International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 12 No. 2, 2026
https://www.theaspd.com/ijes.php

Microplastic Contamination in Coastal Waters of Andhra Pradesh, India: Microscopic and FTIR-Based Characterization

[1*] Gondu Chandrika, [2] Prof. C. Manjulatha, [3] Nutangi Anusha, [4] Dr. M. Ratna Kala

[1*] Department of Environmental Sciences, College of Science and Technology, Andhra University, 530003, India, gonduchandrika@gmail.com
[2] Professor in Zoology, Department of Zoology, College of Science and Technology, Andhra University, 530003, India, prof.cmanjulatha@andhrauniversity.edu.in
[3] Department of Zoology, College of Science and Technology, Andhra University, 530003, India, anushanutangi333@gmail.com
[4] Lecturer in Zoology, Department of Zoology, maadugula, mratnakala@gmail.com

ABSTRACT
Coastal environments are increasingly recognised as facing a problem of microplastic pollution, where plastic particles can persist and enter aquatic food webs. The present study deals with the microplastic contamination in the coastal water of five locations viz. Sagar Beach (Visakhapatnam), Nizampatnam (Guntur), Mypadu (Nellore), Ramayyapatnam Port (Prakasam) and Bandaruvani Peta (Srikakulam) in Andhra Pradesh, India. The water quality was assessed by pH, electrical conductivity, total dissolved solids, temperature, turbidity, chemical oxygen demand, chlorides, hardness, sulphates and salinity. Microplastic particles were isolated by filtration and examined by stereomicroscope and chemical characterisation was carried out by FTIR analysis. Sites examined contained fiber-like and irregular particles, differing in their apparent distribution between sites. The water samples were marine with salinity ranging from 25.6 to 28.5 ppt and electrical conductivity from 40 to 44.5 mS/cm. Ramayyapatnam Port showed highest COD value indicating higher organic loading than other sampling locations. The observed microplastic pollution may be reflective of inputs associated with fishing, tourism, port operations, domestic activities and coastal plastic waste. Our results indicate microplastic pollution in various coastal regions of Andhra Pradesh and emphasise the need for routine monitoring and better management of plastic waste. Further studies of the sediments and the aquatic biota are needed to evaluate the ecological consequences of this contamination.
Key words: *Microplastic, FTIR analysis, costal water, aquatic biota & COD value*

INTRODUCTION

Plastic contamination is one among the most emerging environmental challenges throughout the world because of the progression in production of plastic and its consumption, importantly its inadequate waste management practices. Starting from mid-twentieth century, because of the plastic properties (durability, lightweight nature, versatility, and low production cost) it became absolutely necessary. But, its perseverance in environment resulted in accumulation of plastic, resulting in microplastics that pose significant ecological and human health concerns (Thompson et al., 2009).

Microplastics generally defined as small plastic particles ranging from 0.1 μm to 5 mm in size and stands as an important fraction of plastic pollution (Li et al., 2018; Shen et al., 2020). Depending on origin, these are classified as primary microplastics, (Intentionally produced in microscopic sizes for industrial and commercial applications) and secondary microplastics, (Produced through the fragmentation of larger plastic debris by ultraviolet radiation, mechanical abrasion, and environmental weathering) (Li et al., 2018; Shen et al., 2020).

Microplastics are sourced from a variety of anthropogenic sources. Large amounts of synthetic microfibres are released in the domestic wastewater during washing of textiles and microbeads are released directly into sewage systems via personal care products (Metcalf and Eddy, 2014; Novotna et al., 2019). Other sources are tyre wear particles from traffic, industrial emissions, urban runoff and atmospheric deposition of synthetic fibres (Shen et al., 2020; UNEP, 2021). Rivers are important transport pathways, transporting microplastics from terrestrial environments into lakes, estuaries and coastal waters, where they finally accumulate in aquatic ecosystems (Shen et al., 2020; UNEP, 2021). Because they can linger in aquatic environments for extended periods of time and are resistant to natural degradation, microplastics are particularly hazardous (Lambert and Wagner, 2016; Rochman et al., 2013). Because of their hydrophobic surfaces and high surface-area-to-volume ratio, microplastics are effective adsorbents of environmental contaminants such as heavy metals, pesticides, hydrocarbons, and persistent organic pollutants (POPs). As a result, they serve as vectors for the transportation of harmful substances in aquatic environments (Lambert and Wagner, 2016; Rochman et al., 2013). Polymer density also determines their environmental fate; denser polymers, like polyethylene terephthalate (PET) and polyvinyl chloride (PVC), are more likely to accumulate in sediments, while low-density polymers, like polyethylene (PE) and polypropylene (PP), tend to remain suspended or float in surface waters (Li et al., 2018; Pivokonsky et al., 2018).

According to Shen et al. (2020) and UNEP (2021), microplastics have been discovered in nearly every environmental compartment, including the freshwater and marine environments, soils, and the atmosphere. The seas are the ultimate source of plastic pollution. Because of their widespread prevalence, they can enter aquatic food webs trough ingestion by creatures at various trophic levels, which leads to bioaccumulation and trophic transfer (Li et al., 2018; Shen et al., 2020). Numerous studies have found microplastics in fish and other edible aquatic creatures, raising concerns about possible human exposure thru diet (Li et al., 2018; Shen et al., 2020; WHO, 2019). Microplastic consumption can cause tissue abrasion, intestinal obstruction, decreased feeding efficiency, and physiological stress. Moreover, contaminants adsorbed on the particle surface can absorb into the elementary canal, causing extreme levels of chemicals and toxic substances in the marine ecosystem (Li et al., 2018; Rochman et al., 2013).

The detection and characterisation of microplastics are important to determine their occurrence, distribution and ecological impacts. Chemical digestion with hydrogen peroxide (H_2O_2), Fenton's reagent or alkaline solutions are common methods to degrade organic matter and preserve plastic particles for analysis (Fang et al., 2019; Li et al., 2018). Fourier Transform Infrared Spectroscopy (FTIR) is one of the most popular analytical methods for polymer identification because each polymer has its unique spectral fingerprint. This allows for the correct identification of common polymers like polyethylene (PE), polypropylene (PP), polystyrene (PS) and polyethylene terephthalate (PET) (Fang et al., 2019; Smith, 2011). As an additional analytical method, Raman spectroscopy can identify microplastic particles with high spatial resolution. (Fang et al., 2019; Goldstein et al., 2017).

Andhra Pradesh is located on the southeast coast of India, has a long coastline and many major river systems connecting the Bay of Bengal with inland freshwater habitats. Rapid urbanisation, industrialisation, discharge of residential wastewater, conventional agricultural methods, fisheries and coastal tourism have led to the increase in the quantity of plastic garbage entering aquatic environments. These activities cause disturbance to the aquatic habitats.

Hence, the present work has been undertaken to study the presence, distribution and characterisation of microplastics in certain Andhra Pradesh aquatic environments using microscopic analysis and Fourier Transform Infrared Spectroscopy (FTIR) for polymer identification. The results are expected to provide a baseline of regional microplastic contamination and contribute to future monitoring and management plans for freshwater and coastal ecosystems.

MATERIALS AND METHODS

Study Area and Sampling Sites

Water samples were collected from specific coastal regions in the Indian state of Andhra Pradesh in order to investigate the occurrence of microplastics in marine-influenced aquatic ecosystems. The sampling locations—Ramayapatnam Port Prakasam, Mypadu Nellore, Nizampatnam Guntur, Sagar Beach VSKP, and Bandaruvani Peta Srikakulam—represented coastal habitats with varying degrees of human interference.When selecting a location, factors like environmental diversity, accessibility, and the potential of plastic pollution were taken into account. Physicochemical parameters like temperature, pH, salinity, electrical conductivity (EC), turbidity, and chemical oxygen demand (COD) were measured to characterise the ambient conditions at each sampling location.

Figure 1. GIS-based map showing the geographical distribution of microplastic sampling locations along the Andhra Pradesh coastline. The sampling sites included (A) Sagar Beach, Visakhapatnam; (B) Nizampatnam, Guntur; (C) Mypadu, Nellore; (D) Ramayyapatnam Port, Prakasam; and (E) Bandaruvani Peta, Srikakulam.

Sample Collection

Surface water samples were collected using clean glass bottles in order to minimise contamination from plastic containers. As soon as the bottles were collected, they were marked, sealed, and submitted to the lab for further analysis. Standard sampling procedures, such as wearing gloves, avoiding plastic sampling equipment when possible, and limiting sample exposure to airborne contaminants, were followed throughout the inquiry.

Physicochemical and Microplastic Parameters Studied

In order to describe the environmental conditions at each sampling location and to make it easier to compare the occurrence of microplastics across sampling locations, physicochemical parameters were assessed for the collected water samples. pH, temperature, turbidity, salinity, electrical conductivity (EC), and chemical oxygen demand (COD) were among the variables assessed.

To ascertain whether the sampling environment was acidic or alkaline, the pH of each water sample was determined. Salinity and electrical conductivity were measured to identify marine-influenced settings and describe the ionic content of the water. At the sampling sites, the water's temperature was recorded. While COD was assessed as a measure of the organic load of the water samples, turbidity was identified as an indicator of suspended particle matter.

In order to describe the environmental conditions at each sampling location and to make it easier to compare the occurrence of microplastics across sampling locations, physicochemical parameters were assessed for the collected water samples. pH, temperature, turbidity, salinity, electrical conductivity (EC), and chemical oxygen demand (COD) were among the variables assessed.

To ascertain whether the sampling environment was acidic or alkaline, the pH of each water sample was determined. Salinity and electrical conductivity were measured to identify marine-influenced settings and describe the ionic content of the water. At the sampling sites, the water's temperature was recorded. While COD was assessed as a measure of the organic load of the water samples, turbidity was identified as an indicator of suspended particle matter.

Sample Digestion

The Wet Peroxide Oxidation (WPO) method was used to eliminate organic materials from the water samples. In short, 30% hydrogen peroxide ($H2O_2$) and an iron ($Fe2^+$) catalyst were introduced to the retained material in clean glass beakers to start the oxidation process. The samples were continuously stirred while heated to about 75°C until all visible organic materials had been completely digested. When more hydrogen peroxide was needed to finish the reaction, it was added. The materials were allowed to cool following digestion before being subjected to density separation.

Density Separation and Filtration

A saturated sodium chloride (NaCl) solution (about 5 M, density = 1.15 g mL^{-1}) was used to separate microplastics by density. The digested samples were put in a glass density separator and left undisturbed for the full nite in order to allow lighter plastic particles to float while heavier inorganic particles sank. A 0.3-mm filter was used to capture the floating fraction, which was then thoroughly cleaned with distilled water and left to air dry beneath aluminium foil in a contamination-free environment for at least 24 hours.

Identification and Characterization of Microplastics

A stereomicroscope with a 40× magnification was used to first classify the separated particles according to their size, shape, and colour. The particles were separated into fibres, chunks, films, and pellets according to their morphological characteristics.

The polymers were identified using Fourier Transform Infrared Spectroscopy (FTIR). The infrared spectra obtained from each particle were compared with reference spectra in order to ascertain the polymer composition, which includes polyethylene (PE), polypropylene (PP), polystyrene (PS), and polyethylene terephthalate (PET).

Quality Assurance and Contamination Control

Samples were collected and laboratory analysis performed following stringent contamination control protocols. Glassware and stain less steel equipment was used wherever possible to avoid plastic. All laboratory equipment was cleaned thoroughly using distilled water prior to use and samples were wrapped in aluminium foil when not being processed. Sample handling was carried out in gloves to reduce airborne and procedural contamination and all work was performed in a clean environment.

RESULTS

Microscopic Detection of Suspected Microplastics

Several elongated, filamentous, and irregular particle formations were found in the processed coastal water samples after stereomicroscopic inspection. Samples taken from Sagar Beach (Visakhapatnam), Nizampatnam (Guntur), Mypadu (Nellore), Ramayyapatnam Port (Prakasam), and Bandaruvani Peta (Srikakulam) revealed suspected microplastic-like particles, indicating their presence throughout all examined coastal sites. Within the microscopic field of view, the recovered particles showed discernible differences in size, distribution, and morphology (Figure2).

Throughout the samples, irregular particle formations were also seen in addition to fibres. Some of these particles appeared as tiny, dispersed particles, while others formed localised clusters. They also had uneven edges, irregular forms, and different sizes. Particle distribution varied throughout microscopic fields, with more distributed particle configurations in some locations and a higher concentration of preserved material in others. This variation indicates that the processed samples' amounts and distributions of suspended particulate matter varied.

The stereomicroscopic observations provided clear visual evidence of suspected microplastic-like particles in all examined coastal water samples. However, visual examination alone cannot reliably distinguish synthetic polymers from natural fibers or other anthropogenic particles with similar morphology. Therefore, the recovered particles were further subjected to Fourier Transform Infrared (FTIR) spectroscopy for chemical characterization and confirmation of their material composition.

FTIR Spectral Characterization of Recovered Particles

The chemical composition of samples related to Ramayapatnam Port Prakasam, Mypadu Nellore, Nizampatnam Guntur, Sagar Beach VSKP, and Bandaruvani Peta Srikakulam are examined using FTIR spectroscopy.

In addition to various bands in the lower-wavenumber area between around 450 and 520 cm⁻¹, the FTIR spectrum linked to Sagar Beach showed noticeable spectral characteristics at roughly 3899, 3820, 3510, 3442, and 1638 cm⁻¹. In the 2800–3000 cm⁻¹ area of the spectrum, which would be predicted for substantial aliphatic C–H stretching in polyethylene or polypropylene, there was no discernible absorption pattern.

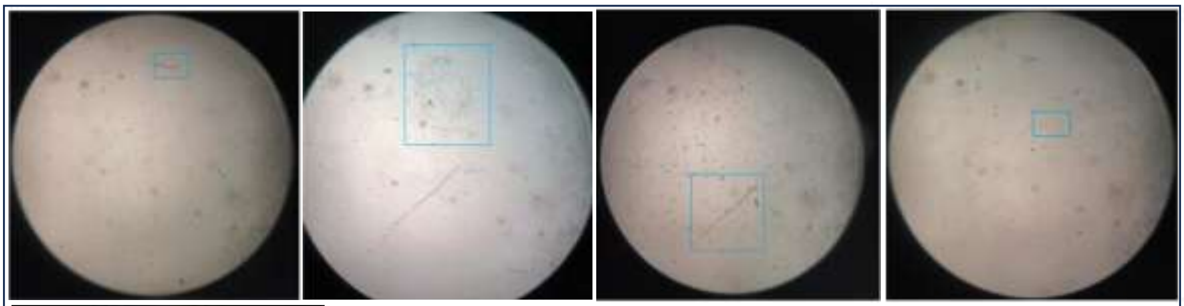
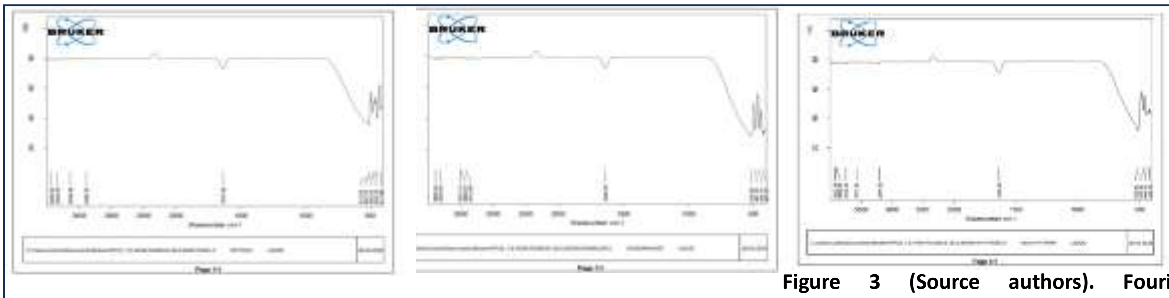


Figure 2 (Source: Authors). Microscopic images of suspected microplastic particles identified in coastal water samples from five sampling locations along the Andhra Pradesh coastline. Shown fiber-like and irregular particulates observed in samples collected from Sagar Beach, Visakhapatnam; (B) Nizampatnam, Guntur; (C) Mypadu, Nellore; (D) Ramayyapatnam Port, Prakasam; and (E) Srikakulam, Prakasam. Blue boxes are used for marking the suspected particles.

In addition to several lower-wavenumber bands about 418–513 cm⁻¹, the Mypadu spectra displayed bands at roughly 3926, 3835, 3639, 3390, and 1638 cm⁻¹. The presented spectrum lacked a noticeable C–H stretching pattern in the 2800–3000 cm⁻¹ range, just like the Sagarnagar spectrum.
Ramayyapatnam Port's FTIR spectrum revealed bands in the range of roughly 423–529 cm⁻¹ along with features at roughly 3830, 3797, 3392, 3365, and 1635 cm⁻¹. Once more, the spectra did not exhibit the prominent hydrocarbon stretching pattern that is typical of PE or PP at 2800–3000 cm⁻¹.
The spectrum for Bandaruranipeta showed many bands between roughly 426 and 520 cm⁻¹, a significant feature near 1636 cm⁻¹, and a peak at roughly 3888 cm⁻¹. No distinct absorption pattern corresponding to the characteristic C–H stretching region of PE or PP was evident in the displayed spectrum.



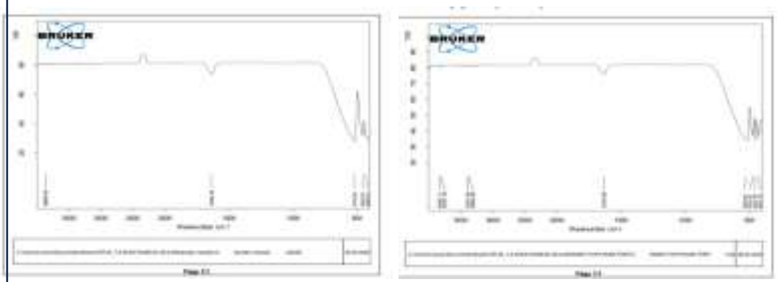


Figure 3 (Source authors). Fourier Transform Infrared (FTIR) spectra of coastal water samples from different sampling locations in Andhra Pradesh. Spectral profiles of samples collected from (A) Sagar Beach, Visakhapatnam, (B) Mypadu, Nellore, (C) Ramayyapatnam Port, Prakasam, (D) Bandaruranipeta, and (E) Nizampatnam, Guntur, showing the observed absorption bands at different wavenumbers used for chemical characterization of the samples.

In addition to various lower-wavenumber bands about 427–516 cm^{-1}, the Nizampatnam spectra showed characteristics at roughly 3922, 3903, 3747, 3708, 3204, and 1637 cm^{-1}. Similar to the other samples, there was no discernible absorption pattern between 2800 and 3000 cm^{-1}.

Comparison of FTIR Spectra Among Sampling Locations

Although the precise peak positions differed among samples, the presented FTIR spectra across the five sampling locations showed generally similar spectral features, especially in the ranges about 3300–3900 cm^{-1} and roughly 1635–1639 cm^{-1}. In the lower-wavenumber range below about 550 cm^{-1}, more bands were seen.

According to the given spectra, the FTIR results by themselves are insufficient to identify the material under analysis as either polyethylene (PE) or polypropylene (PP). Specifically, these spectra do not clearly show the typical hydrocarbon C–H stretching area about 2800–3000 cm^{-1}. Therefore, unless the relevant FTIR library-search results independently validate their polymer identity, the observed filamentous structures should be reported as suspected microplastic particles based on morphology.

Site-wise Observation of Suspected Microplastic Particles

Sagar Beach, Visakhapatnam

Examining the residual particulate matter under a stereomicroscopy revealed lengthy, fiber-like formations. Thin, curving fibres and small particulate particles dispersed over the microscopic field were among the objects seen. Based on their shape, these entities were thot to be microplastic particles. FTIR examination yielded a spectrum with extra bands in the lower-wavenumber area and notable features around 3510–3899 cm^{-1} and roughly 1639 cm^{-1}. Nevertheless, there was no distinctive PE/PP signature visible in the exhibited spectrum.

Mypadu, Nellore

There were discernible filamentous and elongated features in the Mypadu sample, including a noticeable fiber-like particle in the microscopic field. There was also more tiny particulate matter visible. FTIR research revealed lower-wavenumber bands and strong characteristics around 3390–3926 cm^{-1} and 1637–1638 cm^{-1}. There was no discernible PE- or PP-specific absorption pattern in the presented spectra.

Ramayyapatnam Port, Prakasam

The Ramayyapatnam Port sample was examined under a microscope, revealing elongated fiber-like structures and particulate material that were relatively distinct from the background material. The corresponding FTIR spectrum showed several lower-wavenumber bands along with prominent features around 3365–3830 cm^{-1} and roughly 1635 cm^{-1}. However, the spectrum does not provide enough evidence to identify the material as PE or PP.

Bandaruranipeta, Srikakulam

Under a stereomicroscopic analysis, the Bandaruranipeta sample revealed small particle matter and fiber-like features. The examined field showed a clear curved filamentous structure. The FTIR spectra showed bands in the lower-wavenumber area, as well as features at 3888 and 1636 cm^{-1}. The presented spectrum did not show any distinctive PE/PP absorption pattern.

Nizampatnam, Guntur

Both fine particulate matter and discernible filamentous formations were present in the Nizampatnam sample. The microscopic studies showed curved structures and elongated fibre-like particles. Along with lower-wavenumber bands, the related FTIR spectra showed many bands in the 3200–3900 cm^{-1} area and a significant feature about 1637 cm^{-1}. A final PE or PP assignment cannot be made based only on the spectrum that is exhibited.

Sampling location	Major observed FTIR bands (cm^{-1})	Prominent band	General spectral observation
Sagar Beach, Visakhapatnam	3899.05, 3820.84, 3510.13, 3484.91, 3412.86, 1638.55, 516.58, 481.55, 454.14	1638.55	Broad high-wavenumber bands and a prominent band around 1639 cm^{-1}, with additional bands in the lower fingerprint region
Mypadu, Nellore	3926.90, 3834.55, 3638.88, 3390.32, 1637.58, 512.83, 489.74, 468.26, 446.68, 417.68	1637.58	Several bands in the 3300–3900 cm^{-1} region and a prominent band near 1638 cm^{-1}
Ramayyapatnam Port, Prakasam	3830.11, 3797.19, 3391.59, 3365.59, 1634.98, 528.82, 476.02, 462.16, 423.15	1634.98	High-wavenumber bands with a prominent absorption near 1635 cm^{-1} and multiple lower-wavenumber bands
Bandaruvani Peta, Srikakulam	3888.06, 1636.44, 519.53, 454.81, 426.51	1636.44	Fewer prominent bands compared with the other samples, with a distinct band near 1636 cm^{-1}
Nizampatnam, Guntur	3922.88, 3902.88, 3794.06, 3757.06, 3204.65, 1637.43, 516.62, 495.39, 456.55	1637.43	Multiple high-wavenumber bands and a prominent band near 1637 cm^{-1}, together with lower-wavenumber bands

Table:1 Source: Authors FTIR spectral characters of samples collected from five different locations in Andhra Pradesh, India.

DISCUSSION

The present study observed the presence of suspected microplastic particles in coastal water samples collected from Ramayapatnam Port Prakasam, Mypadu Nellore, Nizampatnam Guntur, Sagar Beach VSKP, and Bandaruvani Peta Srikakulam of Andhra Pradesh coast. Stereomicroscopic analysis revealed irregular particles and predominantly fiber-like features. The presence of similar particle types at several sampling sites indicates that microplastic pollution is not localised This is in agreement with other studies (Cole et al., 2011; Li et al., 2018; UNEP, 2021, Anthony et al. 2024) suggesting that microplastics are widely distributed in freshwater, marine and coastal habitats and are affected by hydrodynamic conditions, geographical factors and human activities.

Domestic wastewater, synthetic textiles, fishing nets, ropes, and other plastic items used in coastal activities may be linked to the prevalence of fiber-like particles seen in this study corelates with Cole et al. (2011) findings. Wastewater can introduce synthetic fibres generated during the washing of synthetic garments, and coastal tourism and fishing activities can contribute plastic trash. Smaller particles can then be produced by weathering and fragmentation of larger polymeric materials caused by sunlight, mechanical abrasion, and wave action. Similarly, Ranjani et al. (2021) have documented that Indian coastal habitats, where microplastic contamination is caused by urbanisation, fishing, tourism, and poor waste management.

Recreational and port-influenced regions were among the several coastal habitats represented by the sampling locations. Nizampatnam had the lowest COD value (2), while Ramayyapatnam Port had the highest (48). Although COD by itself cannot determine the source or quantity of microplastics, fluctuations in COD may be a reflection of local anthropogenic activity and organic input variations (Yang et al., 2025; Anthony et al., 2024). FTIR analysis is another method used to characterise the polymers. FTIR is extensively used to confirm polymer composition as it gives molecular fingerprints that can be compared to reference spectra. Spectroscopic confirmation is important as visual identification alone could lead to mis-identification of natural fibres as microplastics. Thus, these particles observed in this investigation could only be referred to as confirmed microplastics when the appropriate FTIR library-match results verify them. In particular, the polymer type should not be assigned only on the basis of the spectral appearance, without the library-match information. Hidalgo-Ruz et al. (2012), Primpke et al. (2018), and Veerasingam et al. (2021) also emphasized that spectroscopic confirmation reduces false identification of natural fibers and improves the reliability of microplastic studies.

Observation of the microplastics in the aquatic ecosystem is important because it spreads into the organisms by ingesting. Previous studies have demonstrated microplastic ingestion in fish and other marine organisms, with possible effects on feeding, growth, reproduction and physiological functions (Boerger et al., 2010; Wright et al., 2013). Evidence from Indian marine environments further indicates that microplastics occur in commercially important fish and other marine organisms. Anthony et al. (2024) reported microplastics in both carnivorous and planktivorous fish from southern India and identified polymers including polyethylene, polypropylene, polystyrene and polyamide.

Importantly, aquatic animals may therefore also be affected by microplastic contamination present in their surrounding environment, although this was not directly evaluated in the present study. Previous experimental studies have reported physical, physiological and reproductive effects following microplastic exposure in aquatic organisms. Microfibers, for example, have been associated with reduced developmental success, delayed larval hatching and impaired embryogenesis in marine polychaetes, while exposure to weathered polyethylene has been associated with changes in immunological and haematological parameters in fish. These findings indicate that microplastic contamination in coastal waters may represent an important potential exposure pathway for aquatic organisms.

Microplastics can also have wider ecological effects by moving around in aquatic food webs. Ingested particles can be transferred between trophic levels and interact with persistent organic pollutants and heavy metals on their surfaces. Plastic ingestion has been shown to transfer hazardous chemicals to fish and induce hepatic stress (Rochman et al. 2013). Therefore, microplastic pollution may have consequences beyond the simple presence of plastic particles, and may lead to interactions between plastics and other environmental pollutants.

The findings are also relevant for seafood and human exposure, since fish and shellfish living in contaminated waters can ingest microplastics. Studies from India have reported the occurrence of microplastics in seafood including commercially important marine organisms (Saha et al., 2021). However, as the present study was restricted to water samples only and did not include aquatic organisms or seafood, direct conclusions regarding microplastic accumulation in animals or human exposure cannot be made.

The present study gives evidence for suspected microplastic contamination in different coastal locations of Andhra Pradesh. The properties of the recovered fibres and fragments and the environmental features of the sampled sites suggest the role of anthropogenic inputs and coastal transport processes. The results support the need for continued monitoring of microplastics in coastal water, sediments and aquatic organisms with standardised sampling and spectroscopic confirmation. Better solid waste management, control of plastic inputs from fisheries and tourism, and proper wastewater management are important to reduce the entry of microplastics into coastal ecosystems.

CONCLUSION

The current investigation shows that five coastal areas along the Andhra Pradesh coastline have microplastic contamination. The majority of the particles found by stereomicroscopic inspection were irregular and fiber-like, suggesting that the coastal waters under investigation contained plastic-derived particles. The largely maritime conditions were corroborated by the physicochemical parameters, with variability among sampling sites reflecting anthropogenic and local environmental impacts.

Because these particles can be consumed by fish and other aquatic creatures and may negatively impact their physiological and reproductive health, the study emphasises the ecological significance of coastal microplastic pollution. Although spectral-library matching should be used to enable final polymer identification, the combination of microscopy and FTIR offered a helpful method for microplastic study. In order to lessen microplastic pollution and safeguard Andhra Pradesh's coastal ecosystems and aquatic resources, the results highlight the necessity of routine monitoring, better plastic-waste management, and control of plastic inputs from fishing, tourism, wastewater, and coastal activities.

REFERENCES

1. Thompson, R. C., Swan, S. H., Moore, C. J., & vom Saal, F. S. (2009). Our plastic age. Philosophical Transactions of the Royal Society B: Biological Sciences, 364(1526), 1973–1976. https://doi.org/10.1098/rstb.2009.0054
2. Li, J., Liu, H., & Chen, J. P. (2018). Microplastics in freshwater systems: A review on occurrence, environmental effects, and methods for microplastics detection. Water Research, 137, 362–374. https://doi.org/10.1016/j.watres.2017.12.056
3. Xu, S., Ma, J., Ji, R., Pan, K., & Miao, A.-J. (2020). Microplastics in aquatic environments: Occurrence, accumulation, and biological effects. Science of the Total Environment, 703, 134699. https://doi.org/10.1016/j.scitotenv.2019.134699
4. Metcalf & Eddy, Inc. (2014). Wastewater Engineering: Treatment and Resource Recovery (5th ed.). McGraw-Hill Education.
5. Novotna, K., Cermakova, L., Pivokonska, L., Cajthaml, T., & Pivokonsky, M. (2019). Microplastics in drinking water treatment – Current knowledge and research needs. Science of the Total Environment, 667, 730–740. https://doi.org/10.1016/j.scitotenv.2019.02.431
6. United Nations Environment Programme (UNEP). (2021). From Pollution to Solution: A Global Assessment of Marine Litter and Plastic Pollution. Nairobi: United Nations Environment Programme. ISBN 978-92-807-3881-0.

7. Lambert, S., & Wagner, M. (2016). Formation of microscopic particles during the degradation of different polymers. Chemosphere, 161, 510–517. https://doi.org/10.1016/j.chemosphere.2016.07.042
8. Rochman, C. M., Browne, M. A., Halpern, B. S., Hentschel, B. T., Hoh, E., Karapanagioti, H. K., Rios-Mendoza, L. M., Takada, H., Teh, S., & Thompson, R. C. (2013). Classify plastic waste as hazardous. Nature, 494(7436), 169–171. https://doi.org/10.1038/494169a
9. Pivokonsky, M., Cermakova, L., Novotna, K., Peer, P., Cajthaml, T., & Janda, V. (2018). Occurrence of microplastics in raw and treated drinking water. Science of the Total Environment, 643, 1644–1651.
https://doi.org/10.1016/j.scitotenv.2018.08.102
10. World Health Organization. (2019). Microplastics in Drinking-Water. Geneva: World Health Organization. ISBN 978-92-4-151619-8.
11. Hidalgo-Ruz, V., Gutow, L., Thompson, R. C., & Thiel, M. (2012). Microplastics in the marine environment: A review of the methods used for identification and quantification. Environmental Science & Technology, 46(6), 3060–3075. https://doi.org/10.1021/es2031505
12. Primpke, S., Wirth, M., Lorenz, C., & Gerdts, G. (2018). Reference database design for the automated analysis of microplastic samples based on Fourier transform infrared (FTIR) spectroscopy. Analytical and Bioanalytical Chemistry, 410(21), 5131–5141. https://doi.org/10.1007/s00216-018-1156-x
13. Veerasingam, S., et al. (2021). Contributions of Fourier transform infrared spectroscopy in microplastic pollution research: A review. Critical Reviews in Environmental Science and Technology, 2681–2743.
https://doi.org/10.1080/10643389.2020.1807450
14. Masura, J., Baker, J. E., Foster, G. D., Arthur, C., & Herring, C. (2015). Laboratory Methods for the Analysis of Microplastics in the Marine Environment: Recommendations for Quantifying Synthetic Particles in Waters and Sediments. NOAA Technical Memorandum NOS-OR&R-48. National Oceanic and Atmospheric Administration, Marine Debris Program.
15. Andrady, A.L. (2011). Microplastics in the marine environment. Marine Pollution Bulletin, 62(8), 1596–1605. doi:10.1016/j.marpolbul.2011.05.030.
16. 2. Cole, M., Lindeque, P., Halsband, C., & Galloway, T.S. (2011). Microplastics as contaminants in the marine environment: A review. Marine Pollution Bulletin, 62(12), 2588–2597. doi:10.1016/j.marpolbul.2011.09.025.
17. Boerger, C.M., Lattin, G.L., Moore, S.L., & Moore, C.J. (2010). Plastic ingestion by planktivorous fishes in the North Pacific Central Gyre. Marine Pollution Bulletin, 60(12), 2275–2278. doi:10.1016/j.marpolbul.2010.08.007.
18. Wright, S.L., Thompson, R.C., & Galloway, T.S. (2013). The physical impacts of microplastics on marine organisms: A review. Environmental Pollution, 178, 483–492. doi:10.1016/j.envpol.2013.02.031.
19. Rochman, C.M., Hoh, E., Kurobe, T., & Teh, S.J. (2013). Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress. Scientific Reports, 3, 3263. doi:10.1038/srep03263.
20. Jambeck, J.R., Geyer, R., Wilcox, C., et al. (2015). Plastic waste inputs from land into the ocean. Science, 347(6223), 768–771. doi:10.1126/science.1260352.
21. Koelmans, A.A., Nor, N.H.M., Hermsen, E., Kooi, M., Mintenig, S.M., & De France, J. (2019). Microplastics in freshwaters and drinking water: Critical review and assessment of data quality. Water Research, 155, 410–422.
doi:10.1016/j.watres.2019.02.054.
22. Carbery, M., O'Connor, W., & Thavamani, P. (2018). Trophic transfer of microplastics and mixed contaminants in the marine food web and implications for human health. Environment International, 115, 400–409.
doi:10.1016/j.envint.2018.03.007.
23. Smith, M., Love, D.C., Rochman, C.M., & Neff, R.A. (2018). Microplastics in seafood and the implications for human health. Current Environmental Health Reports, 5, 375–386. doi:10.1007/s40572-018-0206-z.
24. Prata, J.C., Silva, A.L.P., da Costa, J.P., et al. (2019). Solutions and integrated strategies for the control and mitigation of plastic and microplastic pollution. International Journal of Environmental Research and Public Health, 16, 2411. doi:10.3390/ijerph16132411.
25. Ranjani, M., Veerasingam, S., Venkatachalapathy, R., et al. (2021). Assessment of potential ecological risk of microplastics in the coastal sediments of India: A meta-analysis. Marine Pollution Bulletin, 163, 111969.
doi:10.1016/j.marpolbul.2021.111969.
26. Saha, M., Naik, A., Desai, A., et al. (2021). Microplastics in seafood as an emerging threat to marine environment: A case study in Goa, west coast of India. Chemosphere, 270, 129359. doi:10.1016/j.chemosphere.2020.129359.
27. Anthony, J., Varalakshmi, S., Kumar Sekar, A., et al. (2024). Microplastics pollution in Indian marine environment: Sources, effects and solutions. Frontiers in Marine Science, 11, 1512802. doi:10.3389/fmars.2024.1512802.
28. Yang, X., Huang, G., Geng, X., et al. (2025). Deciphering the behavior and fate of microplastics in coastal aquatic environments: A comprehensive review illuminating coastal dynamics and driving mechanisms. Earth-Science Reviews, 270, 105235.
29. Paul, A., Karmakar Rony, P., Ahmed Tanvir, M., & Naiema, N. (2026). Microplastics in water: Occurrence, detection, and impacts – a comprehensive review of multiple studies. Water Practice & Technology, 21(1), 123–137. doi:10.2166/wpt.2026.188.