

Analysis of Microplastics Released from Plastic Take-Out Food Containers based on Physicochemical Properties

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Abstract: Microplastics (MPs) may be released into food from plastic takeout containers, potentially harming both human health and food safety. Here, MPs released from four different kinds of plastic food containers (polyethylene terephthalate; PET, polypropylene; PP, polystyrene; EPS, polyethylene; PE) were analysed using physicochemical properties like absorption, pH, Turbidity, Density and Viscosity. The findings show higher values of Turbidity, Density for Glass indicating high released MPs were smaller values of Turbidity for Dronas indicating low release of MPs. The four types of containers on average were found to have different MPs concentrations. Furthermore, our analysis revealed that the release of MPs found higher in Glass.

Keywords: Microplastics, Turbidity, absorption, density

1. Introduction

Microplastics are synthetic, high-molecular weight compounds that have been micronized into plastic particles smaller than 5 mm in size. Due to their low rate of biodegradation, these materials primarily stay in the environment and negatively impact the human body, which is the last consumer in the food chain. The world's environment is rife with microplastics. Its possible health risks have drawn a lot of attention as a typical emerging pollutant. The origin, identification, toxicity, and health risk of microplastics in humans are discussed in this brief paper. Microplastics are commonly found in environmental and human samples, according to the literature review. Microplastics may be ingested orally, inhaled, or come into contact with human skin [1]. Plastics are used extensively in everyday life because of their affordability, strength, and light weight. Water and beverages are frequently stored and transported using common plastic items like food containers, water bottles, and disposable glasses. Polymers like polyethylene (PE), polypropylene (PP), and polyethylene terephthalate (PET) make up the majority of these plastics [2].

Despite their benefits, plastics are a major environmental concern, especially when they interact with water. Plastics may eventually leak dangerous materials into water as a result of environmental, chemical, and physical elements like pH, temperature, and UV rays [3]. These leached materials have the potential to change the physicochemical characteristics of water, rendering it unsafe to drink [4]. Little is known about the impact of microplastics on human health and the toxic effects that may vary depending on the type, size, shape, and concentration of microplastics. Therefore, more research is needed to understand the cellular and molecular mechanisms of microplastics toxicity and related pathologies.

The physicochemical properties of plastics include density, conductivity, thermal stability, chemical resistance, and interaction with solvents. Studying these properties helps in

understanding how plastics behave under different conditions and how they influence water quality [5],[6].

This study focuses on analyzing different plastic samples such as plastic water bottles, plastic glasses, traditional plastic containers (dronas), and polythene bags evaluating their effect on water quality parameters like pH, conductivity, turbidity, density, viscosity and presence of additives. The aim is to assess whether these materials are safe for repeated use and their potential environmental impact. The objective of this study was to probe whether heat treatment of disposable plastic materials in water, mimicking their use for hot food or drink, could result in the release of particles and harmful substances in the leachate.

2. Review of Literature

Microplastics have been found in a variety of organisms and multiple parts of the human body [7]. At present, the toxicity research on microplastics show that the exposure will cause intestinal injury, liver infection, flora imbalance, lipid accumulation, and then lead to metabolic disorder [8][9]. In addition, the microplastic exposure increases the expression of inflammatory factors, inhibits the activity of acetylcholinesterase, reduces the quality of germ cells, and affects embryo development. At last, we speculate that the exposure of microplastics may be related to the formation of various chronic diseases. Various studies have highlighted the environmental impact of plastic materials on water systems [10]. Researchers have reported that plastics, especially when exposed to sunlight and environmental conditions, undergo degradation and release microplastics and chemical additives into water bodies. These substances can significantly influence water quality [11][12].

Previous studies have shown that plastic bottles made of polyethylene terephthalate (PET) can release trace amounts of antimony and other compounds into water, especially under high temperature conditions [13]. Similarly, polyvinyl

chloride (PVC) plastics are known to release harmful plasticizers such as phthalates, which can affect aquatic organisms [14]. Studies using UV-Visible spectroscopy have indicated that water stored in plastic containers exhibits higher absorbance compared to water stored in glass containers. This suggests the presence of dissolved organic and inorganic substances leached from plastics. Changes in pH have also been observed, indicating chemical interactions between water and plastic surfaces [15]. Research on turbidity has shown that degraded plastic particles increase the cloudiness of water, which affects light penetration and aquatic life [16]. Viscosity and density studies further reveal that the presence of dissolved plastic components can slightly alter their values.

Previous studies have shown that plastics can significantly affect water quality through the release of additives and degradation products. Researchers have identified that plastic materials contain compounds such as bisphenol A (BPA), phthalates, and heavy metals, which may leach into water under certain conditions.

Studies on polyethylene terephthalate (PET) bottles indicate that prolonged storage and exposure to sunlight can increase the migration of antimony and other substances into water. Similarly, polypropylene-based plastic glasses have shown moderate chemical stability but may degrade under high temperatures.

Research using UV-Visible spectroscopy has demonstrated that organic compounds released from plastics can absorb

light in the UV region, indicating contamination. Spectrophotometric analysis is therefore widely used to detect such impurities in water. Other studies have focused on conductivity measurements, which reveal that the presence of dissolved ions increases when plastics release additives into water. Density and structural analysis of plastics also help in identifying their composition and degradation behaviour. Environmental studies have highlighted the issue of microplastics, which form due to the breakdown of larger plastic materials. These microplastics not only affect aquatic ecosystems but also enter drinking water sources, posing health risks.

Overall, the literature suggests that while plastics are convenient, their interaction with water can lead to contamination, especially under unfavourable conditions such as high temperature, repeated use, and long storage periods. Microplastics pollution has emerged as a critical environmental concern affecting soil health, agriculture, ecosystems, and human well-being.

3. Materials Methods

The materials used in this study include:

- Plastic water bottles (PET)
- Plastic water glasses (PP)
- Plastic dronas (disposable plastic containers) (EPS)
- Polythene bag (PE)
- Distilled water
- Chemicals for testing (if required)



(1) Plastic bottle



(2) Plastic Glass



(3) Plastic Dronas



(4) Polythene bag

Instruments used in this study include:

- UV-Visible Spectrophotometer
- Conductivity meter
- pH meter
- Specific gravity bottle
- Ostwald Viscometer
- Analytical balance

Physicochemical Analysis of different Plastics samples:

Water samples were used for analysis:

- Density Measurement: Determined using mass and volume relationship.
- Conductivity Test: To assess electrical conductivity of plastic-treated water.
- UV-Visible spectrophotometry: To detect microparticals and colour additives detection
- pH: Using a pH meter
- Conductivity: Using a conductivity meter
- Turbidity: Using a turbidity meter
- UV Absorbance: Using UV-Visible spectrophotometer to detect organic impurities.

Procedure for water samples preparation used for analysis:

Sample Preparation: -

Plastic samples including plastic bottles, plastic glasses, plastic plates (drones), and plastic bags (polythene) were collected and cleaned thoroughly to remove surface impurities. Each plastic sample were dried at room temperature and sunlight exposure for a fixed period. Next, this collected clean samples were cut into small, uniform pieces. Exactly 5 grams of each prepared plastic sample were placed inside a conical flask. Poured 100 ml of distilled water into the flask with the plastic, then heated the entire mixture in a water bath at approximately 60 °C for 30 minutes.

Physicochemical Analysis of Plastics samples solutions:

1) Spectrophotometer (λ_{max}):

The sample solution was prepared carefully to ensure a clear solution with no precipitate. The spectrophotometer was switched on and allowed to warm up for 10 to 15 minutes before the desired wavelength was selected. A cuvette was filled with the solvent blank (ethanol/alcohol), placed into the instrument holder, and the absorbance was set to zero. Finally, the blank was replaced with the sample solution, and the absorbance value was recorded.

2) pH Measurement:

To measure pH using the instrument method, the pH meter was switched on and calibrated using standard buffer solutions. The glass electrode was rinsed, washed with distilled water, and then immersed directly into the sample solution to record the final pH reading. Alternatively, for the manual method, a strip of pH paper was dipped into the solution and removed so the colour change could be observed. This colour was compared against a standard reference chart to estimate the pH value.

3) Conductivity:

The conductivity meter was turned on to measure the ability of the solution to conduct an electric current. The instrument was calibrated using a standard potassium chloride (KCl) solution, and the probe was rinsed thoroughly with distilled water. The sample was then transferred into a clean beaker, the conductivity cell was immersed into the solution, and the resulting reading was recorded.

4) Density Determination:

A clean, dry measuring cylinder was obtained, and the liquid sample was poured into it to note the precise volume (V). The mass of the empty Specific gravity bottle (M_0) and the mass of the Specific gravity bottle filled with the liquid sample (M_1) were both weighed on a balance. The actual mass of the sample was calculated by subtracting (M_1 from M_0). Finally, the density of the sample was calculated using the standard formula of mass divided by volume.

5) Viscosity Determination:

The cleaned and dried Ostwald viscometer was placed vertically in a water bath with a constant temperature. A predetermined amount of the reference liquid typically distilled water, was pipetted into the viscometer's wider bulb. The liquid was raised above the upper mark by blowing or sucking it up into the upper bulb. A stopwatch was started precisely as the meniscus passed the upper mark and stopped as it crossed the lower mark to record the efflux time while the liquid was allowed to flow downward under gravity. To find the sample liquid's flow time (t) at 25 °C, the entire process was repeated. Lastly, the recorded flow times and the densities of both liquids were used to calculate the sample's relative viscosity.

6) Determination of Turbidity (Turbidity Meter)

To guaranty electronic stability, the turbidity meter was turned on and given time to warm up. Standard turbidity suspensions (such as 0 NTU and a higher reference standard) were used to calibrate the device. To get rid of fingerprints and water droplets, a clean sample cell was rinsed with distilled water, filled with the liquid sample, and then thoroughly dried with a cloth. After the cell was properly positioned, the instrument chamber was covered with the light shield. The turbidity values were recorded in Nephelometric Turbidity Units (NTU) after the digital reading stabilized.

4. Result and Discussion

1) Spectrophotometer:

Table 1: UV Absorption Wavelength and Absorbance Values of Different Samples

Sr. No.	Sample	Wavelength (nm)	Absorbance(A)
1	Distilled Water	-	0
2	Plastic Bottle	275	0.568
3	Plastic Glass	272	0.512
4	Plastic Dronas	270	0.455
5	Polythene bags	268	0.365

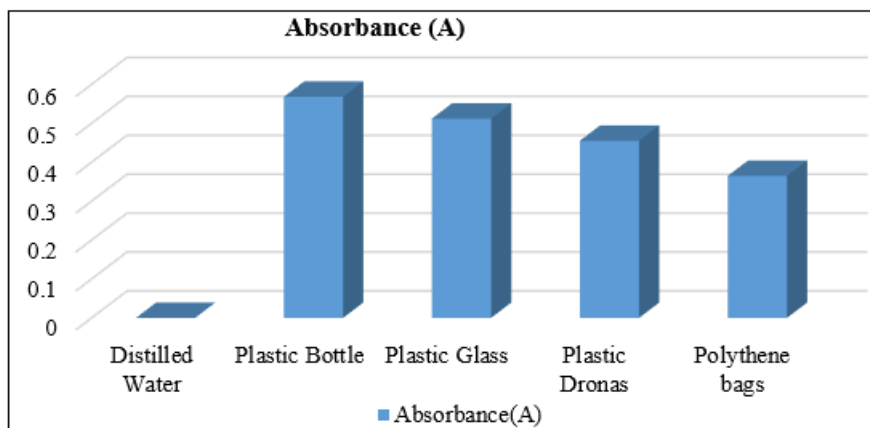


Figure 1: Comparison of UV Absorbance (260–280 nm) across Different Material Samples

The 260–280 nm ultraviolet (UV) band is highly characteristic for detecting the presence of organic compounds, aromatic rings, plastic additives (like plasticizers, stabilizers), and certain polymer types. Higher Absorbance = Higher Microplastic Content: A higher value means more light was blocked, signalling a greater quantity of suspended microplastic particles, nanoplastics, or leached chemical compounds in the sample. The Bottle sample consistently shows highest absorbance levels, peaking at 0.568 at 275 nm. This means it release more microplastics in water as compare to other samples while Polythene bag represents a lower relative abundance.

2) pH determination

The pH values range from 6.0 to 6.9, which are all slightly acidic to near-neutral. In the context of microplastic content analysis, changes in pH typically reflect chemical leaching, plastic degradation, or the presence of acidic impurities from the container materials.

Table 2: pH Values of Different Samples

Sr No	Sample	pH
1	Dist. Water	6.5
2	Plastic Bottle	6.8
3	Plastic Glass	6.9
4	Plastic Dronas	6
5	Polythene bags	6.7

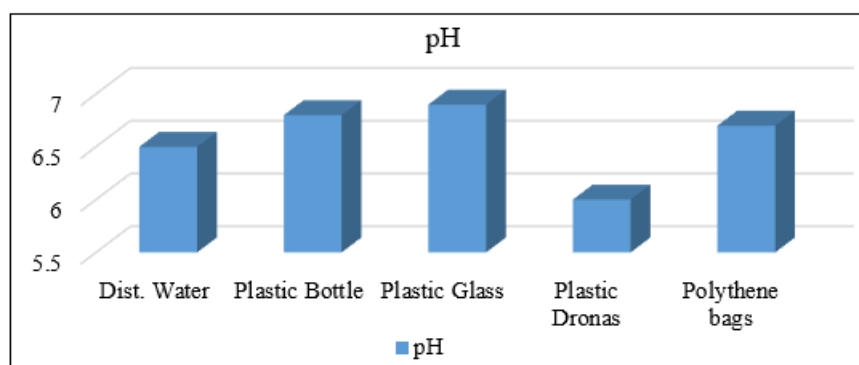


Figure 2: Comparison of pH across Different Material Samples

Most of samples are slightly acidic to near-neutral (6.0 to 6.9). Bottle (pH 6.8) & 3. Glass (pH 6.9) sample both show a pH closest to neutral. Glass (6.9) is the closest to being perfectly neutral. Dronas sample (6.0) is the most acidic sample among all, even more so than the distilled water reference (6.5). pH alone doesn't prove microplastics are present, it proves that the container (Plastic) is interacting chemically with the liquid. When plastics degrade due to heat, light, or mechanical stress, they can release acidic byproducts (like carboxylic acids) alongside microplastic particles, shifting the pH down.

3) Turbidity:

By using turbidity (measured in NTU) as an indirect indicator

of particle shedding. When pure distilled water (1.0 NTU) is stored in different containers for a long time, any increase in turbidity suggests that particles-potentially microplastics or chemical leachates have been released.

Table 3: Turbidity Values of Different Samples

Sr. No	Sample	Turbidity (NTU)
1	Dist. Water	1
2	Plastic Bottle	17.8
3	Plastic Glass	17.5
4	Plastic Dronas	14.8
5	Polythene bags	16.6

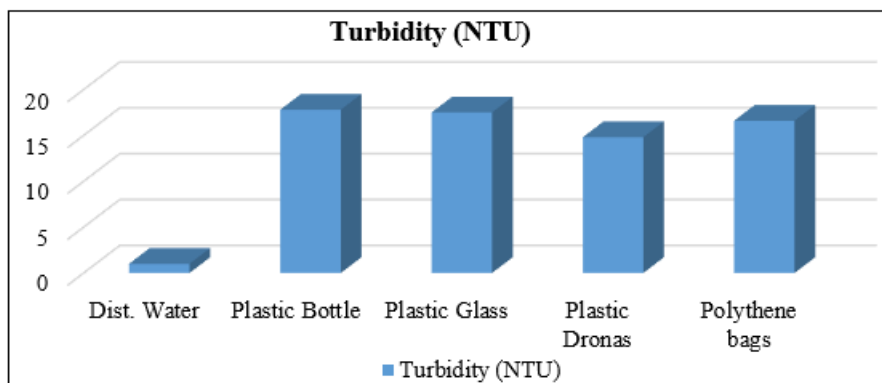


Figure 3: Comparison of Turbidity across Different Material Samples

The high turbidity confirms significant particle shedding. Because these are synthetic polymers, a massive portion of this turbidity is almost certainly **microplastic fragments or plasticizers** leaking into the water. The Plastic Bottle sample (17.8 NTU) and Plastic Glass sample (17.5 NTU) are having higher values of turbidity indicating much more suspended particulate matter than the standard water. Dronas is the clearest of the four test materials but is still significantly more turbid than distilled water.

4) Density

In microplastic analysis, density is the primary factor that

determines whether a plastic particle will float, remain suspended, or sink in a water body. Pure distilled water has a baseline density of $\sim 1.00 \text{ g/cm}^3$

Table 4: Density Values of Different Samples

Sr. No	Sample	Density (g/cm^3)
1	Dist. Water	1
2	Plastic Bottle	1.009
3	Plastic Glass	1.0078
4	Plastic Dronas	1.0082
5	Polythene bags	1.0078

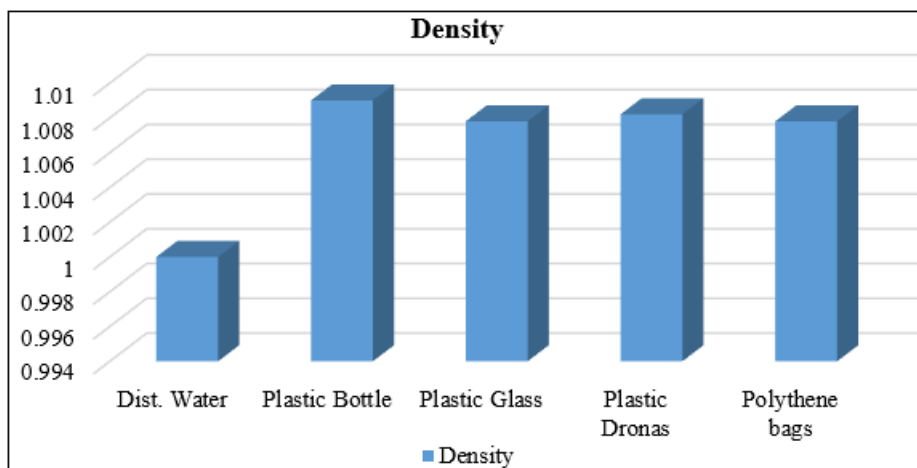


Figure 4: Comparison of Density across Different Material Samples

This sample has the **highest density**. Plastic bottles are typically made of PET (Polyethylene Terephthalate). When bottles degrade, they release microfibers and fragments that are heavier than water. The high density suggests a mix of heavy organic matter and plastic fragments. The water samples of plastic bottle (1.0090) showed the highest density among all samples.

Similarly, the densities of glass sample (1.0078), dronas (1.0082), and polythene (1.0078) were also slightly higher than distilled water. Overall, the density results show that storing water in different plastic materials causes only a slight increase in density, likely due to minor leaching of substances.

5) Viscosity:

The flow time of plastic dronas solution (27.63) was found to be the lowest among all samples meaning it has the lowest viscosity (1.0676 cP) behaves closest to pure water. This may

be because of less dissolved particles, allowing it to flow easily. The **Plastic Glass** sample takes the longest time to flow (36.74 seconds), giving it the highest internal friction and viscosity (1.3427 cP). The flow time values for bottle (34.16) and polythene (33.57) were also higher than distilled water. Overall, the results show presence of plastic particles and other matter may be responsible for higher viscosity than distilled water, indicating minor changes in water composition. Among all samples, glass showed the highest value, while dronas had the least effect.

Table 5: Relative Viscosity Values of Different Samples

Sr. No	Sample	Flow time (s)	Relative Viscosity
1	Dist. Water	27.63	1
2	Plastic Bottle	34.16	1.2475
3	Plastic Glass	36.74	1.34
4	Plastic Dronas	29.2	1.0655
5	Polythene bags	33.57	1.2244

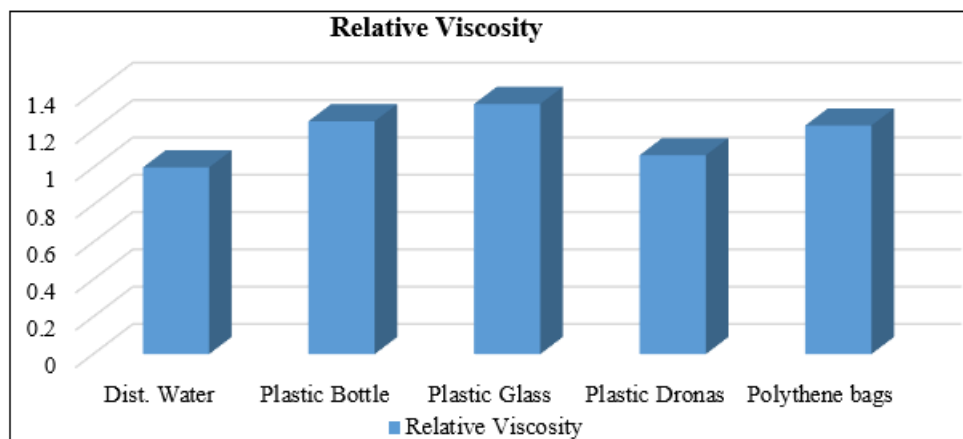


Figure 5: Comparison of Relative Viscosity across Different Material Samples

5. Conclusion

This study highlights the importance of understanding the physicochemical properties of plastics and their impact on water quality. The findings indicate that different plastic materials behave differently when in contact with water, and some may release harmful substances over time.

All plastic samples show measurable absorbance at wavelengths between 268 nm and 275 nm, confirming the leaching of organic chemical additives or microplastics into the water, with the Plastic Bottle displaying the highest level (0.568 A). The pH values remain mostly stable around a neutral range, though Plastic Dronas significantly lowered the water pH to a more acidic 6.0, indicating the release of acidic compounds. The plastic bottle proving a high concentration of suspended particulate matter (17.8 NTU). The structural properties of the water were noticeably altered; all plastic samples exhibited an increase in density. This physical alteration is further backed by prolonged flow times, causing the relative viscosity to spike significantly, peaked by the Plastic Glass at a relative viscosity of 1.3400. In summary, storing or exposing water to plastic items drastically degrades its quality by introducing chemical leachates and physical micro-impurities that change the liquid's fundamental fluid dynamics.

References

- [1] Li Y, Tao L, Wang Q, Wang F, Li G, Song M. Potential health impact of microplastics: a review of environmental distribution, human exposure, and toxic effects. *Environment & Health*. 2023 Aug 10;1(4):249.
- [2] Andrady AL. Microplastics in the marine environment. *Marine pollution bulletin*. 2011 Aug 1;62(8):1596-605.
- [3] Winiarska E, Jutel M, Zemelka-Wiacek M. The potential impact of nano-and microplastics on human health: Understanding human health risks. *Environmental research*. 2024 Jun 15; 251: 118535.
- [4] Haleem N, Kumar P, Zhang C, Jamal Y, Hua G, Yao B, Yang X. Microplastics and associated chemicals in drinking water: A review of their occurrence and human health implications. *Science of The Total Environment*. 2024 Feb 20; 912: 169594.
- [5] Pondala S, Botsa SM. Physical, thermal, chemical and biological approaches for plastics degradation—A review. *Cleaner Chemical Engineering*. 2025 Dec 1; 11: 100162.
- [6] Bhattacharya A, Kundu N, Yadav S, Aseri GK, Jain N. Physicochemical features of microplastics and their impact on the ecosystem with current research trends. *Sustainable Green Nanomaterials for Mitigation of Microplastics and Plastic Additives Pollution*. 2026 Jan 1:63-96.
- [7] Roslan NS, Lee YY, Ibrahim YS, Anuar ST, Yusof KM, Lai LA, Brentnall T. Detection of microplastics in human tissues and organs: A scoping review. *Journal of global health*. 2024 Aug 23; 14: 04179.
- [8] Zhou L, Ran L, He Y, Huang Y. Mechanisms of microplastics on gastrointestinal injury and liver metabolism disorder. *Molecular medicine reports*. 2025 Feb 18;31(4):98.
- [9] Thin ZS, Chew J, Ong TY, Raja Ali RA, Gew LT. Impact of microplastics on the human gut microbiome: a systematic review of microbial composition, diversity, and metabolic disruptions. *BMC gastroenterology*. 2025 Aug 13;25(1):583.
- [10] Kye H, Kim J, Ju S, Lee J, Lim C, Yoon Y. Microplastics in water systems: A review of their impacts on the environment and their potential hazards. *Heliyon*. 2023 Mar 1;9(3).
- [11] Pal D, Prabhakar R, Barua VB, Zekker I, Burlakovs J, Krauklis A, Hogland W, Vincevica-Gaile Z. Microplastics in aquatic systems: A comprehensive review of its distribution, environmental interactions, and health risks. *Environmental Science and Pollution Research*. 2025 Jan;32(1):56-88.
- [12] Issac MN, Kandasubramanian B. Effect of microplastics in water and aquatic systems. *Environmental Science and Pollution Research*. 2021 Apr;28(16):19544-62.
- [13] Westerhoff P, Prapaipong P, Shock E, Hillaireau A. Antimony leaching from polyethylene terephthalate (PET) plastic used for bottled drinking water. *Water research*. 2008 Feb 1;42(3):551-6.
- [14] Keresztes S, Tatár E, Czégény Z, Zárny G, Mihucz VG. Study on the leaching of phthalates from polyethylene terephthalate bottles into mineral water. *Science of the total environment*. 2013 Aug 1; 458: 451-8.
- [15] Binibor PI, Nwachukwu NA, Ndulue GU, Ndukwe DU, Ngwu AO, Usman OH. Investigating the effect of storage materials on the quality of potable water. *European Journal of Sustainable Development*

Research. 2025;9(3):2542-4742.

- [16] Matos T, Martins MS, Henriques R, Goncalves LM. A review of methods and instruments to monitor turbidity and suspended sediment concentration. Journal of Water Process Engineering. 2024 Jul 1; 64: 105624.