dengue fever where platelet enhancement is critical. The formulated and standardized Oral dissolving stripsusing papaya leaf extract were subjected to organoleptic evaluation with 30 semi trained panel members in 9 hedonic scale.

Keywords: *Papaya leaf extract, disintegration, ODS, anti- inflammatory*

Graphic Abstract

Nir spectral imaging for non-destructive detection of microplastics in fish filets

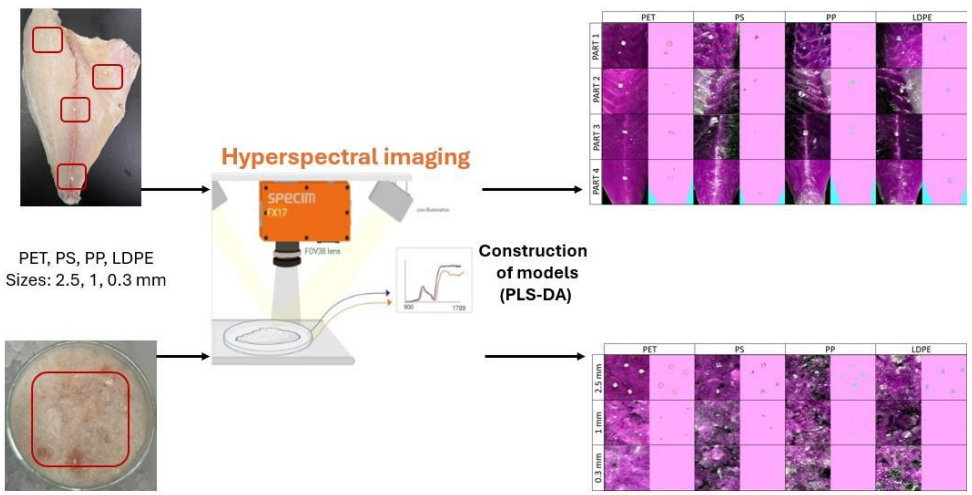
Clara Peiris[1] , Josep Comaposada[1], Begonya Marcos*[1]
[1]*IRTA, Food Quality and Technology, Finca Camps I Armet s/n, 17121 Monells, Spain*
*Email address corresponding author: * begonya.m ar cos@ir t a.cat*

Abstract

Global concern towards microplastics (MP), a heterogeneous group of plastic particles of sizes 0.1-5,000 µm, has increased in recent years for their consideration as environmental pollutants [1,2]. MP are being consumed by a wide range of fish and invertebrate species, and even humans. In fact, MP have been found in human's blood, placenta, and organs [3,4]. However, there is limited knowledge on the occurrence and origin of MP, mainly due to the lack of a standardized and affordable methodology for analysis. Moreover, research on MP contamination in food matrices is still limited because of the diverse range of MP types, sizes, and shapes; and the complexity of the detection of such small particles from a food matrix [5,6,7]. Non-destructive methodologies such as NIR or hyperspectral imaging (HSI) have showed great potential in detecting MP in food matrices. This study seeks to assess the viability of analysing polyethylene terephthalate (PET), polystyrene (PS), polypropylene (PP) and low-density polyethylene (LDPE) microparticles in gilt-head bream fillets without the need for sample pretreatment. With this purpose, PET, PS, PP, and LDPE microparticles (2.5, 1, and 0.3 mm) were obtained by grinding and sieving virgin pellets. Whole and ground gilt-head bream filets samples were artificially contaminated with the obtained MPs. A push-broom Specim FX17 camera (935-1720 nm) equipped with a FOV38 lens was used to acquire spectral images. SpecimINSIGHT software was used for analysis. The best combination of spectra preprocessing strategies were used to develop models (partial least square discriminant analysis, PLS-DA) for MP classification. A PLS-DA classification model able to identify PET, LDPE, PP, and PS microparticles in whole and ground gilt-head bream was developed with a CV accuracy of 99.90%. Particles in the range of 1-2.5 were detected, however particles of 0.3 mm, which were in the range of the pixel size of the HSI equipment, were not detected in the studied conditions. The obtained results have demonstrated the potential of HSI, a non-destructive methodology, for MP analysis in food matrices. To ameliorate particle detection (0.3 mm), further research will be focused on the use of a macro lens to improve pixel size.

Keywords:*food, microplastics, polymer microparticles, fish, NIR spectral imaging*.

Graphic abstract



Gummies using yellow pumpkin

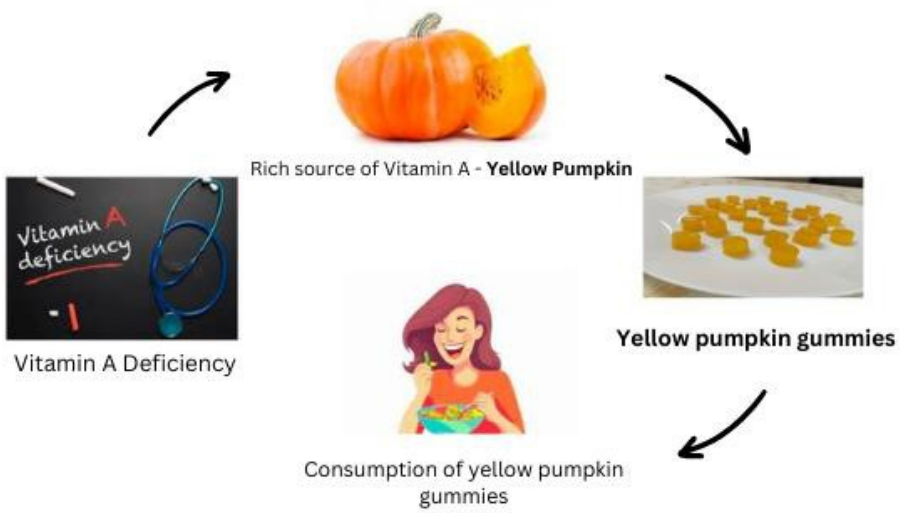
[1]Poomagal.K.P , [2]Dr.Paramasivam Raajeswari,
[1]II PG student, [2]Professor
Corresponding author: punnagaiyarasi77@gmail.com

Abstract

The yellow pumpkin, scientifically known as Cucurbita pepo, is a vibrant and versatile vegetable. In addition to its cultural significance, the yellow pumpkin boasts impressive nutritional credentials, offering a rich source of essential vitamins, minerals, and antioxidants, making it a valuable addition to any diet. Rich in beta-carotene, a precursor to vitamin A, yellow pumpkin promotes healthy vision, immune function, and skin integrity. Additionally, it contains significant amounts of vitamin C, potassium, and fiber, contributing to overall health and well-being. The incorporation of yellow pumpkin into gummies represents a creative and convenient way to harness its nutritional benefits. These gummies offer a convenient and enjoyable way to supplement one's diet with essential nutrients found in yellow pumpkin. Yellow pumpkin gummies can serve as a dietary supplement for individuals looking to boost their intake of essential nutrients, particularly vitamin A, vitamin C, and fiber, which are abundant in yellow pumpkin. While commercially available gummies come in a variety of flavors and formulations, those infused with yellow pumpkin offer a unique nutritional profile. Unlike traditional gummies, which may rely on artificial colors and flavors, yellow pumpkin gummies derive their vibrant hue and flavor from natural sources. Additionally, they provide added nutritional value to the inclusion of yellow pumpkin extract or puree, distinguishing them as a healthier alternative. Gummies using yellow pumpkin will have 7.13 g/100g of protein ,141.85 g/100g of energy, 28.24 of iron to it. Yellow pumpkin gummies have broad appeal across different age groups, and the gummies are poised to make a significant impact in the food and supplement industry. Gummies using yellow pumpkins are made with natural ingredients, including yellow pumpkin extract or puree, which provides the vibrant color and unique flavor. They attract consumers looking for both flavor and nutritional value in their snacks

Keywords: yellow pumpkin, gummies, nutritious, vitamin A, supplement

Graphical Abstract:



The influence of crushing method, oxidative aging and exposure duration of tire wear microplastics on *C. elegans*

Sefine Oksal Kilinc

Humboldt-Universität zu Berlin, HU Berlin · Institute for Biology
Corresponding author :kilincse@hu-berlin.de

Abstract

Microplastic pollution in soil is 4 to 23-fold higher than in oceans. Tire abrasion is one of the greatest sources for microplastic in aquatic and terrestrial environments. Despite that fact, investigations in microplastic pollution and its effects in soil ecosystem are scarce or do not consider aging procedures occurring in nature. A huge gap in knowledge exists regarding the interaction of tire wear microplastic (TWMP) with soil biota. The aim of the present study is to quantify the toxicity of TWMP on the nematode *Caenorhabditis elegans* under laboratory set-ups according to BS ISO 10872:2010. Various types of TWMP were tested. One TWMP powder was originated from crushing with a cryomill, the other powder was produced with a diamond grinding machine. The powders were then aged with the application of 1.7 g ozone per gramm TWMP and/or 20 minutes of heat at 100°C.

The toxicity was tested for different TWMP leachate concentrations, as well as for varying crushing and aging methods and degrees of aging applied to the TWMP. We also tested the influence of the leachate exposure duration. The TWMP concentration in the experimental solution were 1 g, 0.5 g and 0.25 g per 10 ml, equivalent to a soil concentration of 3.2 %, 1.6 % and 0.8 % in dry soil. All concentrations revealed significant toxic effects of aged TWMP on *C. elegance*. Significant differences were also observed between the toxicities of pristine TWMP crushed with a cryomill and with a diamond grinding machine at all concentrations. Pearson correlation tests indicate negative correlation between offspring per adult *C. elegans* and duration of the ozone application on TWMP. The tested exposure of 24,

48, 72 and 98 hours did not show significant differences in the survival of the nematodes. Overall the results highlight the importance of oxidative and mechanical aging of tire wear concerning toxic effects on soil biota and questions the use of pristine particle in scientific practice.

Keywords: *microplastic, pollution, tire wear, tire abrasion, C. elegans, nematode, terrestrial system, soil condition, oxidative aging, ozone*

Sustainable Edible and Ecofriendly Packaging Films and Tableware Tackling Plastic Pollution towards Greener Biome

Dr.PA.Raajeswari
Avinashilingam Institute for Home Science and Higher Education for Women
Coimbatore- 641 043, Tamil Nadu, India
Corresponding author: raajeswarifsn@avi nut y.ac.in

Abstract

Single-use plastics (SUP) are extensively manufactured and consumed due to the disposable nature of contemporary lifestyles, rapid industrialization, and urbanization, posing significant threats to terrestrial and aquatic ecosystems. Discovering more economically viable and sustainable SUP alternatives is the need of the hour. Encouraging alternative, affordable, and widely favored solutions to a greener future is the way to go. The best solution to replace SUP is edible and environmentally friendly packing films and tableware.

Food loss or waste, in developed or developing countries, are growing concern from a social, economic, and environmental perspective. 1.3 billion tons of food waste that are generated throughout the entire food supply chain, from the stages of agriculture to final consumption that annually produces around 3.3 gigatons of CO2 equivalent and 6% of total anthropogenic greenhouse gas emissions (Amicarelli *et al*., 2021). The current research focuses on utilizing food or agro-industrial residue as the base material for formulating edible packaging material with the broad objective of developing edible and environmentally sustainable films and tableware with under-utilized micronutrient-rich foods to add value to eliminate SUP in manufacturing, production, and packaging units from lower to upper crust food industries with reference to all societal applications, a step towards sustainability and circular economy.

Edible and Eco-friendly packaging materials like films, cutlery, and crockery were developed to be eaten as such or degraded in the environment. Edible films were formulated and standardized from cereals, millets, and tubers for high starch sources, and seaweeds that were actively enhanced by edible flowers, spices, herbs, and citrus peels, whereas eco-friendly films were from straw, peel, and husk by film casting technique in film making machine. Edible tableware was formulated from cereals and millets. Eco-friendly tableware from agro and industrial waste including meal cake, groundnut shell, tamarind seeds, and malted grain residue by baking technique in specific molds. Nutrient analysis, sensory evaluation, physio-chemical properties, functional properties (FTIR, XRD, TGA), mechanical properties (tensile strength, elongation at break, water vapor and oxygen transmission rate for films; exposure test, drop test, tensile strength for tableware), shelf-life study, and biodegradability for standardized edible and eco-friendly films and tableware. Starch from tubers, cereals, and hydrocolloids from seaweeds were extracted and accustomed as raw material for edible films.

The selected food materials for standardizing edible films were rice, wheat, maize, tapioca, and potato for starch extraction through standardized procedures (Puchongkavarin *et al*., 2005; Lazim *et al*., 2021). The crystal size of the starch extracted was below 12.84 ± 3.73 nm that ensures the film-forming property. Different permutations and combinations were tried from the extracted starch and hydrocolloids and the promising proportions were trailed in a patented edible film-making machine through the casting technique (Teixeira *et al*., 2021). Then the standardized formulations were enriched as active films by incorporating or coating extracts with functional properties. Extracts from orange peel, banana leaf and banana brat

were incorporated in casting solution and essential oil from holy basil and country borage were coated to fabricate active films that are resistant to microbes. Mechanical properties like elongation at break, tensile strength, water vapor permeability, oxygen permeability, FTIR, XRD were done to characterize the nature of edible films. Active films coated with essential oil from herbs showed better mechanical and physiochemical properties than standard films. It also increases the optical property, consumer acceptance, and permeability rate. Fabricated films were packed with South Indian snacks and savories, coffee powder, tea powder, and sweeteners. Starch films showed between 0.62 to 0.86 Mpa tensile strength with a 10 to 14 percent break at elongation. Cereal films from rice, wheat, and corn showed 0.84, 0.96, and 1.21 cm^3/m^2*24h*0.1 MPa WVPR at 33, 31, and 30 hours respectively All the films degraded in 90 days in the inoculum and were partially soluble in aqueous solution. Brine shrimp lethality assays for toxicity showed below 5 percent. The incorporation of active compounds has increased its mechanical properties, and sensory characteristics, and extended its shelf life, and has not affected its degradability, solubility, or toxicity.

Tableware like cups, bowl, spoons, straws, and plates were tried from edible and agro-industrial residue sources that native and locally available food sources like rice,wheat, maize, sorghum, pearl millet, finger millet, proso millet, oats, and barley (Dordevic *et al.,* 2021). The quality of the standardized tableware was analyzed through sensory attributes, FTIR, XRD, Thermogravimetric analysis, tensile strength, drop resistance, volume holding capacity, and resistance to heat and cold (Guine, 2022; Nehra *et al*., 2022). Nutritionally, all the tableware showed good quality of nutrients, it holds hot liquids for 30 minutes and ice cubes for more than one hour. It has good liquid holding capacity and mechanical properties than the products available in the market. The tensile strength of the cutlery was between 18 N and 28 N with 0.59 N adhesive force that completely degraded within 15 days in topsoil. Eco-friendly Tableware from onion peel, rice straw, and groundnut shells were standardized. The source material was agricultural leftovers, which were inexpensive, buried, or burned as garbage, polluting the environment. These can be used as a raw material for the productionof different cutlery and crockery that degrades in soil, reduce SUP pollution, and pave the way to save lives underwater and on land to transform the world.

Utilization of SUP everywhere tends to have adverse effect on land and ocean resources and may have the chance of leaving empty resources for the future hood. Edible and eco-friendly films and tableware provide a sustainable solution to eliminate waste recycling and are developed with the potential to be consumed by living beings or degrade naturally in the environment. Consumption of edible tableware would met the daily dietary requirement of consumers as nutrient-rich food ingredients are chosen as a traditional raw material with modern essence. Eco-friendly tableware acts as the primary and secondary packaging material as well. Utilization of local and native, cost-effective sources transforms edible and eco-friendly films and tableware to be highly affordable. Development of edible and biodegradable packaging materials would pave the way to solve the menace of discarding plastics, leading to complete bio assimilation and reducing waste dumping in land and marine. Achieving Sustainable Developmental Goals 2, 3, 14, and 15 namely zero hunger, good health, and well-being, life below water, and life on land are the pricky points behind this novel innovation towards a sustainable greener biome.

Keywords: *biopolymer, tableware, edible and eco-friendly, packaging material*

Sustainable fire-retardant sawdust for microplastic cleanup and oil spill recovery: an eco-friendly marine solution

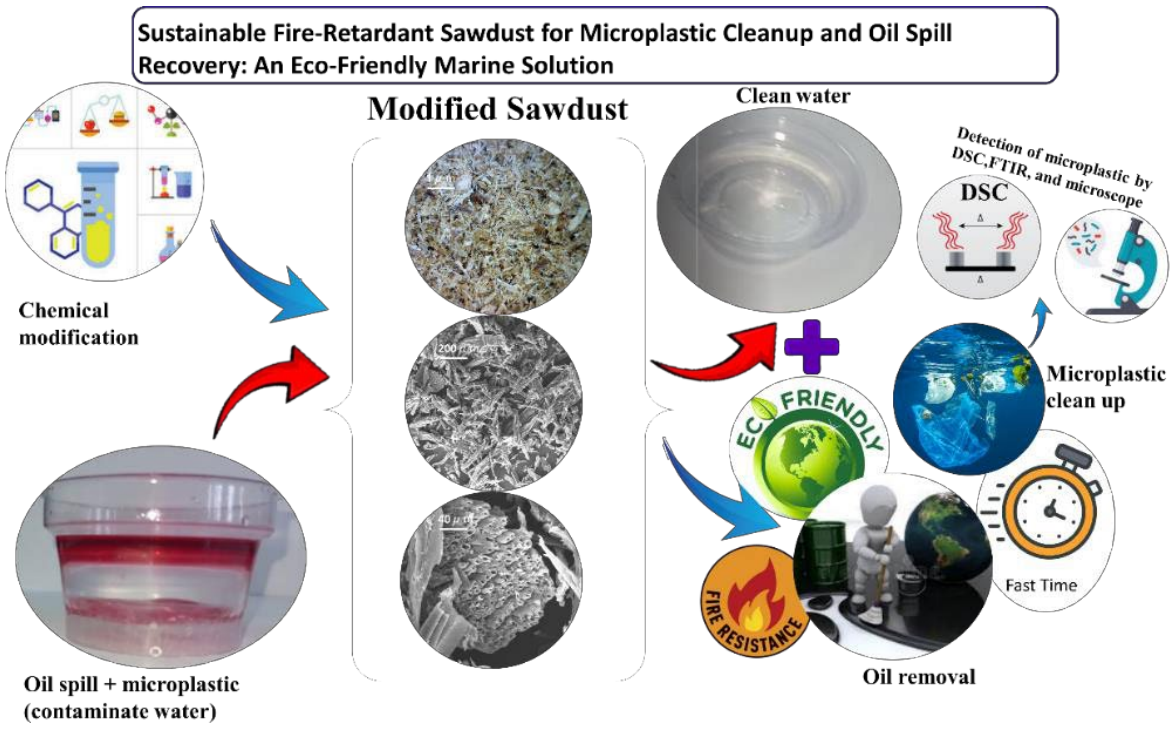
Mohamed Mohamady ghobashy
Polymer Chemistry Department, Industrial Irradiation Division, National Centre for Radiation Research and Technology (NCRRT), Egyptian Atomic Energy Authority, Cairo, Egypt
Corresponding author : mohamed_ghobashy@yahoo.com

Abstract

Oil spills and microplastic pose grave threats to marine ecosystems, underscoring the urgency for eco-friendly, cost-effective cleanup solutions. This study introduces an innovative, rapid (equilibrium time <30 min), and cost-effective ($0.12/kg) approach to address oily wastewater and microplastic contamination, utilizing sawdust as a readily available and eco-friendly resource. This study presents a novel approach by chemically modifying sawdust using Alum substance as a sustainable material to create a fire-resistant sorbent for efficient oil spill recovery and microplastic cleanup. The modified sawdust exhibited remarkable oil absorption capacities, ranging from 5.2 to 9.8 g/g for diverse oil types, including crude oil, motor oil, pump oil, and waste engine oil. Characterization techniques such as FTIR, XRD, and SEM revealed a complex porous network with a surface area of 312 m^2/g and fire-retardant properties with a limiting oxygen index of 28%. Furthermore, modifying a sawdust fiber with a water contact angle of 96° enhanced the material's efficacy for microplastic cleanup (up to 96%). N_2 adsorption-desorption analysis indicated a hierarchical macropore structure with a pore volume of 0.72 cm^3/g, while pseudo-second-order reaction kinetics analysis demonstrated chemisorption-dominated processes with a rate constant of 0.038 g/(mg·min). The modified sawdust holds promise for efficient oil spill cleanup and recovery, contributing to the preservation of marine ecosystems while mitigating environmental risks posed by oil spills and microplastic pollution. Additionally, the study provides an in-depth analysis of plastic particles accumulated along test using Differential scanning calorimetry (DSC) and microscope analysis methods, revealing low-density polyethylene (LDPE) and polyethylene vinyl acetate (PEVA) as the common microplastics in surface waters. This is due LDPE, with a density ranging from 0.91 to 0.94 g/cm^3, is lighter than water, contributing to its widespread distribution on the surface of water bodies. Similarly, PEVA, with a density typically around 0.93 to 0.95 g/cm^3, also tends to float and remain suspended in surface waters. These microplastics were effectively removed by the modified sawdust, exhibiting up to 96% removal efficiency, making it a promising material for microplastic cleanup in marine environments.

Keywords: *Microplastic; Oil spill; Sawdust; Marine; LDPE*

Graphic Abstract



Moringa infused feast: nutrient- packed dissolvable soup pouches: an alternative to instant plastic soup pouches

Swethaa.H.K, Dr.Paramasivam Raajeswari,

Corresponding author:hkswethaa@gmail.com

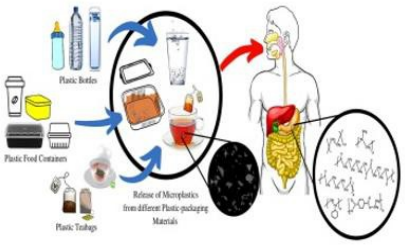
Abstract

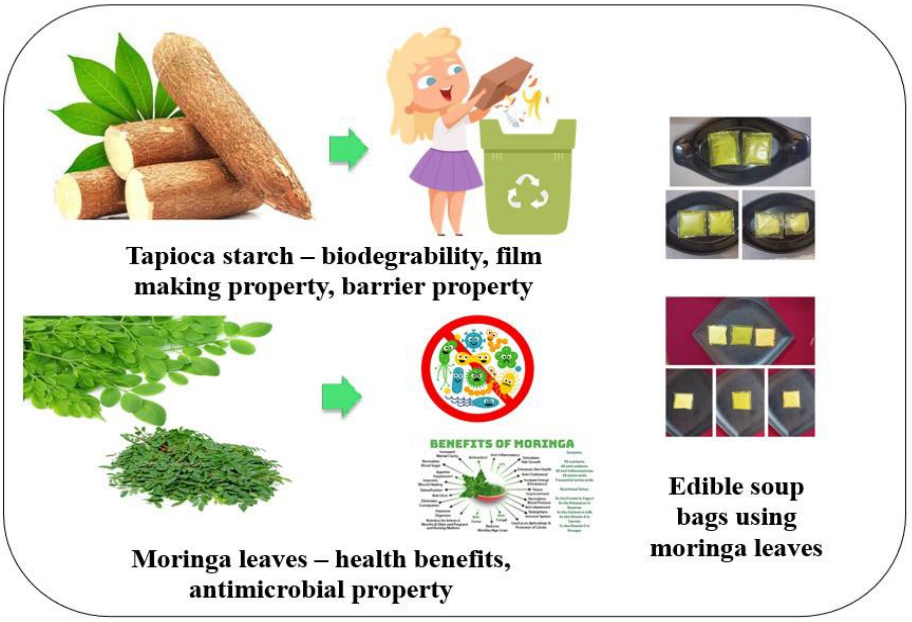
Moringa leaves infused edible soup bags represent an innovative solution to multiple challenges facing the food packaging industry. By eliminating the need for traditional single-use containers, these edible bags offer a promising avenue for reducing plastic waste and promoting sustainability. They offer a promising solution to the global plastic pollution problem. As the use of plastic films are creating more health and environmental hazards it is important to replace plastic films with any other eco-friendly materials. Keeping this in mind an attempt was made to formulate edible soup bags with moringa leaves to make it eco-friendly and nutrient dense. Moringa leaves boast high levels of vitamins A, C, and E, as well as calcium, potassium, and protein, making them a potent dietary supplement. They are known to promote healthy skin, boost immune function, regulate blood sugar levels, and improve overall well-being. Moringa leaves are rich in antioxidants, antimicrobial compounds which could enhance the bag's properties. The antimicrobial properties of moringa may contribute to the preservation of packaged products, potentially extending their shelf life. This combination not only aligns with sustainability goals but also introduces natural elements that could benefit both the environment and consumers. Due to film making properties, biodegrability and barrier properties tapioca starch is used to make edible soup bags. The formulated and standardized edible soup bags were subjected to organoleptic evaluation with 30 semi trained panel members in 9 hedonic scale. The development of tapioca starch-based edible soup bags enriched with moringa leaves extract represents a significant advancement in sustainable packaging and food innovation. As society continues to prioritize sustainability and health-conscious choices, these edible soup bags are poised to make a meaningful impact on both environmental and dietary fronts. The soup bags provide consumers with a convenient, eco-friendly way to enjoy a nutritious meal and also reducing plastic waste. Creating an edible tapioca-based starch bag with moringa leaf extract is a creative and sustainable idea, offering a convenient and nutritious solution.

Keywords: *Moringa leaves, edible soup bags, Tapioca starch, sustainability, nutritious.*

Graphic Abstract

Plastic films – more health and environmental hazards





Co-contamination of Heavy Metals (Cd & Cr) and Microplastics in Soil-Water Media

Shravani Yadav, Brijesh Kumar Yadav

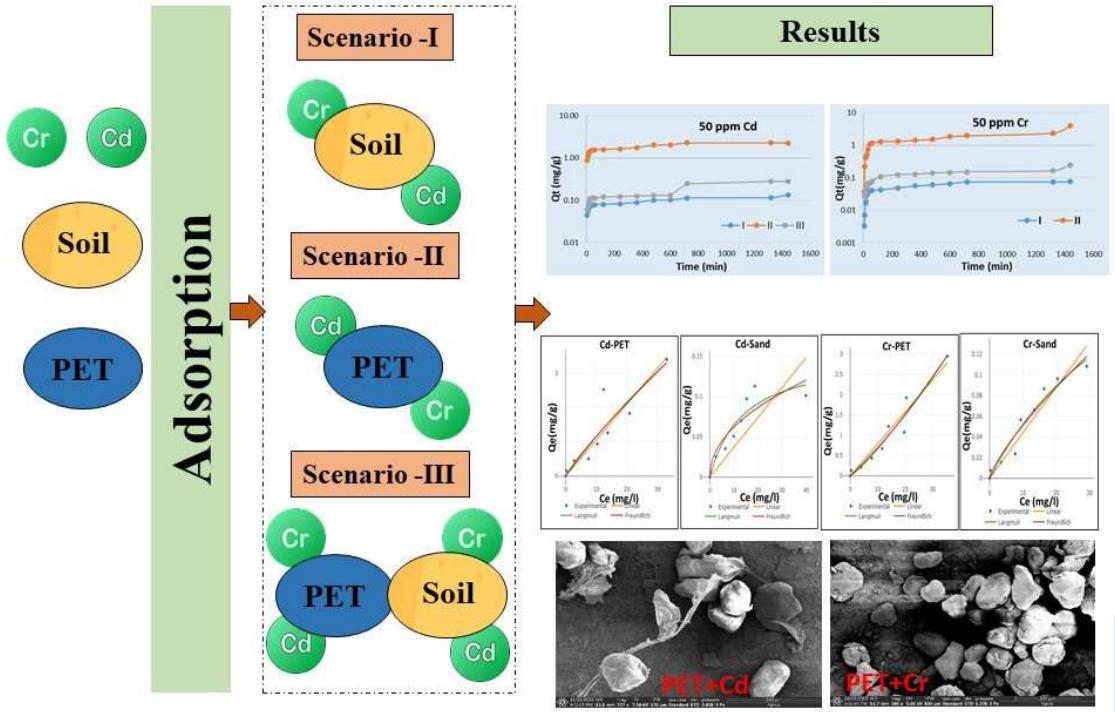
Department of Hydrology, Indian Institute of Technology Roorkee
Corresponding author : brijesh.yadav@hy.iitr.ac.in

Abstract

Microplastics (MPs) are smaller pieces of plastic debris with a size less than 5mm. They are emerging contaminants found in terrestrial and marine ecosystems, the atmosphere, and living organisms. The adsorption of heavy metals poses a serious problem with MPs on terrestrial soil-water resources due to their widespread use, toxicity, and non-degradable nature. In this study, we examined the adsorption of cadmium(Cd) and chromium(Cr), heavy metals, on polyethylene terephthalate (PET- C_{10} H_8 O_4) MPs. The adsorption experiment was carried out with different heavy metal concentrations of 50ppm, 30ppm, 25ppm, 20ppm, 15ppm, 10ppm, 5ppm and 1ppm. The heavy metal concentration in environmental soil samples was found to be less than 30 ppm; however, 50 ppm is a higher limit considered solely for experimental purposes. The size of PET ranges from 100 µm to 200µm. The adsorption experiments were conducted in three scenarios: adsorption of heavy metals and soil (I), adsorption of heavy metals and MPs (II), and adsorption of heavy metals, sand, and MPs (III). The experiments showed that MPs showed a trojan horse effect depicting higher sites of adsorption in comparison with Scenario I & III. It is observed that the pseudo-second-order kinetic model and Freundlich model fitted the adsorption of Cr and Cd on all of the MPs. Our findings highlight the potential of MPs to act as a vector for heavy metals through adsorption on their surfaces. Our study plays a crucial role in understanding the environmental impact of MPs and heavy metals in soil-water media, thereby highlighting the importance of our research in addressing this issue.

Keywords: *microplastics, saturated porous media, adsorption, co-contamination, heavy metal*

Graphical Abstract:



Exploring Microplastic Pollution in Landfill Leachates

Ana Mendes[a], Mark Healy[b], Jermaine Descartes[c], and Liam Morrison[a]

[a] *Earth and Ocean Sciences, School of Natural Sciences and Ryan Institute, National University of Ireland, Galway, Ireland*

[b] *Civil Engineering and Ryan Institute, College of Science and Engineering, University of Galway, Ireland*

[c] *Applied Ecology Unit, School of Natural Sciences and Ryan Institute, National University of Ireland, Galway, Ireland*

Corresponding author: ana .mendes@universityofgalway.ie

Abstract

Leachates from landfills can be a significant source of microplastics to the environment due to the degradation and fragmentation of plastic waste within the landfill environment[1,2,3]. As rainwater or other liquids percolate through the landfill, they interact with various plastic materials, leading to the formation of smaller particles[1, 2, 4]. These microplastics migrate into surrounding soil, groundwater, and open waters through direct leaching, ultimately entering the broader environment and posing potential ecological and environmental risks[1, 4]. Additionally, microplastic-contaminated sludge from leachate-treatment facilities is often used as fertilizer, further disseminating these particles[1, 3]. The abundance of microplastics in landfill leachate varies based on the types of waste present. To mitigate associated risks, effective treatment strategies for landfill leachate are essential[1].

This project aims to assess the occurrence of microplastics in leachates derived from lined, unlined, and mixed sources in both historic (closed) and operational landfills, as well as in the surrounding groundwater[2]. The investigation involved the extraction through filtration and density separation, followed by isolation using stereo microscopy and subsequent quantification and polymer identification via advanced Raman spectroscopy techniques[4].

This research will enhance our understanding of microplastic distribution in landfill leachate and provide valuable insights for developing more effective mitigation strategies.

Keywords: Leachates, Contamination, Groundwater

Graphical Abstract

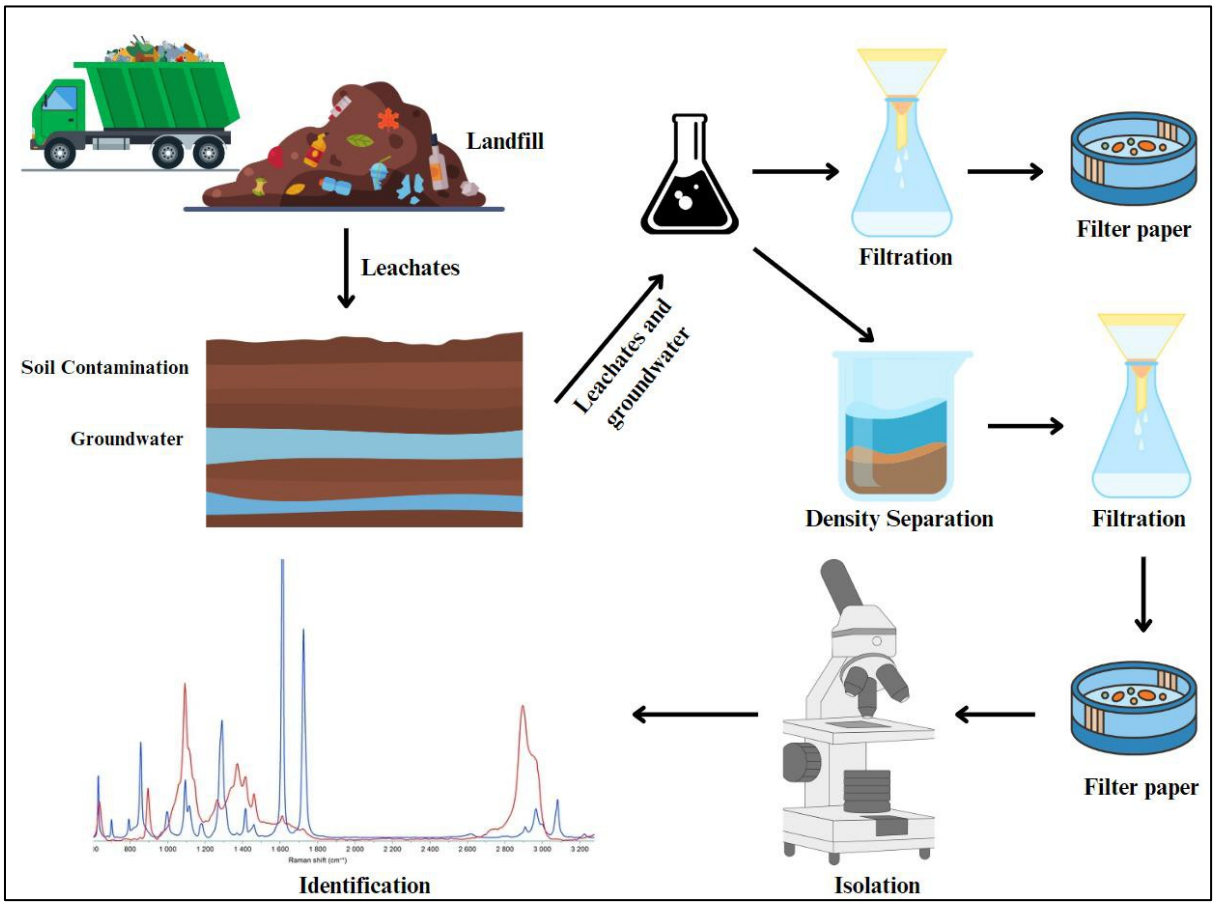


PHOTO AGING OF 1 µM POLYSTYRENE (PS) MICROPLASTICS

Emine Merve Canga*, Aoife Gowen, Jun-Li Xu

School of Biosystems and Food Engineering,University College Dublin
emine.canga@ucdconnect.ie

Abstract

The photo aging of microplastics (MPs) is one of the most important aging pathways of plastic polymers. Understanding how MPs aging under UV radiation, is crucial for assessing their long-term effects. Grasping these changes helps to shed light on how these particles interact with other molecules and organisms. Polystyrene (PS) is one of the most common types of MPs, often found in various consumer products and packaging materials, and we investigated the effects of UV radiation on 1 µm PS MPs for 10 days in our study. Dried PS MPs on a glass slide were exposed to 36 W UV-C light for 10 days, and samples were resuspended for further analysis. Chemical characterization of untreated UV-treated samples was achieved through optical photothermal infrared (O-PTIR), obtaining IR spectra. Peaks at 1743 cm^{-1} related carbonyl groups were slightly shifted to 1727 cm^{-1}, and other characteristic peaks at 1453 cm^{-1} and 1493 cm^{-1} overlapped for 5 days and 10 days under UV light. These changes showed that UV radiation caused chemical modification of PS MPs. Scanning electron microscope (SEM) images and dynamic light scattering (DLS) analysis showed that size of samples was decreased due to UV light. Zeta potential of untreated samples was -36.1 mV and it decreased to -39.7 after 10 day exposure. In conclusion, our results showed that UV radiation changed both physical and chemical properties of 1 µm PS MPs and these alteration might change biomolecular interaction, reactivity and toxicity of microplastics.

Keywords: *photo aging, UV exposure, polystyrene, microplastics*

Assessing the impact of chemicals in plastics on the immune system

Neema Negi, Dorte Herzke, Hege Hjertholm, Monica Andreassen, Berit Brunstad Granum, Igor Snapkow, Hubert Dirven

Department of Chemical Toxicology, Division of Climate and Environmental Health. Norwegian Institute of Public Health (NIPH)
Hubert.Dirven@fhi.no

Abstract

Chemicals in plastics encompass a diverse array of substances used in the manufacturing of plastic materials, contributing to their properties such as enhancing flexibility, durability, color, and resistance to heat and UV radiation. Common plastics like polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS), polyethylene terephthalate (PET), acrylonitrile butadiene styrene (ABS), and polycarbonate (PC) are ubiquitous in everyday products due to their versatility and affordability[1]. Over 16,000 chemicals have been identified that are potentially present in plastic materials, yet only 6% are currently regulated internationally[2]. These include flame retardants, UV stabilizers, per- and polyfluoroalkyl substances (PFASs), phthalates, bisphenols, alkylphenols and alkylphenol ethoxylates, biocides, certain metals, polycyclic aromatic hydrocarbons, and non-intentionally added substances (NIAS). Out of over 4,200 plastic chemicals of concern, approximately 3,600 are currently unregulated on a global scale[2]. These chemicals can leach under various conditions, potentially causing health issues[3]. In human biomonitoring studies in Norway as conducted at our institute widespread exposure to phthalates and phenols in children was demonstrated, suggesting that these chemicals can leach from plastics and are taken up from for example food and drinks and excreted in the urine.

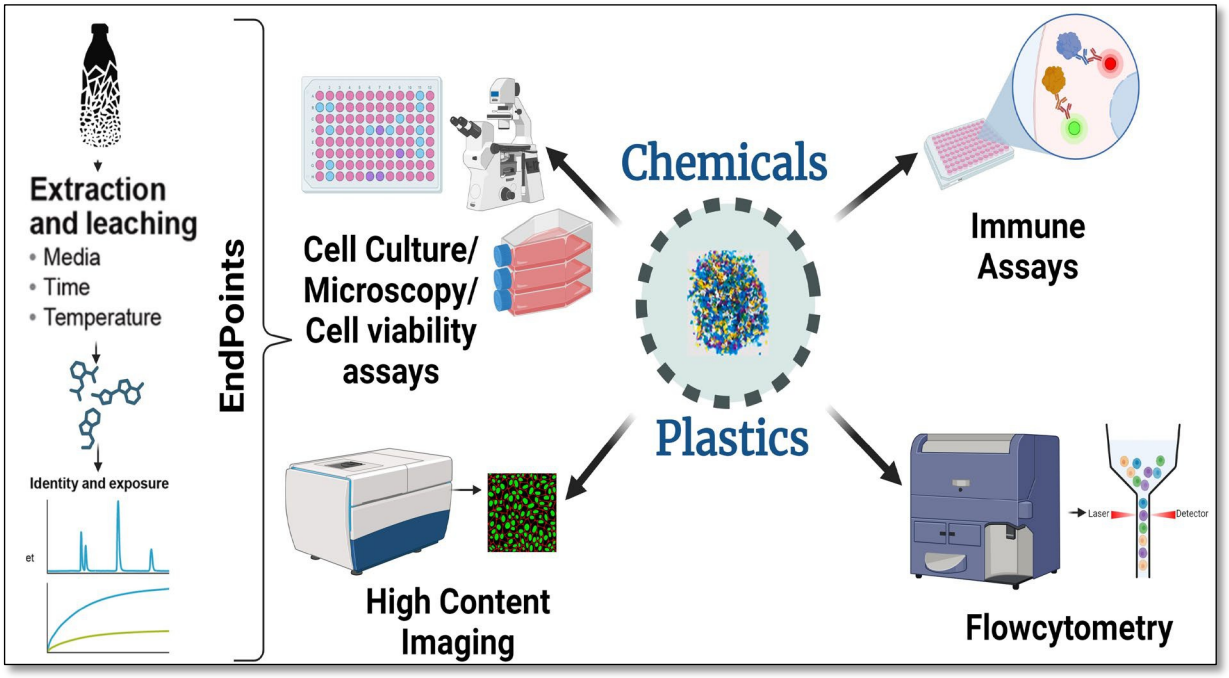
The Norwegian government is prioritizing this issue and may propose regulatory action in the EU through REACH. Immunotoxicity, the harmful effect of certain chemicals on the immune system, is a concern with plastics. Chemicals like BPA, phthalates, PBDEs, and styrene may impact immune function. The complexity of leaching chemicals from plastics, including mixture effects, requires urgent action to address related risks.

This project aims to explore the impact chemicals leaching from plastics, identified as significant concerns, utilizing both established cell lines and human primary cells. Our research plan will integrate a diverse array of methodologies, including cell culture techniques, cell viability assays, high-content imaging, flow cytometry as well as other immune assays. Through these methods, we seek to deepen our understanding of the potential immune- related implications associated with these chemicals in plastics. Statistical analyses for this study will be conducted using GraphPad Prism 9.0 and R programming language.

This project seeks to bridge the knowledge gap by delving into the extent of immunotoxicity associated with plastic chemicals, filling a critical knowledge gap for future policy and health considerations.

Keywords: *chemicals, plastics, immunotoxicity, REACH, leaching*

Graphic Abstract



Evaluating solvent-induced microplastic contamination during sample treatment using O-PTIR and spectral matching methods

Cihang Yang, Jun-Li Xu*, Aoife Gowen*

Spectral Imaging Research Group, School of Biosystems and Food Engineering , University College Dublin, , Dublin, Ireland

** Corresponding author: aoife.gowen@ucd.ie, junli.xu@ucd.ie*

Abstract

The accumulation of microplastics (MPs) in various environments poses significant challenges due to their potential risks to both ecological systems and human health(Dris et al., 2018). In recent microplastic research, preprocessing methods have been utilized to eliminate non-microplastic particles before collecting spectral information and optical images, significantly reducing interference from these particles(Li et al., 2022). This study investigates the potential for solvent-induced microplastic contamination during these preprocessing phases. We employed Optical Photothermal Infrared (O-PTIR) combined with spectral matching techniques to assess the extent of contamination.

Following the procedure outlined in previous studies(Yang et al., 2024), we aimed to collect as much spectral data as possible to characterize the entire filter. We chose nine subsampled areas of the filter based on previous studies and furthermore collected 20 optical images around the central coordinates of each area. This resulted in a total of 180 optical images, representing 17.4% of one filter. Spectral Matching methods were used to identify these particles and estimate the amounts of MPs that may be contained in a given amount of solvent.

In summary, we have identified the presence of microplastics in solvents commonly used in the preprocessing of microplastic samples. This discovery underscores the critical need for advanced methodologies in detecting microplastic contaminants to ensure the accurate assessment of MPs during qualitative and quantitative analyses.

Keywords:

Investigating the biological effects of polypropylene on CACO-2 cells

Raphaela O. G. Ferreira, Aoife Gowen and Jun-Li Xu.
UCD School of Biosystems & Food Engineering, University College Dublin, Belfield, Dublin 4, Ireland;
UCD Conway Institute, University College Dublin, Dublin, Ireland.

Abstract

Microplastics are ubiquitous and can come into contact with human cells through ingestion, particularly through the use of food containers made of Polypropylene (PP) - the most produced plastic in Europe. Studies have indicated the release of PP particles from food containers following prolonged storage. Although PP has been detected in the human colon, its effects remain uncertain. Our study aimed to investigate the impact of PP particles on Caco-2 cells, focusing on cell viability, cytotoxicity, and oxidative stress. Caco-2 cells - widely used for in vitro experiments as a model of the human intestinal epithelial barrier -, were exposed to PP particles at varying concentrations (50, 200, and 500 µg/ml) for durations of 24 and 48 hours. Cell viability was assessed using the MTT assay, cytotoxicity/membrane damage were evaluated through LDH assays, and oxidative stress levels were quantified using CellRox. The findings revealed a 30% rise in cell viability across all Polypropylene (PP) concentrations after 24 hours. However, a subsequent decline was observed after 48 hours in all concentrations, with the 200µg/ml showing the lowest cell viability rate in the concentrations of 65%. No membrane damage was detected in Caco-2 cells following PP exposure. Furthermore, oxidative stress levels surged by approximately 50% across all experimental conditions after 24 hours, persisting at elevated levels compared to control samples after 48 hours. These findings align with previous studies on other plastics, highlighting oxidative stress as a potential mechanism affecting cell viability and supporting the implications of our research. Our findings contribute to understanding of the biological effects of plastic exposure, urging for continued investigation into the broader health implications of plastic usage.

Keywords:

In-situ detection of microplastics in the aquatic environment: A systematic literature review

Ismaila Abimbola[1], Marion McAfee[2], Leo Creedon[2], Salem Gharbia[1]

1. Department of Environmental Science, Faculty of Science, ATU Sligo
2. Centre for Mathematical Modelling and Intelligent Systems for Health and Environment (MISHE), ATU Sligo

Abstract

Microplastics are ubiquitous in the aquatic environment and have emerged as a significant environmental issue due to their potential impacts on human health and the ecosystem. While the direct health effects of microplastics are not yet well established, the potential for these tiny particles to transport toxic pollutants and microorganisms poses significant risks. Current laboratory-based detection methods for microplastics suffer from various drawbacks, including a lack of standardization, limited spatial and temporal coverage, high costs, and time-consuming procedures. As a result, there is a pressing need for the development of in-situ techniques to detect and monitor microplastics in aquatic settings, to effectively identify and understand their sources, pathways, and behaviours. This study adopted a systematic literature review method to assess technologies designed for the in-situ detection and monitoring of aquatic microplastics, without the need for sample preparation. Four scientific databases were searched from inception to March 2023 and 65 relevant studies were reviewed. Optical, holography, hyperspectral, spectroscopy, and remote sensing methods have emerged as the primary technologies utilized for in-situ microplastic detection in aquatic environments. Many studies integrated data and images from these technologies with machine learning models to develop classifiers capable of accurately quantifying the physical and chemical properties of microplastics and discriminating them from other particles. Despite being in the early stages of development, this review demonstrates that in-situ detection of microplastics in aquatic environments can be achieved with high accuracy.

Keywords

Strategies to lower risks of false positivity and increase throughput in microplastic detection

Junhao Xie, Cihang Yang, Aoife Gowen, and Jun-Li Xu

School of Biosystems and Food Engineering, University College Dublin, Belfield, Dublin 4, Ireland.

Abstract

In microplastic (MP) research, false positives (e.g., misidentifying non-MPs as MPs) contribute to significant variability in research outcomes across different studies. Reducing false positives is one of the key objectives of this study. Another objective is to propose a method to increase MP detection throughput by selective data collection. Methods: To reduce false positives, the study employed high-temperature filtration and alcohol treatment on filter membranes to eliminate non-MP particles. To select appropriate wavenumbers for selective data collection, support vector machine (SVM) models were utilized. The results reveal that alcohol rinsing is particularly effective in reducing the presence of non-MP particles. In contrast, high-temperature filtration did not provide a substantial benefit in removing non-MPs. Additionally, the selective data collection at the couple of identified wavenumbers (as oppose to the full spectral range) accelerated the detection process, leading to a remarkable improvement in analytical throughput (Although this is identification based on only a couple of variables, the reliability is not compromised, as evidenced by the 85%+ accuracies of the SVM models trained in this study). This streamlined approach allows for quicker and more accurate MP analysis by focusing on the most relevant spectral data. This research contributes valuable insights into improving both the accuracy and efficiency of MP detection, which is crucial for advancing environmental monitoring and pollution control efforts. Note: selective data collection at designated wavenumbers could be made possible by tunable IR sources.

Keywords: *microplastics, ir spectra, cnn, classification,*

A switch and its application of multilayer nano-CS_XWO_3@PAH@PSS@PBS core-shell composites for near infrared quenched fluorescence

Ruixing LI
School of Materials Science and Engineering, Beihang University,
Corresponding author : 1499149583@qq.com

Abstract

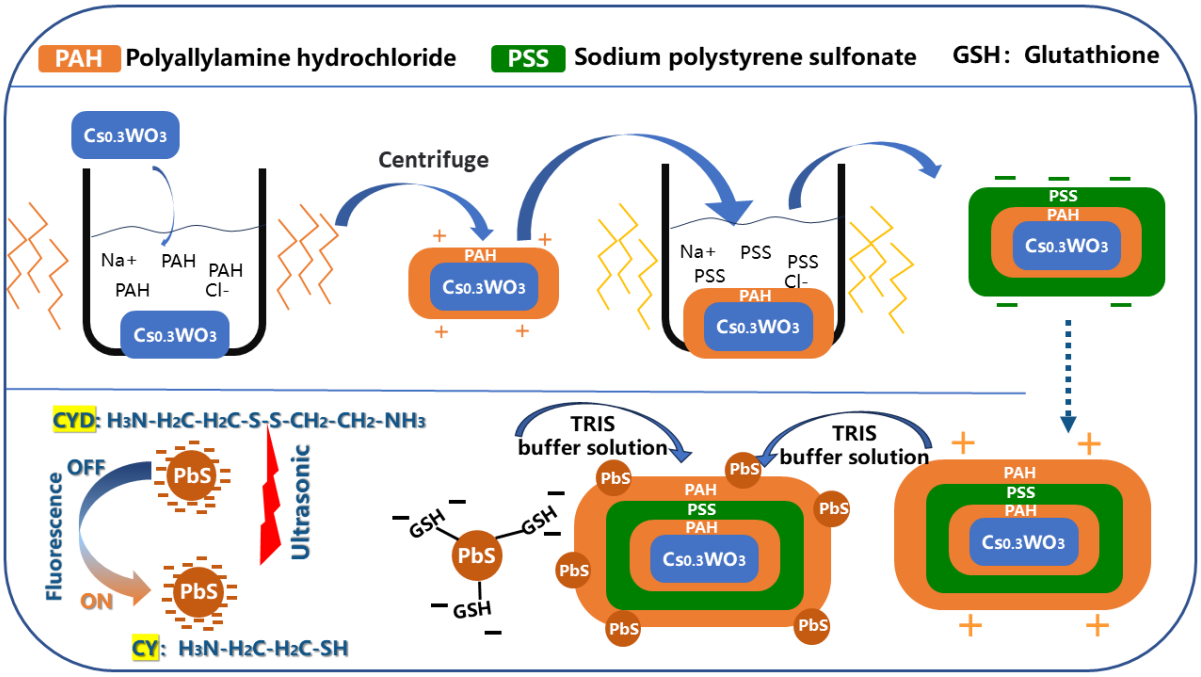
The magnetic resonance imaging, CT, B-ultrasound, *etc*. are difficult to discover small pathological tissue, for example, the differentiation of benign and malignant tumors, chemical composition changes in tissues, fluorescence is able to solve. The concentration of glutathione (GSH) in cancer cells is much higher than healthy cells [1]. In this work, nano-Cs_xWO_3@PAH@PSS@PbS (PAH: polyallylamine hydrochloride; PSS: sodium polystyrene sulfonate) organic-inorganic hybrid composites with a subject matter of GSH responsive fluorescence property were designed and constructed.

Firstly, both water-soluble PbS quantum dots with near-infrared fluorescence emission and Cs_xWO_3 with localized surface plasmon resonance (LSPR) effect were synthesized, respectively [2]. A layer-by-layer (LBL) self-assembly method is used to layer both PAH and PSS onto Cs_xWO_3 surface to achieve a distance control between Cs_xWO_3 and PbS, and finally build a multilayer Nano-CsWO@PAH@PSS@PbS core-shell composites.

The as-synthesized composites is a quenched fluorescence switch and could realize detection of GSH. In addition, we found that Cs_xWO_3 can detect GSH faster under light conditions. The above results give the opportunity for the selective detection of cancer cells *etc*. by using the switch of quenched fluorescence of nano-CsWO@PAH@PSS@PbS composites with normal healthy cells.

Keywords : *cesium tungsten bronze; polyallylamine hydrochloride; near-infrared, fluorescence; glutathione*

Graphic Abstract



Quantification of microplastics in indoor air and bottled water samples by pyrolysis coupled to gas chromatography orbitrap mass spectrometry and *in vitro* toxicity

*G. Zuri[1], C. Bedia[1], A. Karanasiou[1] and S. Lacorte[1]

[1]*Institute of Environmental Assessment and Water Research of the Spanish Research Council (IDAEA - CSIC) Jordi Girona 18-26, 08034 Barcelona*

**Presenting author email: giuseppina.zuri@idaea.csic.es*

Abstract

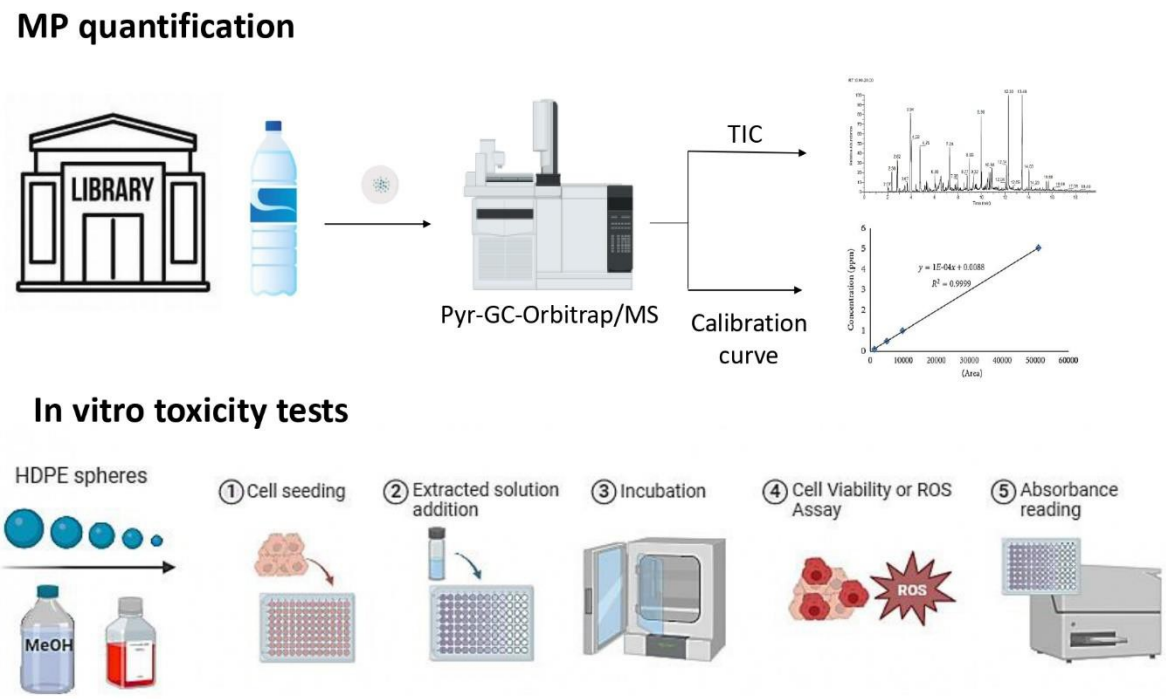
The present study characterizes microplastics (MP) in public libraries located in Barcelona and bottled water (BW) form 4 different countries (Spain, Italy, France, Portugal) with the final aim to determine the exposure in humans and use the results to perform in vitro toxicity tests on hepatoma cell lines (HepG2). Airborne particles were collected using a 25 mm filter holder connected to a Leland Legacy air sampling pump with an intake flow rate previously calibrated of 10.0 ± 0.1 L/min. Glass fiber filters were used. Sampling duration was 3 h and conducted while the libraries were closed to the public. Whereas for BW, 5 L of water were filtered for each brand. Initially, particles were examined using a stereomicroscope to assess their total number, shape, size, and color. Subsequently, the particles were identified, and their concentration measured using pyrolysis coupled to gas chromatography and mass spectrometry. The calibration was performed using standards polymer mixtures of the most common plastic polymers, including polypropylene (PP), polystyrene (PS), polycarbonate (PC), polyethylene (PE), nitrile rubber (NBR), acrylonitrile butadiene styrene (ABS), polyvinyl chloride (PVC) and polymethyl methacrylate (PMMA). The identification of polymers was performed at the exact mass, fragmentation patterns and using the retention time of each polymer. Further, the polymer type was confirmed with the NIST library. Their concentration was extrapolated from the calibration curve built with standards. The method has been recently validated in our laboratory (Torres-Agullo et al., 2024). MP were detected both in air and BW. The only polymer quantified was HDPE both in air and water. In libraries, MP were detected in 13 out of 14 samples (93%). The concentration of PE ranged from <LOD to 1.074 µg MP m^{-3} of air. The inhalation intake was also calculated considering the respiratory rate, tidal volume, and an average stay in the libraries of 3 hours. Adults can inhale up to 1.5 µg of microplastics while spending 3 hours in a library, which might be of concern especially for libraries' staff and usual visitors.

MP were detected in 30 out of 37 samples (81%) of BW. PET plastic bottle itself does not release MP, since it was not detected. However, BW contains PE used to manufacture the cap. In water, PE concentration ranged from <LOD to 0.439 µg L^{-1}. Considering a 2L water intake, as recommended, adults might ingest up to 0.013 µg MP/kg bw/day only from BW consumption. Overall, this study quantifies the amount of MP that can be inhaled and ingested by humans and shows that the polymer we are mostly exposed to is PE.

Therefore, *in vitro* toxicological studies were performed by exposing HepG2 to PE extract at concentration of 1 µg $µl^{-1}$ and the endpoints of cell viability and reactive oxygen species (ROS) generation were evaluated. No differences were observed in the viability nor ROS generation compared to the control, therefore the concentration used did not cause any toxicity on HepG2 cells. The results of the present study demonstrate the ubiquity of microplastics and highlight that the most widely found polymer is PE, meaning that we are exposed to it both *via* inhalation of air and ingestion of water. In the future, we aim at creating a larger campaign collecting samples from different indoor and outdoor environments to make a more precise human exposure assessment (Zuri et al., 2023) and to carry out different *in vitro* studies using a combination of pristine and weathered plastic polymers to assess possible synergic, additive, or antagonistic effects.

Keywords : *airborne microplastics, bottled water, Pyr-GC-MS, cell viability, ROS*

Graphic Abstract



Innovating packaging with a comprehensive framework of food systems game changers lab cohort 8 and membrane technology packaging for plastic pollution reduction

Lukanga Hakim Muhsin*, Kizito Eddison, Allan Sentogo, Kabuye Kyofatogabye
Kampala Capital City Authority (KCCA)
Corresponding email : hakimmuhsin00@gmail.com

Abstract

We begin by outlining the pervasive risks associated with plastic pollution, emphasizing the urgency of reducing plastic usage in everyday life. Through a series of working sessions, participants engage in learning objectives focused on understanding risk assessment procedures and building a risk management framework tailored to plastic pollution challenges in Uganda. This framework incorporates both qualitative and quantitative evaluations, integrating regulatory and non-regulatory responses from stake holders to mitigate plastic pollution hazards effectively. The methodology outlined in the abstract offers innovative packaging solutions for the entire farm-to-fork supply chain. These solutions include cutting-edge materials, modular reusable packaging, and a **Reuse-as-a-Service model**, aiming to eliminate single use plastics, extend food shelf life, increase food security, reduce carbon footprint, and improve livelihoods for farming communities. The proposed Farm-to-Fork membrane Technology packaging Solution addresses both food and packaging waste. Government intervention, such as Kampala Capital City Authority KCCA, is suggested to enforce stricter controls on single-use plastics and incentives the adoption of biodegradable alternatives. The abstract also proposes a phased pilot program for the Farm-to-Fork packaging solution, involving collaboration with small/mid-size farmers, distributors, retailers, and local and national food brands.

The framework includes the use of membrane technology and multi-layer bulk food biodegradable packaging to reduce plastic pollution. It also emphasizes the transition to a circular farm-to-fork packaging system to minimize packaging waste and pollution. The abstract acknowledges systemic barriers, such as potential resistance from traditional single use food packaging companies. However, it highlights opportunities for systemic change, such as offering more sustainable packaging solutions that align with a circular economy. In conclusion, the abstract facilitates collaborative efforts to address plastic pollution, fostering innovation and capacity building for a sustainable future. It references similar innovative solutions already in action, such as reusable/refillable containers, bags for dry perishables and produce, portion control/container kits, and shelf-life-extending containers. Overall, the abstract presents a comprehensive and innovative approach to plastic pollution risk assessment and mitigation, with a focus on stakeholder collaboration, technological innovation, and sustainable business models.

Assessment of microplastics in the soil ecosystem of Sonitpur district within the Brahmaputra river catchment

Ankita Saha*, Sumi Handique

Affiliations: Tezpur University, Tezpur, Assam, India – 784028
*Corresponding author: ankitas@tezu.ernet.in**

Abstract

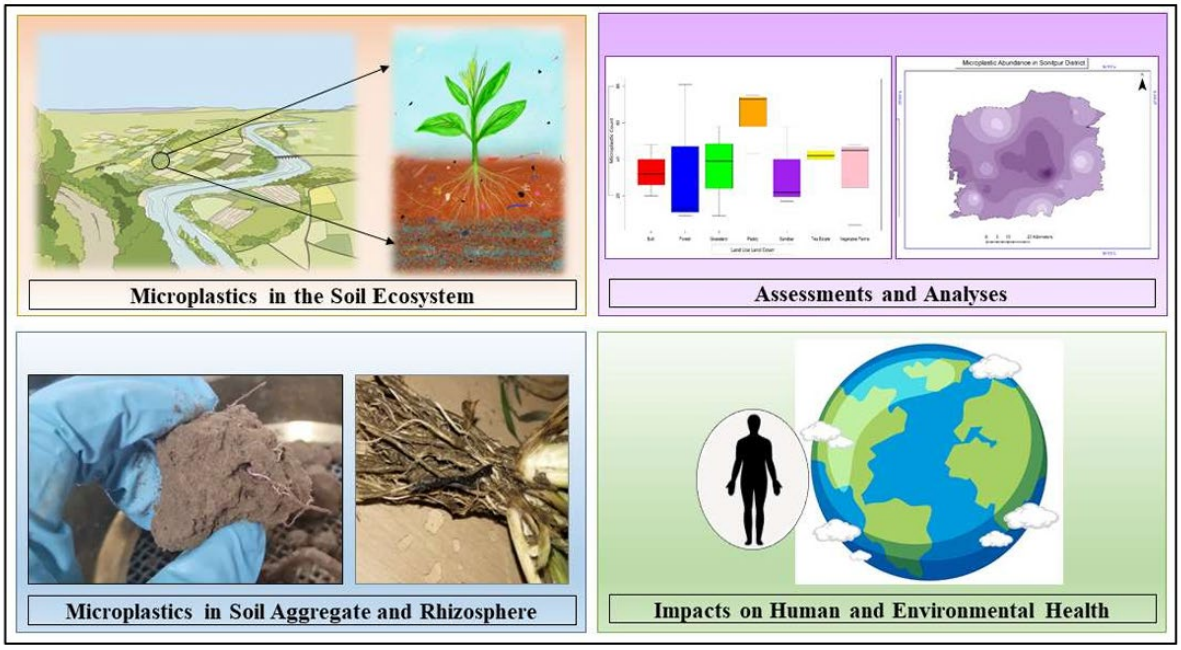
Microplastics (MPs) are pervasive environmental contaminants, significantly impacting soil and plant health, groundwater quality and overall ecosystem integrity. Soil acts as both a major sink and source for MPs, and distribution and abundance of MPs may be influenced by land use and land cover (LULC). MPs may also act as carriers for other elements. This study investigates the distribution and abundance of MPs in the terrestrial ecosystem of a flood-prone district in the Brahmaputra River basin in Assam, India. Understanding MP distribution dynamics may aid in developing effective mitigation measures to safeguard environmental and human health.

Soil samples were collected from selected LULC types across the study area. Groundwater samples were collected from open wells, and grass samples were collected to investigate MP uptake in vegetation where root, shoot and leaf tissues were analysed. MPs were extracted through organic matter digestion and vacuum filtration, and characterized using infrared spectroscopy. Quantification of MPs was done via microscopy. Elemental analysis of soil and groundwater samples was conducted using SEM-EDX and ICP-OES. Geostatistical analyses were employed to assess the spatial distribution patterns of MPs and other potentially toxic elements. To elucidate their impact on soil properties and contamination pathways, MP distributions were compared with soil properties such as soil organic carbon, bulk density, etc. and LULC types.

MPs were detected in all the soil and groundwater samples, whereas in case of plants, MPs were detected only in the root tissues. The predominant MPs identified include polyethylene terephthalate and polypropylene, with over 100 microfibers counted per kg of soil in some samples. Concentrations higher than the recommended WHO limits for Fe and Mn were observed in 23% of the groundwater samples, along with upto 17 MPs detected in some samples. Soils from urban and agricultural LULC types had significantly ($p<0.05$) higher MP concentrations. The results suggest that MPs interact with soil particles suggesting potential impacts on soil quality and structure. The results also indicate increased risk of adverse impacts on human health from MPs owing to the various exposure pathways.

Keywords : *microplastics, LULC, soil contamination, groundwater*

Graphical abstract:



Gymnema sylvestre- infused edible blobs: addressing growing global challenges in diabetes management and plastic pollution

Uthra B.*, Dr.Paramasivam Raajeswari

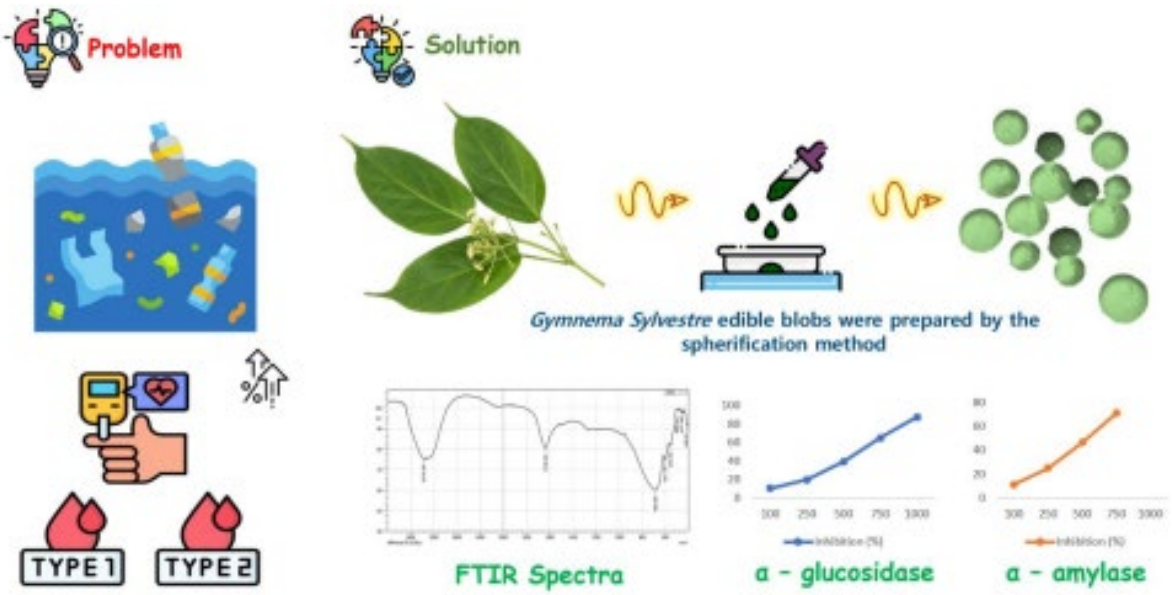
Department of Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore – 641043
Corresponding Author – 21phfnf007@avinuty.ac.in

Abstract:

Plastic pollution and diabetes represent two significant and growing global challenges, each with substantial health and environmental impacts. *Gymnema Sylvestre*, known for its antidiabetic and therapeutic properties, has been traditionally used in herbal medicine. This research focuses on standardizing and characterizing an edible blob formulated from *Gymnema Sylvestre* leaves. Standardization involves optimizing the extraction process and ensuring consistent concentrations of active ingredients across different batches. The blobs were prepared by the spherification method by immersing sodium alginate solution in a water bath of calcium chloride. The physical and chemical stability of the edible blob is assessed under various storage conditions. FTIR spectra of the edible blob showed a Mannuronic acid functional group at wave number 600 -800 cm^{-1}, CO stretching at wave number 1600 – 1800 $cm^{-1}$and OH functional group at wave number 3200 – 3600cm^{-1}. The turbidity of the edible blob was 328 NTU. The extract exhibited significant inhibitory activity against α glucosidase (IC50 = 499.26 ± 0.27 µg/mL) and α-amylase(IC50 = 499.27 ± 2.73 µg/mL) with IC50 values indicating potency. Additionally, the total phenolic content was found to be 20.38 ± 2.73 mg/g and the antioxidant activity of the extract was measured as 64.62 ± 3.28 percent at 100 µg/mL. The production of blobs is found to have both strengths and weaknesses. Its eco-friendly, local and native sources and biodegradability are the strengths, and the lack of awareness among the common public is another concern. The results indicate that the standardized edible blob retains its bioactive properties, showing enhanced stability, and offers a palatable delivery method for *Gymnema Sylvestre's* health benefits. This innovative approach has the potential to provide an effective convenient and alternative natural treatment for diabetes, contributing to improved health outcomes while also highlighting the importance of sustainable practices in combating plastic pollution through the development of biodegradable and environmentally friendly packaging solutions for such products.

Keywords: *Gymnema Sylvestre*, *antidiabetic, edible blob, sustainable, plastic pollution*

Graphical Abstract



Lanthanide-doped upconverting nanoparticles as a luminescent tag for environmental assessment of nano- and microplastics

Joanna Musiał*, Natalia Jurga, Dominika Przybylska and Tomasz Grzyb

Department of Rare Earths, Faculty of Chemistry, Adam Mickiewicz University, Uniwersytetu Poznańskiego 8, 61-614 Poznań, Poland
*Email address of the corresponding author: * joanna.musial@amu.edu.pl*

Abstract

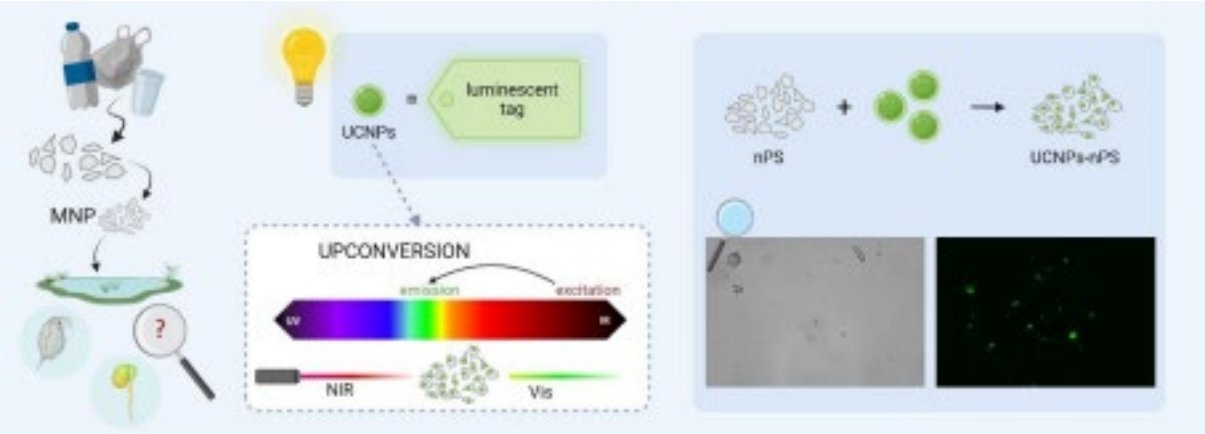
The occurrence of micro- and nanoplastics (MNP) in the environment has become a global problem. Their ubiquity results mainly from the mechanical breakdown of daily-use plastic products and has raised concerns due to possible detrimental effects in living organisms, including humans. Abundant evidence of the enhanced MNP bioavailability, translocation in tissues and through the trophic chain fuels the need to assess their persistence in aqueous and terrestrial matrices [1]. However, MNP monitoring remains challenging, as they evade many detection techniques.

Therefore, it is of utmost importance to develop methods that enable distinguishing and separating MNP from the background matrix. One solution could be tracing MNP by incorporating selected markers – for example, lanthanide-based upconverting nanoparticles (UCNPs). Most importantly, UCNPs convert longer-wavelength excitation light (such as near infrared, NIR) into shorter-wavelength emission light (such as visible). Moreover, in contrast to traditional fluorescent probes, UCNPs display unique luminescent properties, such as sharp emission bands, low background signals, large Stokes shifts, high resistance to photobleaching, and the possibility of excitation using light high tissue penetration depth [2]. Therefore, UCNPs stand out as an excellent luminescent marker for MNP.

The present study aimed to obtain UCNPs-incorporated nanoscale polystyrene particles (nPS). Several methods were used to prepare the materials, either via bottom-up or top-down approach: *in situ* photopolymerization of styrene monomer [3], nanoprecipitation [4] and cryo-milling of a polystyrene plastic material doped with UCNPs beforehand [5]. Dynamic light scattering and transmission electron microscopy analyses confirmed obtaining nano-scale particles. Their morphology differed depending on the preparation method used. Successful incorporation of the UCNPs into the polymer matrix was confirmed via fluorescent microscopy – upon NIR light excitation, UCNPs-nPS displayed bright green upconversion emission. The prepared nPS were identified using Fourier-Transformation Infrared Spectroscopy (FTIR). Further efforts are needed to optimize the UCNPs-nPS preparation and post-synthesis purification to find the most environmentally representative model of luminescent MNPs.

Keywords: *polymerization*, *polystyrene*, *upconverting nanoparticles*

Graphical Abstract



Magnetic micro-nanoparticles for microfiber removal in effluents

Cabigliera S.B.[1]*, Scopetani C.[1 2], Muzzi B.[3], Albino M.[3], Chelazzi D.[1 2] , Cantagalli D.[4], Cincinelli A.[1 2] and Martellini T.[1 2]

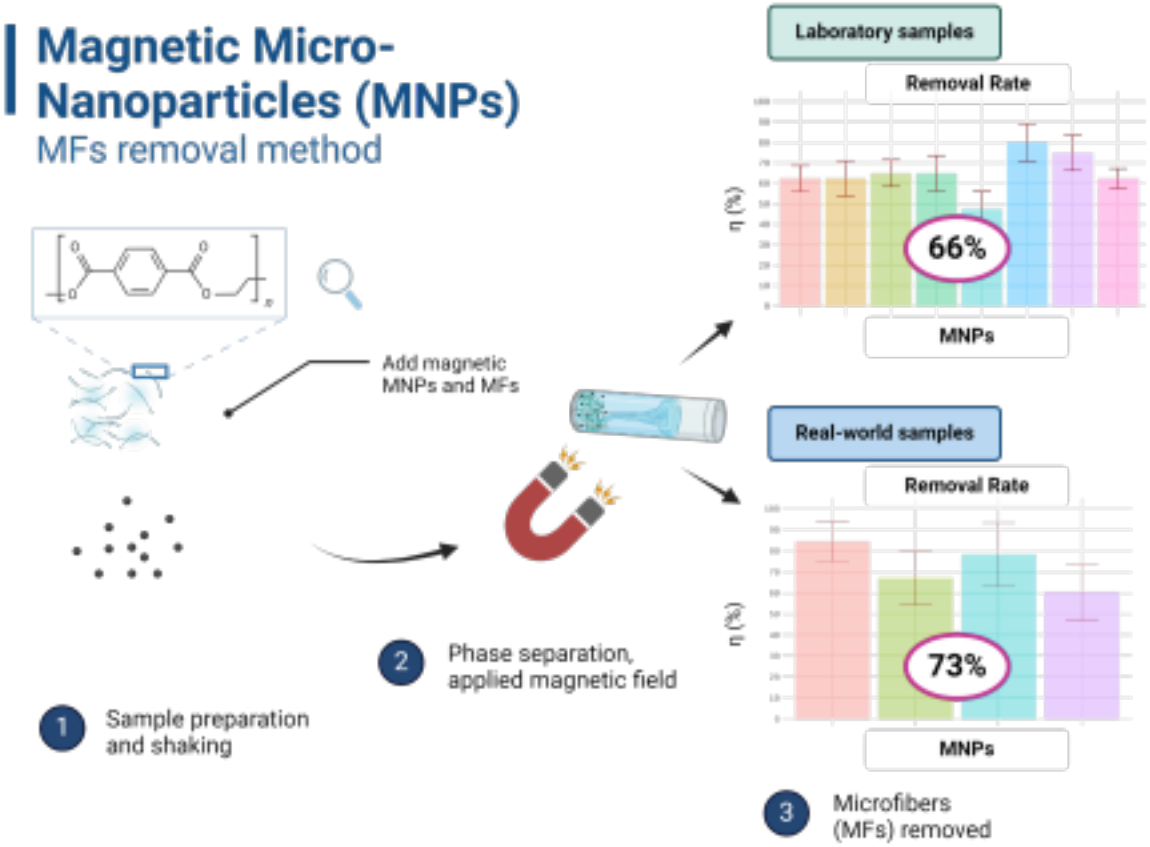
[1] Department of Chemistry "Ugo Schiff", Via della Lastruccia, 3 - Sesto Fiorentino, 50019, FI, Italy [2] Consorzio Interuniversitario per lo Sviluppo dei Sistemi a Grande Interfase (CSGI), University of Florence, Via della Lastruccia 3 – Sesto Fiorentino, 50019, FI, Italy
[3] Istituto di Chimica dei Composti Organometallici - ICCOM-CNR, Via Madonna del Piano, 10 - Sesto Fiorentino, 50019, FI, Italy
[4] ÈCOSÌ, partner company, Via Giovanni Giorgi 12 - Forlì, 47122, FC, Italy
**serenabenedetta.cabigliera@unifi.it*

Abstract

The escalating presence of microplastics (MPs) and microfibers (MFs) in aquatic environments presents a significant threat to ecosystem and human health. This study investigates the use of magnetic micro-nanoparticles (MNPs) as a novel method for removing textile-derived MFs from water [1] [2], both in laboratory and industrial settings. Eight different types of MNPs were evaluated for their efficacy in capturing and removing MFs from water samples. Methodologies included characterizing the physical and chemical properties of the MNPs, optimizing treatment conditions, and testing on both synthetic and real-world industrial wastewater samples. The results demonstrated that all tested MNPs, particularly those made from iron and iron oxides, achieved significant MFs removal efficiencies in laboratory settings, with rates exceeding 63% and reaching 80%. For water samples from industrial textile washing processes, removal rates reached 85% for one type of MNPs, with values higher than 60% for every other MNPs. These findings underscore the potential of magnetic MNPs to offer an effective and scalable solution for mitigating MFs pollution in water, contributing to the development of sustainable remediation strategies. Further research is required to refine the technology and explore its environmental and economic impacts on a larger scale [3].

Keywords: *magnetic micro-nanoparticles; microfibers; water remediation; environmental sustainability*

Graphic Abstract



Disintegrating microplastics and nanoplastics by bioremediation to mitigate climate change induced human health risks

Hira Azhar*, Noreen Khalid, Zonaira Qaiser

Government College Women University Sialkot, Sialkot, Pakistan

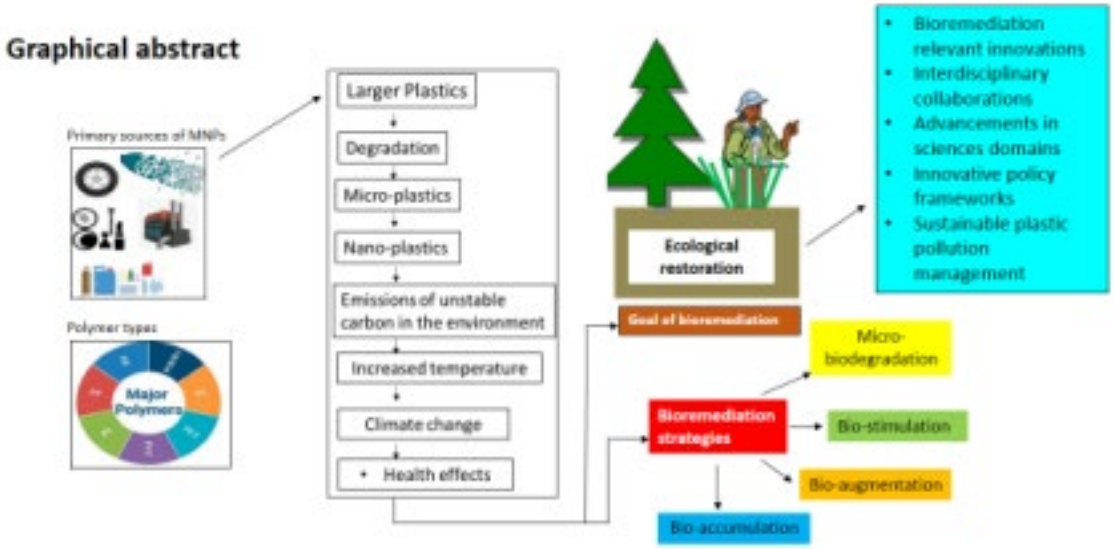
Corresponding author E-mail: hiraazhar1206@gmail.com

Abstract

Plastic pollution is adversely changing the climate which is shifting the atmospheric structure of biosphere rapidly devastating habitats and inducing severe human health problems. Plastics when release in natural environments, degrade into smaller plastics of different size and shapes called micro-plastics and nano-plastics. During disintegration, plastics contribute to the carbon emissions along with other greenhouse gases which consequence the climate change exacerbation and human health severities. Remediation of MPs and NPs still remains challenging as their working protocols are not promising the goal of sustainability. Bioremediation can thus serve as an effective and promising approach to mitigate the impacts of climate change. MNPs in natural environment to increase the trapping of heat in the atmosphere resulting adverse climate change which subsequently induce severe human health disturbances. Potential bioremediation strategies which work independently or in chain mechanisms, can be effective to achieve sustainable remediation of MNPs by microorganisms which sequester carbon, fixing it in biogeochemical cycles. Bioremediation strategies involves biodegradation stimulated by bio-stimulation and bio accumulation. However, to amplify these mechanisms, bio-augmentation and other biotechnological bioremediation approaches are also offered by bio-remediators. The bioremediation goal fosters the ecological restoration of plastic contaminated environments and mitigating the climate change impacts on human health. To achieve this goal, interdisciplinary collaborations are imperative which provides foundations for micro-bioremediation relevant innovations and advancements in biotechnology, microbiology, microbial ecology and environmental sciences domains. Innovative policy frameworks should be formulated to adopt bioremediation practices globally to ensure sustainable plastic pollution management and environment conservation by mitigating climate change to protect human health.

Keywords: *climate change, micro-biodegradation, bio-stimulation, bio-augmentation, human health.*

Graphical abstract



Internalization of nano plastics in major edible crop plants and their subsequent toxic impacts on human health

Hira Azhar* and Noreen Khalid

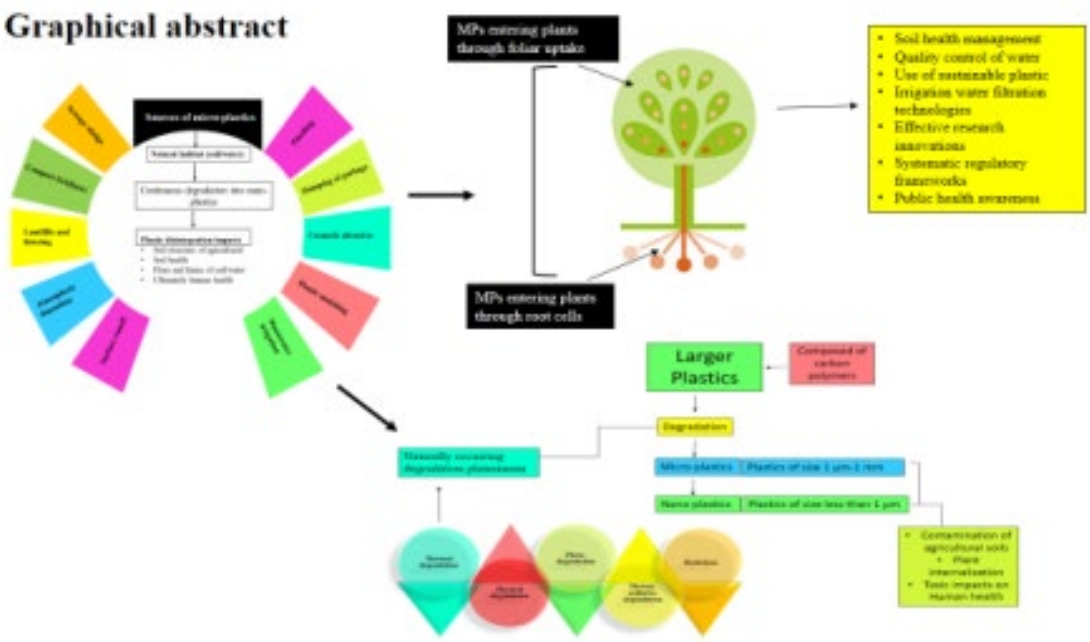
Government College Women University Sialkot, Sialkot, Pakistan

Corresponding author E-mail: hiraazhar1206@gmail.com

Abstract

Crop plants mainly wheat, rice, corn, vegetables and fruits are major food source for humans yet are highly exposed to plastics which poses significant risks to human health. Severe toxicity of plastics occurs when they get transformed into smaller particles like microplastics of size less than 5mm due to chemical, physical and biological processes, which further break down to nanoplastics of size less than 1µm. Nanoplastics are so small that they can even internalize in the plants by penetrating root cell walls reaching vascular system and by foliar uptake by stomata or epidermal layers. Agricultural soil carry NPs which arise from fertilizers, plastic mulching, and contaminated water irrigation. After internalization, NPs interrupt the physiological systems of plants which as a result affect the nutritional and morphological parameters of plants. Consumption of crop plants not only affects humans by NPs transfer but also due to disturbed health of consumed plants induced by NPs. Humans are reported to have severe diseases like gastrointestinal, respiratory, immunological, hormonal, neurological, cardiovascular, reproductive, developmental and allergic disturbances after their entry in blood stream by consuming NPs contaminated foods. This review paper covers the lack of comprehensive understanding, frameworks to mitigate NPs from environment and safeguarding human health. Mitigation strategies to ensure food safety and quality include soil health management, quality control of water, use of sustainable plastic, irrigation water filtration technologies, effective research innovations, systematic regulatory frameworks and public health awareness.

Keywords: *plastic pollution, nano-plastics, human health, plants health, edible plants*


Graphical abstract
MPs entering plants through foliar uptake
MPs entering plants through root cells
Soil health management
Quality control of water
Use of sustainable plastic
Irrigation water filtration technologies
Effective research innovations
Systematic regulatory frameworks
Public health awareness
Larger Plastics
Degradation

Revealing the interaction between invisible polluters: Microplastics and mercury in the Scheldt estuary (Belgium)

Sybrien Lievens*, Natacha Brion and Yue Gao

Archaeology, Environmental Changes & Geo-Chemistry (AMGC), VUB, Pleinlaan 2, 1050 Brussels, Belgium

**Corresponding author : Sybrien.Lievens@vub.be*

Abstract

Microplastics—particles less than 5 mm in diameter—are ubiquitous pollutants, found from the ocean depths to the atmosphere. These tiny particles are not inert debris; they serve as vectors for co-existing inorganic and organic pollutants, significantly influencing the transport, fate and bioavailability of these toxic compounds. As plastic pollution continues to increase worldwide, the urgency to understand these interactions intensifies. In the environment, microplastics undergo ageing and biofilm formation, altering their surface properties and potentially increasing their capacity to adsorb and transport mercury, one of the most toxic elements to humans. The interaction between microplastics and mercury can lead to complex mixture effects with yet unknown health and environmental consequences. It is crucial to understand the continuous conversion of the different mercury species into one another because of their different toxicity levels.

This research focuses on the Scheldt estuary, a critical waterway in Belgium with a long history of industrial pollution that contributes to persistently elevated mercury levels. By analysing microplastic and mercury concentrations in the Scheldt and conducting controlled laboratory experiments, this study aims to understand how aged with biofilm covered microplastics influence the mercury cycle. The insights gained could be used to develop strategies to protect and sustain aquatic environments, which are essential for our own well-being.

Keywords: *microplastics, Scheldt estuary, mercury*