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MORALITY BEFORE KNOWLEDGE

Characterization and abundance of microplastics in coastal water pools: Composition, morphology, and environmental implications

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ABSTRACT
Background: Microplastic pollution has become a global problem which needs to be bewared of. Microplastics were distributed in various marine environments around the world, one of which is in the water column. **Findings:** The consumed microplastics by marine organism will reduce the intake of nutrients that should be obtained from food. The purpose of this study are (1) To identify microplastics that existed in water column, (2) To calculate microplastics abundance in the water column, (3) To know the types of microplastic polymers in the watercolumn. **Methods:** This study used purposive sampling method as the research method in determining the study's sampling point. The observation of microplastics in seawater was performed by visual identification method using the Stereomicroscope Euromax SB 1902. Plastic polymer analysis used FTIR Shimadzu Prestige-21 and reading polymer results used Open Specy. Statistical analysis used Oneway Anova test and T test using SPSS software. **Conclusion:** This study found microplastics in the Parepare's waters. The microplastics found in the Parepare's waters have the same characteristics in terms of color and shape. The color of the microplastic that dominates was blue and the shape of the microplastic that dominates was fiber, and for the size of microplastics were grouped into 4 sizes found at high tide and low tide, which were: <0.5 mm; 0.5-<1.0mm; 1.0-<2.5mm; and 2.5-5 mm. The highest average abundance microplastics at high and low tides was found in Lumpue waters at high tide in 8.34 Item/m^3 and at low tide in 6.12 Item/m^3. The types of polymers obtained are; Polyethylene terephthalate (PET), High Density Polyethylene (HDPE), and Low Density Polyethylene (LDPE). **Novelty/Originality of this article:** Microplastics in water pools pose a hidden environmental and health risk, as these tiny particles can accumulate from various sources and may carry harmful toxins, affecting both water quality and swimmers.

KEYWORDS: fourier transform infrared spectroscopy (FTIR) analysis; microplastics; parepare's open specy.

1. Introduction

Marine debris is a one of the factors that can change the a quality of waters caused by anthropogenic activities (Aspi & Bara'allo, 2013). One of the most common types of a waste found in land and sea areas is plastic waste. This is in accordance with the statement (Dias & Lovejoy, 2012) which states that plastic is one of the dominant types of waste. Marine debris is a solid, persistent material, produced or processed, and intentionally or unintentionally left in the marine environment (Browne et al., 2008). Marine debris comes in various forms. Marine debris has become a major and growing global problem, and is a

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threat to the sustainability of marine life (Chang, 2012). Plastic is the main component of marine debris, with single-use packaging increasing the share of the global marine debris burden (Tahir el al., 2018). Every country, both developing and developed countries, has the biggest environmental problem, namely plastic waste pollution (Datu, 2019). The continuous entry of plastic into the sea accompanied by low degradation capacity that reaches tens to hundreds of years and inadequate waste management causes plastic waste to accumulate in the marine environment (Afdal et al., 2019). It can be said that plastic is now part of modern life, found every day in the form of food and beverage packaging, in household goods (Eriksen et al., 2014). Plastic is widely used because it is lightweight, durable and cheap. However, because it is durable, it will be a problem when disposed of incorrectly, resulting in long-term accumulation in the environment. The plastic waste is then fragmented/degraded into microplastics that have a diameter of 500 μm−5 mm (Hidalgo-Ruz et al., 2012) and forms of microplastics such as fragments, foam, film, line, pellets (GESAMP, 2019).

Plastic pollution has a wide impact, including human health, economy, tourism and beach aesthetics (Thompson et al., 2009). Microplastic pollution in waters can have negative impacts, especially for organisms in the ocean, the physical effects of microplastics can be seen when microplastics are at high concentrations (Fischer et al., 2016). Consumption of microplastics by organisms in the ocean results in reduced nutritional intake that should be obtained from food. This results in low energy reserves owned by organisms (Duis & Coors, 2016). Having a small size in waters allows microplastics to be easily carried by currents and waves so that they are trapped in ecosystems in marine waters, one of which is the seagrass ecosystem (Hafidh et al., 2018). The finding of microplastic particle contamination at different seagrass cover percentages was carried out by Tahir et al. (2019), clearly showing the potential for microplastics to enter through the food chain. As we know, humans often consume seafood, for example fish, from there microplastics can enter the human body. Microplastics contain many hazardous compounds such as PCBs, metals, and PBDEs, where these compounds have dangerous effects if accumulated in the human body (Grossman, 2016). Therefore, microplastic pollution has become a global problem that needs to be watched out for (Hutabarat & Evans, 1984). The distribution of microplastics in various marine environments around the world, one of which is in the water column. The waters of Parepare City have a high potential for contamination by microplastics, with a coastline of 11.5 km (Djamaluddin, 2007) various human activities both on land and at sea including ports, tourism, maritime, which can indirectly produce plastic waste. However, information about the presence of microplastics in the water column of Parepare City can be said to be still minimal. Based on this background, a study was conducted to determine the presence of microplastics in the water column in the waters of Parepare City.

2. Methods

This research was conducted on October 24, 2020, located in the waters of Parepare City, South Sulawesi. Sample preparation and analysis were carried out at the Marine Ecotoxicology Laboratory and the Chemical Oceanography Laboratory, Marine Science Study Program, Faculty of Marine Sciences and Fisheries, Hasanuddin University. Furthermore, FTIR (Fourier Transform Infra Red) Spectroscopy was carried out at the Integrated Chemistry Laboratory, Chemistry Study Program, Faculty of Mathematics and Natural Sciences, Hasanuddin University, Makassar.

Table 1. Tools used and their functions

Tools	Function
Cool box	To store water samples
Petri Dish	To media to observe samples
Microscope	To identify microplastics
ATK	Stationery
Drop pipette	To take/move liquids

GPS (Global Position System)	To take sampling coordinate points
Camera	To document research activities
FT-IR (Faourier Transfrom Infrared)	To determine the type of polymer in microplastic samples
Centrifuge tube	To store filtered samples
Iron Bucket	To store water samples
Kemmerer water sampler	To take seawater samples
Buchner funnel	To containers to filter seawater samples
Vacuum pump	To speed up filtering
Manta-net mesh size 100 µm	To filter water

A tool is an object or device used to make human work easier in various fields. Each tool has a specific function, such as a hammer to hit nails or scissors to cut objects. The development of technology has created various sophisticated tools that increase work efficiency and accuracy. In industry, heavy equipment such as excavators and bulldozers are used to assist in construction work. Proper use of tools and routine maintenance can extend their service life and maintain optimal performance.

Then, quality raw materials greatly determine the final result of a product. Each type of material has different characteristics, so it must be selected according to needs. In the food industry, the selection of fresh and hygienic materials is very important to maintain product quality and safety. Building materials such as cement, sand, and bricks must meet standards so that the construction is strong and durable. Innovation in the use of environmentally friendly materials is growing to support industrial sustainability.

Table 2. Materials used and their functions

Materials	Function
Whatman filter	To filter water samples
KOH 10%	To dissolve organic materials
Tape	To mark samples
Tissue roll	To dry tools
Aquades	To sterilize tools
Sea water	As a sample
Sample bottle	To store water samples

2.1 Preparation stage and determination of sampling location points

The preparation stage includes consultation about this research and an initial survey to determine the research location. Then conducting a literature study on the research conditions, and determining the methods to be used during the research conducted in the field or in the laboratory. Determination of the location point for seawater sampling refers to the condition of the surrounding area, using the purposive random sampling method. The distance between station 1 to station 2 is around 1.9 km, and the distance between station 2 to station 3 is around 5.7 km. Station 1 is a location for trading activities, community settlements, and there is also the Parepare BBM Terminal (TBBM). Station 2 is a location around which there are port activities, trade, and community settlements. Meanwhile, Station 3 is a tourist location around which there are community settlements. The waters of Parepare City are in the bay area where stations 1 and 2 are inside the bay and station 3 is outside the bay.

Furthemore, seawater sampling: Seawater sampling was carried out at 3 (three) stations. Each station was repeated 5 times for water sampling. Seawater sampling was carried out during high and low tide, with a schedule using secondary data from the Meteorology, Climatology, and Geophysics Agency (BKMG). Seawater sampling was carried out by taking seawater samples using Kemerrer Water. Samples with a volume of 2 liters were put into an iron bucket 5 times, so that the volume of water taken was 10 liters. Furthermore, the seawater sample was poured into a Manta-net (mesh size 100 µm). The water in the cod-end was put into a sample bottle and then dripped with 3-5 drops of 10% KOH, then put into a cool box, and taken to the laboratory for analysis. Measurement of physical oceanography parameters. Current: Current speed measurements are carried out using a current kite, namely by determining the distance traveled by the kite (5 meters) then calculating the travel time of the current kite and looking at the wind direction and degrees on the compass. This measurement is carried out three times for each station. The formula for determining current speed is (Najemia, 2019):

$$V = \frac{s}{t} \quad \text{(Eq. 1)}$$

In the context of kite movement, the current speed (V) is calculated based on the length of the kite string (s) and the travel time of the kite (t). Speed (V) indicates how fast the kite moves in meters per second (m/s). The length of the kite string (s) is measured in meters (m) and reflects how far the kite can move from its anchor point. The travel time (t) in seconds (s) represents the duration required for the kite to cover a certain distance. Using these parameters, kite movement can be further analyzed under various wind conditions and altitudes.

To complete the current data from field measurements, secondary data is used. Tides: Tide measurements are carried out using the Doodson Method. Manual tidal measurements use a scaled pole that is attached to the pier pole with the smallest scale of 1 cm. Measurements are taken every 30 minutes, with a measurement duration of 39 hours. Then record the measurement time, peak tide, middle tide, and low tide every 30 minutes. Calculations using the Doodson method formula, namely (Armos, 2013):

$$MSL = \frac{\sum fi \times Hi}{\sum fi} \quad \text{(Eq. 2)}$$

The formula for calculating the Mean Sea Level (MSL) can be expressed by considering the multiplication factor from the Doodson Table and the sea level heights at specific observation points. In this context: MSL (Mean Sea Level) refers to the average sea level over a specific period. fi (Multiplication Factor I) is a factor obtained from the Doodson Table, used to calculate the contribution of each tidal component to the sea level height. Hi (Sea Level Height i) represents the sea level height in centimeters (cm) at a specific observation point. By considering these factors, MSL can be calculated as part of tidal analysis to determine trends in sea level changes in a given region. To complement the tidal data from field measurements, secondary data is used.

2.2 Microplastic observation in water samples

Prepare the tools and materials used, previously wearing a mask and gloves as aseptic personal equipment. Insert Whatman filter paper with pores measuring 0.45 µm with a diameter of 47 mm into the Buchner funnel using tweezers. Connect the vacuum pump to a power source. Next, insert the seawater sample little by little into the vacuum pump. After all the seawater samples have been filtered, unplug the vacuum pump from the power source. Then, remove the Whatman filter paper, place it in a petri dish for microplastic observation with a stereo microscope.

After going through the filtration process, the next step is to observe the sample by taking a Whatman filter that has been placed in a petri dish, then observing the sample under a macroscope. This observation is carried out until the sample runs out. In the process of observing the microplastic image documented using a camera, the observation results are recorded, both the shape, color and size of the microplastic. After that, the microplastic particles that have been found are placed on a glass slide and covered using a cover glass, for the purpose of analyzing the type of polymer, this is done so that the microplastic particles are safe and not blown away by the wind, considering the particles are very small and light. To provide a scalebar on the image results, the ImageJ application is used. Furthermore, to determine the type of polymer from the microplastic, a test is carried out using an FTIR spectrophotometer.

2.3 Fourier transform infrared spectroscopy (FTIR) analysis

Analysis of plastic polymers using the Shimadzhu Prestige-21 Fourier-Transform InfraRed Spectroscopy (FTIR) Analysis tool. FTIR is one of the measurement methods to detect the molecular structure of compounds through the identification of functional groups that make up the compound. FTIR is one of the instruments that is widely used to determine the vibration spectrum of molecules that can be used to predict the structure of chemical compounds. This tool works by measuring the amount of absorbance at different IR Infrared wavelengths to find molecular vibration information, the value of this molecular vibration will later provide information about the molecular structure. The infrared absorption band is very distinctive and specific for each type of chemical bond or functional group (Vigren, 2015). To identify functional groups using the FTIR tool, namely, it is done by placing the microplastic sample into a container, then placing and mixing the sample with KBr crystals, then making KBr pellets (KBr pills) with a mini hand press tool. After the KBr pill is formed, the sample is ready to be analyzed and measured using an FTIR spectrophotometer at a wave number of 340-4500 cm-1 with a resolution of 4 and a scan count of 200 (Dachrianus, 2004). To determine the type of polymer from the microplastic sample obtained, the initial step that needs to be taken is to identify the absorption of each chemical bond at each wave number value (Table 3).

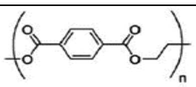
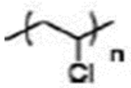
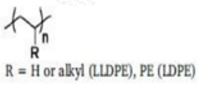
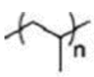
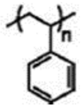
Table 3. List of wave numbers of various types of bonds

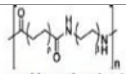
Wave Number (cm-1)	Types of Bonds
3750-3000	O-H, N-H stretch
3000-2700	stretch -CH3, -CH2-, C-H, C-H aldehydes
2400-2100	stretch -C≡C-, C≡N
1900-1650	C=O stretch (acids, aldehydes, ketones, amides, esters, anhydrides)
1675-1500	C=C stretch (aromatic and aliphatic), C=N
1475-1300	C-H bending
1000-650	C=C-H, Ar-H bending

(Dachrianus, 2004)

After identifying the type of bond, the next step is to match the type of bond obtained with the type of bond in each polymer (Table 6).

Table 4. List of interpretations of chemical bond values for various types of polymers

Polymer	Chemical Structure	Absorption (Wave Value)	Chemical Bonds
Polyethylene terephthalate(PETE)		1713, 1241, 1094, & 720	C═O stretch, C─O stretch, C─O stretch, & CH Aromatic
High-densyty polyethylene (HDPE)		2915, 2845, 1472, 1462, 730, & 717	C─H stretch, C─H stretch, CH2 bend, CH2 bend, CH2, & CH2
Polyvinyl chloride (PVC)		1427, 1331, 1255, 1099, 966, & 616	CH2 bend, CH bend, CH bend, C─C stretch, CH2, & CH stretch
Low-density polyethylene (LDPE)		2915, 2845, 1467, 1462, 1377, & 730	C─H stretch, C─H stretch, CH2 bend, CH2 bend, CH3bend, & CH2
Polypropylene (PP)		717, 2950, 2915, 2838, 1455, 1377, 1166, 997, 972, 840, & 808	CH2, C─H stretch, C─H stretch, C─H stretch, CH2 bend, CH3 bend, C─Cstretch, CH bend, C─C stretch, C─CH3strerch, & C─C stretch
Polystyrene (PS)		3024, 2847, 1601, 1492, 1451, 1027, 694, & 537	Aromatic, C─H strectch, C─H strectch, Aromatic ring, Aromatic ring, CH2 bend, Aromatic CH bend, Aromatic CH bend, & Aromatic ring

Nylon	 r and b vary from 0 to 12 based on monomer type	3298, 2932, 2858, 1634, 1538, 1464, 1372, 1274, & 1199	N—H strectch, C—H strectch, C—H strectch, C═O strectch, C-N bend, CH2 bend, CH2 bend, C—N strectch, & CH2 bend

(Jung, 2018)

2.4 Data analysis

K represents the abundance of microplastics in units of particles per cubic meter of water (items/m^3). The value of K is obtained by dividing the number of microplastic (MP) fragments found in a water sample by the volume of water (ℓ) used in the test. In other words, K indicates how many microplastic particles are present in each cubic meter of analyzed water. This value is essential for understanding the level of microplastic pollution in a body of water and serves as an indicator of the aquatic environmental quality. Microplastic Abundance (items/m3) (Marine Debris Program, N. (2015) :

$$K = \frac{MP}{l} \quad \text{(Eq. 3)}$$

In this study, the data analysis used was the OneWay Anova Test to compare the average abundance of microplastics between stations, the Paired T Test to compare the average microplastics at high and low tide. Levene's test to see h0 = the same variance (p>0.05), ha = different variance (p<0.05). If the results are the same variance (p>0.05) then the data obtained will be continued with the test above. However, if the obtained ha = different variance (p<0.05) then the ha value is transformed into log h0 and can then be continued with the test above. If the results are still ha = different variance (p<0.05) then a Non-Parametric test is carried out with the Mann-Whitney Test.

3. Result and Discussion

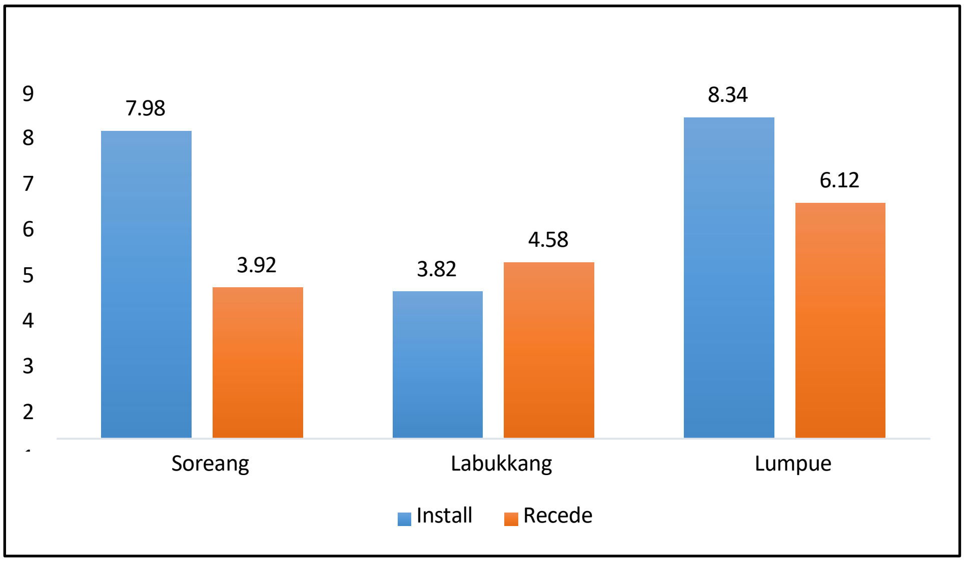
Parepare City borders Pinrang Regency to the north, Sidrap Regency to the east, Barru Regency to the south and the Makassar Strait to the west. The area of Parepare City is recorded as 99.33 km2 which includes 4 sub-districts, namely Bacukiki, West Bacukiki, Ujung and Soreang Districts and has a population of 143,710 people (BPS Parepare, 2019). Sampling was carried out on October 24, 2020 when the sea water was receding at around 08:32-11:36 WITA and when the sea water was high tide at around 13:14-16:38 WITA, sampling was carried out at 3 stations, namely Soreang waters, Nusantara Harbor waters, Lumpue waters.

Table 5. Overview of the research location

Station	Location	Information
1.	Soreang Waters	Located in Soreang sub-district, Soreang waters are the location of trade activities, community settlements, and there is also the Parepare BBM Terminal (TBBM). The distance between Soreang waters to the harbor waters is around 1.9 km, and the distance between the harbor waters to Lumpue waters is around 5.7 km
2.	Labukkang Waters	Located in Labukkang sub-district, Labukkang waters are a location surrounded by port activities, trade, and settlements. The distance between the port waters and Lumpue waters is around 5.7 km
3.	Lumpue Waters	Located very far from 3 other stations, Lumpue Waters is a tourist location surrounded by residential areas. There is a lot of garbage that is thought to be the result of the use of people who are visiting the Lumpue Beach tourist location or household waste from residential areas.

3.1 Microplastics in the water column in Parepare City waters

With the number of water samples collected at 3 stations totaling 30 bottles covering sampling at high tide and low tide. The highest abundance of microplastics at high tide was found in Lumpue waters with an average abundance of 8.34 Items/m3, and the highest abundance of microplastics at low tide was also found in Lumpue waters with an average of 6.12 Items/m3 (Figure 1).



Fig, 1. Abundance of microplastics in water at high and low tide.

Based on the results of the study of the characteristics of microplastics in the water column in the Parepare City Waters with 3 sampling stations, they have the same characteristics both at high tide and low tide (Figure 2), the dominant color is blue. Based on the research results, there are three forms of microplastics found, namely fiber, fragments and films. The most common form of microplastic found both at high tide (Figure 2) and low tide (Figure 3) is fiber, followed by the form of film type microplastics, and the lowest percentage of microplastic forms is fragments.

The bar chart (Figure 3) shows the percentage composition of different microplastic forms found in seawater at low tide across three sampling points. Series1, which likely represents fibers or fragments, consistently dominates the composition at all points with values above 70%, while Series2 and Series3 show much lower percentages. Notably, Series3 decreases from point 1 to point 3, while Series2 slightly increases, suggesting a variation in microplastic type distribution along the sampling area.

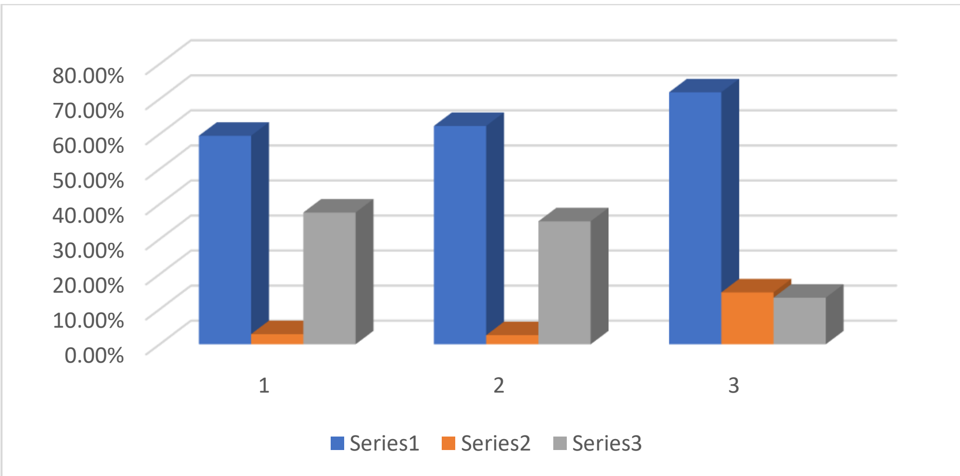


Fig. 2. Composition of microplastic forms (%) found in seawater during high tide.

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The graph illustrates the percentage composition of different microplastic forms found in seawater at low tide, represented by Series1 (blue), Series2 (orange), and Series3 (gray) across three sample points. Series1 consistently shows the highest proportion, increasing from around 75% at point 1 to about 90% at point 3. In contrast, Series2 shows a slight increase, while Series3 gradually declines, indicating a shift toward dominance of one microplastic type over others in the sampled areas.

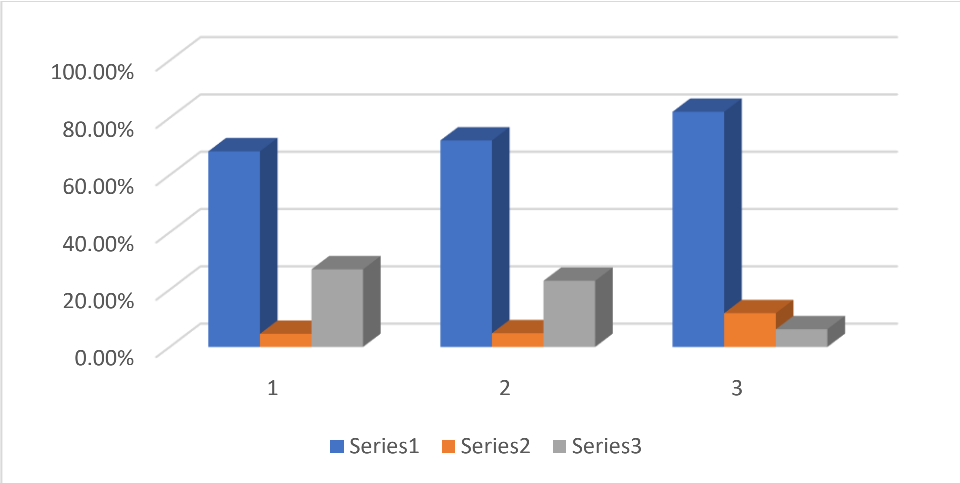

Fig. 3. Composition of microplastic forms (%) found in seawater at low tide

The results of observations of microplastics in the water column in the waters of Parepare City with a line shape and dominant blue color (Figure 4)

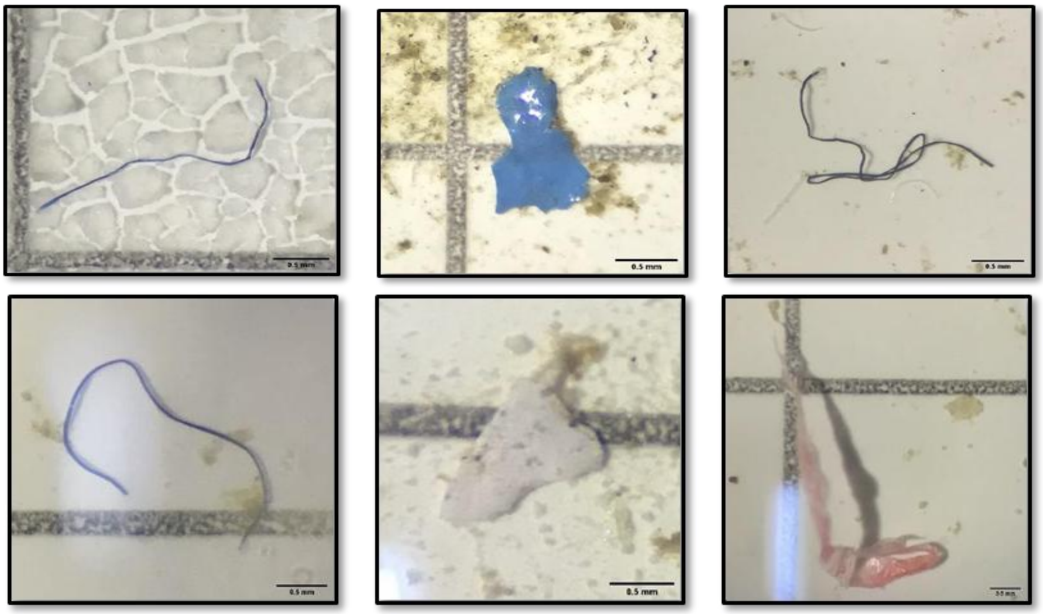

Fig. 4. Microplastics in the water column in Parepare City Waters

3.2.3 Microplastic size

From the results of observations that have been carried out at high tide there are 1,007 items and at low tide there are 730 microplastic items found at three different stations where each station was repeated 5 times, with a size range of 0.5 - 5 mm. The size of microplastics that dominate from Soreang waters to Lumpue waters at high tide and low tide is in the range of 1.0 - <2.5 mm. The size of microplastics 1.0 - <2.5 mm is the size that has the largest percentage, while the percentage of microplastics with the lowest size is <0.5 mm (Figures 7 and 8).

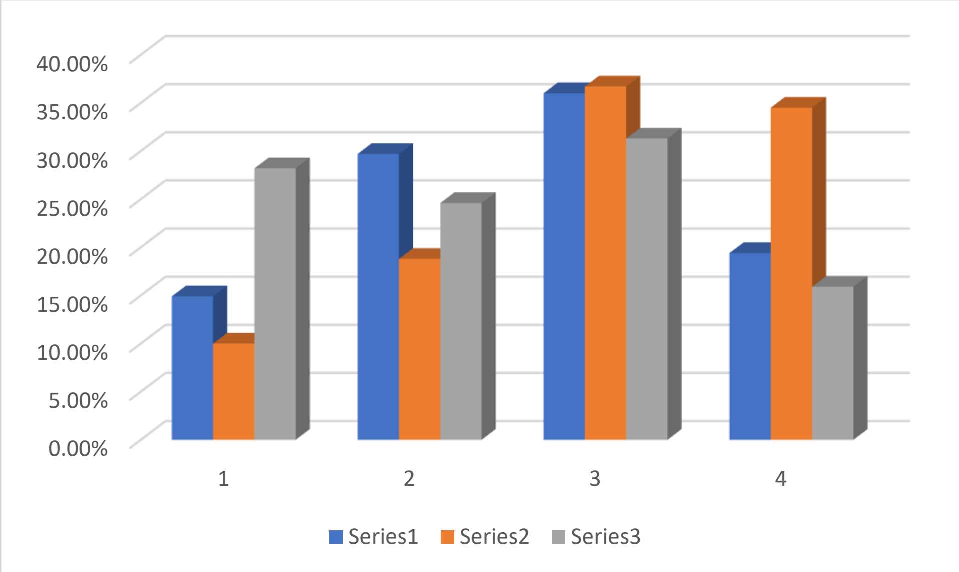

Fig. 5. Composition of microplastic sizes (%) found in seawater during high tide

The chart displays the percentage composition of various microplastic sizes found in seawater at low tide across four sampling points. At point 3, all size categories (Series1, Series2, and Series3) peak, with Series3 being the highest at nearly 50%. Meanwhile, point 1 shows the lowest values for all three series, suggesting that microplastic size distribution increases up to point 3 before dropping again at point 4.

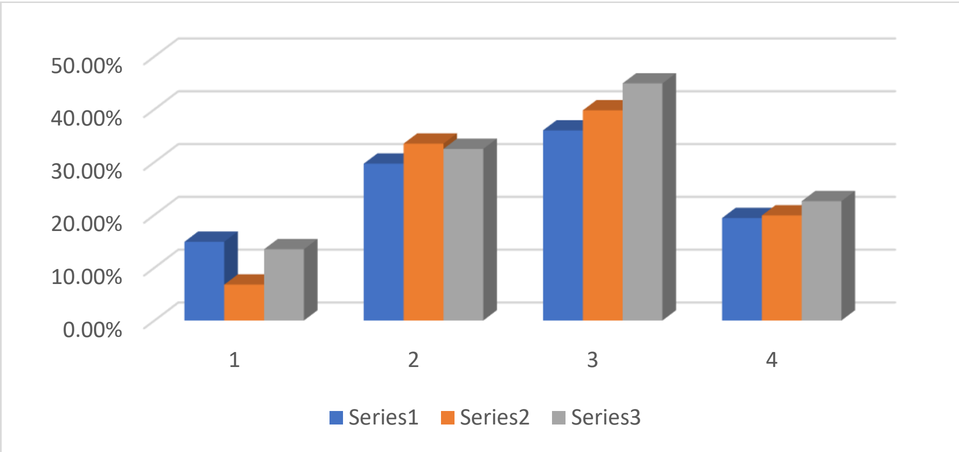

Fig. 6. Composition of microplastic sizes (%) found in seawater at low tide.

3.2.4 Current and ups-down

Based on the results of a current measurements at 3 stations using current kites, the current speed at high tide ranged between 0.08 – 0.19 m/s, and the current speed at low tide ranged between 0.03 – 0.14 m/s.

Table 6. Current speed

Current Speed (m/s): Soreang Waters	Current Velocity (m/s): Harbor waters	Current Speed (m/s): Lumpue Waters
High (0.19) & Low (0.14)	High (0.15) & Low (0.07)	High (0.08) & Low (0.03)

Based on secondary data, the tidal prediction on September 21-22 2020 shows that the tidal type in the waters of Parepare City is a Semi-Diurnal tidal type.

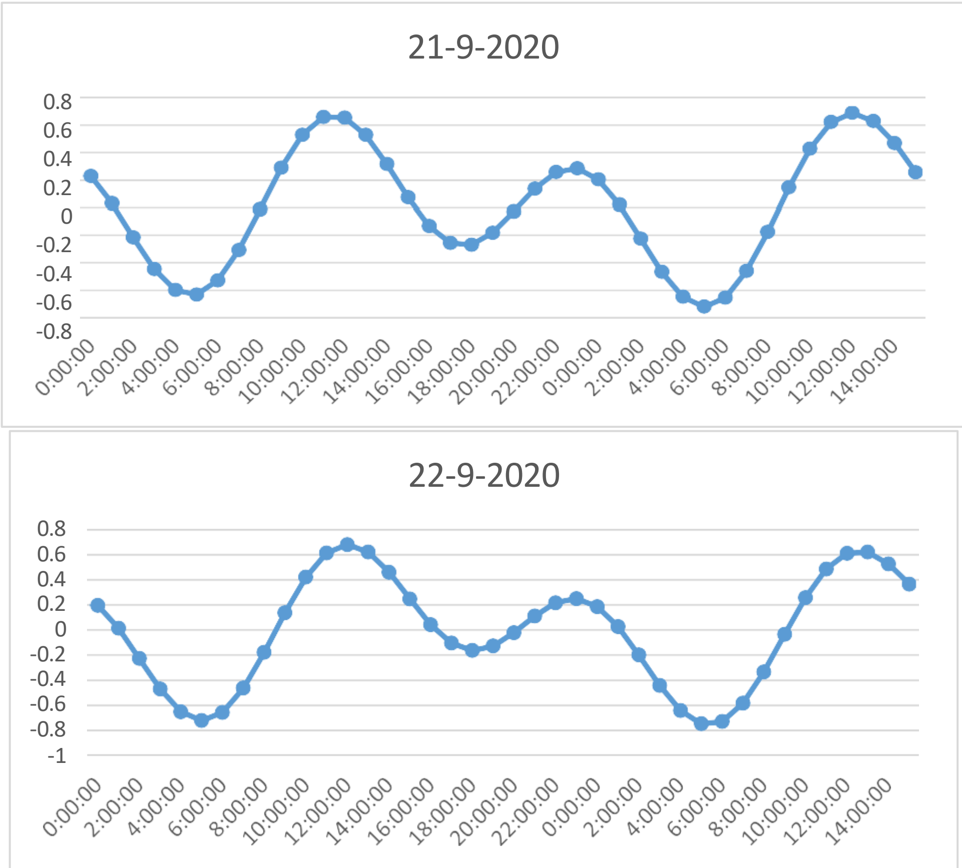

Fig. 7. Prediction graph of tidal data for Parepare Waters 21-22 September 2020

3.3 FTIR analysis results of microplastics

Based on the results of the interpretation of the wavelength of microplastic samples, from a total of 7 samples analyzed, 3 types of polymers were found, namely, Polyethylene terephthalate (PET), Low density polyethylene (LDPE), High-density polyethylene (HDPE). The most common polymer type found was PET at 71% (n = 5), and the LDPE polymer type at 14% (n = 1) the same as HDPE which was found at 14% (n = 1).

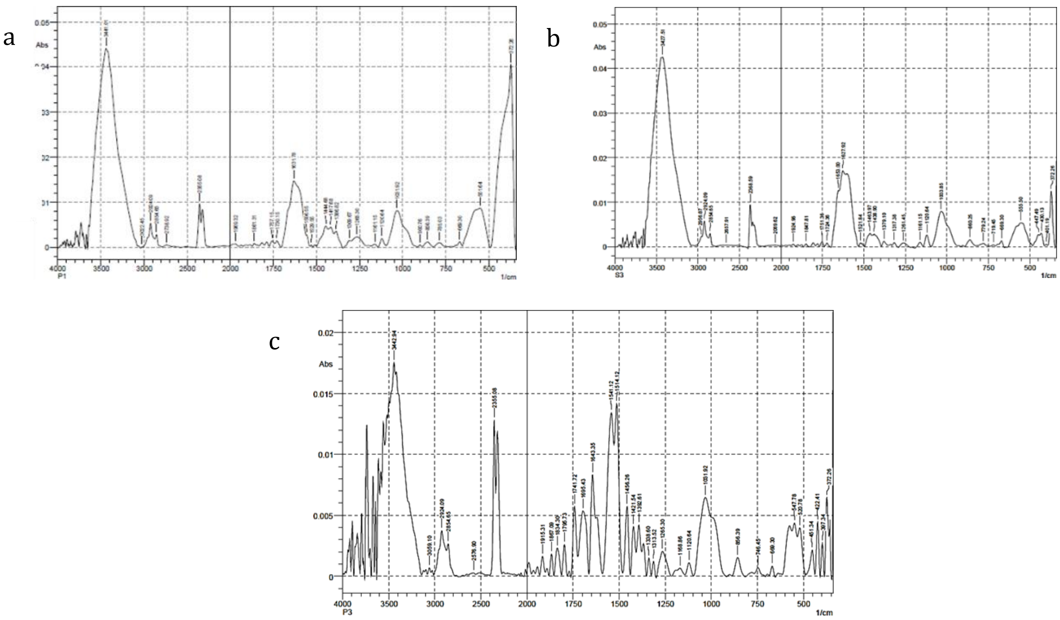

Fig. 8. FTIR results that have a wavelength match with (a) PET polymer; (b) LDPE polymer; (c) HDPE polymer

3.4. Location overview

Based on the results of observations in the waters of Parepare City, the most dominant waste was found to be plastic waste which was seen on the beach up to about 200m from the beach. The majority of people around the sampling station work as fishermen using nets and boats. In the coastal area and about 100m from the shoreline of the Soreang waters, a lot of plastic waste was found such as bottles, used food plastic, styrofoam, nets, cloth, plastic sacks, broken household appliances, and pieces of fishing boats made of fiber plastic (Kuhn et al., 2015). In the Labukkang waters, there were several plastic wastes that were seen floating such as bottles, used plastic/food packaging, and styrofoam (Manaw, 2017).

Similar to the other two stations, the Lumpue waters also found dominant plastic waste such as styrofoam, used food and beverage plastic, fishing nets were also found because some people around the Soreang waters also work as fishermen (Moos et al., 2017). Although each sampling location has a public waste disposal site, there are still many people who are not disciplined in handling their respective waste, so that there is still a lot of floating waste in the waters of Parepare City. According to Mandasarari (2014), the types of waste that are often found on the coast are glass waste, used plastic/food packaging, fishing nets, sacks and carpets, and cloth.

3.5 Abundance of microplastics in the water column in Parepare City waters

The total microplastics found in the water column in this study at high tide were 1,007 items and at low tide there were 730 microplastic items found from three different stations where each station was repeated 5 times (Appendix 5). Based on the results of the study, the highest average abundance of microplastics at high tide was found in Lumpue waters at 8.34 Items/m3 and the lowest abundance of microplastics at high tide was found in Labukkang waters at 3.82 Items/m3. While the highest abundance of microplastics at low tide was found in Lumpue waters at 6.12 Items/m3 and the lowest abundance of microplastics at low tide was found in Soreang waters at 3.92 Items/m3 (Appendix 4).

To see the comparison of the average abundance of microplastics between stations, a One Way Anova test was carried out to compare the average abundance of microplastics between stations and a paired T test to see the average abundance of microplastics at high tide and low tide. Based on the results of the One Way Anova test at high tide the sig value = 0.000 (Appendix 8), at low tide the sig value = 0.081 (Appendix 8). Based on the test results at high tide the sig value <0.05, indicates a significant difference in the abundance of microplastics between the three stations at high tide, while at low tide the sig value >0.05, indicates no difference in the abundance of microplastics between the three stations at low tide. Based on the results of further tests (Post Hoc Test), it is known that there is a significant difference in the abundance of microplastics at high tide in the port waters, this is influenced by the location of the study in the Soreang waters area which has a deeper water depth than the other two stations, so that microplastics in the water depth are trapped. Based on the results of the paired T Test with a sig value = 0.256 (Appendix 9) there is no significant difference in the average abundance of microplastics at high tide and at low tide. The high tide and strong current conditions cause the volume of seawater to enter and clean the microplastic particles in the water column at the time of sampling, so that there are fewer microplastic particles found in the waters of Soreang (NOAA, 2016). In a study conducted (Azizah, et al., 2019) explained that strong currents will more easily transport microplastic particles in the water column to move to another place.

The high abundance of microplastics in this study is suspected because the area around the waters is a tourist spot that can cause pollution unintentionally (Nontji, 2017). These results show the significance of the research location and the abundance of microplastics obtained (Nur & Obbard, 2014). Around the waters of Lumpue, there is a river that is connected to the coast, so that waste that is dumped into the river will be carried to the sea (Seltenrich, 2015). Waste carried through river water mostly comes from household waste (Rochman et al., 2015). Several studies in other places have shown a higher average value of microplastic abundance than in Parepare Waters, such as Jakarta Bay and Banyuurip Waters. It is suspected that the waters of Jakarta Bay and Banyurip Waters are areas with many Anthropogenic activities that cause high potential for microplastic pollution from various sources. However, in Benoa Bay, the average value of microplastic abundance is lower than the average value of microplastic abundance in Parepare Waters.

Table 7. Abundance of microplastics found in previous studies

Location	Microplastic Amount (Particles/m3)	Reference
Parepare Waters (High Tide)	3.82 – 8.34	Author's research
Parepare Waters (Low Ebb)	3.92-6.12	Author's research
Benoa Bay, Badung Regency, Bali	0.43-0.58	Nugroho et al,. 2018
Jakarta Bay, Jakarta	1822-2578	Setyowati, 2021
Banyuurip Waters, Gresik Regency, East Java	57.11	Ayuningtyas et al., 2019

3.6 Color, shape, and size of microplastics in the water column in Parepare City waters

Characteristics of microplastics in the water column in Parepare City Waters with 3 microplastic color sampling stations found in this study were blue, black, red, white, and clear. The results of this study have the same color characteristics both at high tide and low tide (Figure 3). The highest percentage of microplastic color is blue, both at high tide and low tide. The blue microplastic color in Parepare City waters is thought to come from the original color from clothing threads, leftover washing water, and human anthropogenic activities (Setyowati, 2021). In the study (Castro et al. 2016) found as much as 60% of blue microplastics in water samples. In terms of the color of the microplastics that are still found to be concentrated, it means that the microplastics have not experienced a major color change (discolouring) (Hiwari, 2019).

Based on the results of this study, three forms of microplastics were found, namely fiber, fragments and films. The form of microplastics that is most commonly found both at high tide and low tide is fiber, followed by the form of film type microplastics, and the lowest percentage of microplastic forms is fragments. This can be seen from the composition of microplastic forms (%) in Figure 4 and Figure 5. The highest fiber microplastics at high and low tide are in Soreang waters with a percentage at high tide of 71.9%, and at low tide of 82.1%. The type of fiber found with the highest percentage in this study is thought to be due to the large number of fishing activities such as fishing using various fishing gear which causes a high percentage of fiber microplastics (Tankovic, 2015). This is supported by a study (Hiwari et al. 2019) which states that fiber microplastics were found as much as 63% on Nembrala Beach. There are several possibilities that fiber microplastics are the most due to the influence of anthropogenic activities (Tejakusuma, 2011).

Fiber comes from synthetic fabrics or fishing nets. Fishermen's activities such as fishing using various fishing gear, most of which are used by fishermen come from ropes (fiber type) or plastic sacks that have undergone degradation (Widianarko & Hantoro, 2018). In addition, fiber microplastics that enter the aquatic environment can also be produced from wastewater from washing clothes (Nor and Obbard, 2014). The second type of microplastic that is often found is the film type, which comes from plastic bags and other food packaging that tends to be transparent and degraded (Claessens et al., 2011). It is suspected that it is the main contributor to plastic food packaging waste that is thrown into coastal waters (Wisha & Heriati, 2016). This type of film can come from plastic bags that have a fairly low density so that they are easily broken down into small pieces (A'yun, 2019).

The lowest type of microplastic found in this study was fragments (Wright et al., 2013). These microplastics were found to come from pieces of beverage and food bottles, plastic gallons, used pipes from the activities of the surrounding community that were thrown into coastal waters (Zettler et al., 2013). Fragment type microplastics have a low density so that they can easily break down in waters (Hildago-Rus et al., 2012). From the results of observations that have been carried out at high tide there are 1,007 items and at low tide there are 730 microplastic items found from three different stations where each station was repeated 5 times, with a size range of 0.5 - 5 mm. The size of microplastics that dominate the waters of Soreang-3 at high tide and low tide is in the range of 0.5 - 5 mm. The size of microplastics 1.0 - <2.5 mm is the size that has the largest percentage, while the percentage of microplastics with the lowest size is <0.5 mm. The percentage of microplastic sizes can be seen in Figures 7 and 8. The longer the age of plastic in sea waters, the more degradation will occur so that it becomes smaller particles (Pan et al., 2019).

3.7 FTIR analysis results of microplastics

In this study, observations were also made using FT-IR. The study conducted with FT-IR was not for all existing samples, only taking a few samples to identify the type of polymer using FT-IR. To read the results of the wavelength is to compare the similarity of the spectrum with the library or table of the FT-IR analysis instrument. From these results it is known that the identified microplastics obtained several types of polymer spectra. Based on the results of this study using FT-IR analysis, it shows a spectrum that has a high level of similarity with several types of polymers, namely Polythelyene therapthalate (PET) 71% (n = 5), High Density Polyethylene (HDPE) 14% (n = 1), and Low Density Polyethylene (LDPE) 14% (n = 1). Polythelyene therapthalate (PET) polymer obtained in this study is a type of plastic that is relatively thin, smooth and transparent. Polythelyene therapthalate (PET) type polymers are also used as basic materials for making bottles or packaging glasses, binders, and textiles (Lusher, 2017).

For High Density Polyethylene (HDPE) polymers, this is a type of plastic that has a long time to decompose. HDPE is a material that is resistant to high temperatures, stronger, harder and opaque (Harumningtyas, 2010). High Density Polyethylene (HDPE) is usually used in the manufacture of plastic trash cans, cosmetic containers, milk bottles, medicine bottles, and children's toys (Abdillah & Hisbullah, 2017). Low Density Polyethylene (LDPE) polymers are a type of plastic that has a low density, is flexible, slightly translucent, and has a slightly slippery surface. The application of this type of polymer is widely used in plastic bags (Gesamp, 2015).

4. Conclusion

Based on the results of the research that has been conducted, it can be concluded that: Microplastics were found sampling stations in the waters of Parepare City. The highest average abundance of microplastics at high tide was found in Lumpue waters at 8.34 Items/m3 and the lowest abundance of microplastics at high tide in Labukkang waters at 3.82 Items/m3. While the highest abundance of microplastics at low tide was found in Lumpue waters at 6.12 Items/m3 and the lowest abundance of microplastics at low tide in Soreang waters at 3.92 Items/m3. Microplastics found in the waters of Parepare City have the same characteristics in terms of color and shape. The dominant color of microplastics is blue and the dominant shape of microplastics is fiber. Meanwhile, the size of microplastics is grouped into 4 sizes found at high tide and low tide, namely: <0.5 mm; 0.5-<1.0 mm; 1.0-<2.5 mm; and 2.5-5 mm. Based on results of FT-IR analysis, several types of polymers were obtained, namely Polythelyene therapthalate (PET), High Density Polyethylene (HDPE), and Low Density Polyethylene (LDPE).

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