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IDENTIFICATION OF MICROPLASTIC CONTENT IN REFILLED DRINKING WATER IN THE DISTRICT OF GUNUNG ANYAR SURABAYA, INDONESIA

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ABSTRACT

The need for drinking water is increasing, especially in urban areas. To meet the drinking water needs, people use refilled drinking water as the main alternative because the price of bottled drinking water is relatively expensive. In bottled drinking water, it is known that it contains microplastics which can harm human health, while no research has been conducted to determine the microplastic content in refilled drinking water. Therefore, research is needed to determine the microplastic content in refilled drinking water and its causes. In this study, 25 refill drinking water samples were used using the Fourier Transform Infra Red (FTIR) analysis method to determine the types of microplastics and manual calculation methods to determine the number of microplastics. From the research results, it was found that all samples contained microplastic, according to their type, it was found that 25 samples contained HDPE type microplastics, 13 samples contained PVC type microplastics and 11 samples contained PE type microplastics.

KEY WORDS: Microplastic, Refill dringking water, FTIR

INTRODUCTION

Drinking water is a primary need for humans, including the people of Surabaya. In meeting their daily drinking water needs, people rely on bottled drinking water, the price of bottled drinking water is relatively expensive so not all people can use it. One of the other alternatives in meeting drinking water needs is to use refill drinking water (Utami *et al.*, 2017). Refilled drinking water can be an alternative to meet daily drinking water needs. The price of refilled drinking water is cheaper, besides that, the refill drinking water industry is also increasingly mushrooming. This is because there is not much capital spent in setting up a refill drinking water depot (Yusuf and Putra, 2016).

Refilled drinking water can be an alternative in meeting people's drinking water needs. However, (Marpaung and Marsono, 2013). so the quality of refilled drinking water must be further tested.

Recently, there has been a lot of discussion about the content of microplastics in drinking water. According to research conducted by Global State University of New York supported by Orb Media, from 259 sample bottles of bottled drinking water from various brands in the world, 93% contain microplastics(Reynolds, 2019). including several brands of bottled drinking water that are widely used in Indonesia. Meanwhile, research on microplastics on refill drinking water is still rare.

Microplastics are defined as plastic particles under 5 mm in size (Talvitie *et al.*, 2017). Seeing these findings, it is possible that microplastics can pose a danger to human health. Accumulation of microplastics in the body can cause inflammation of the organs. Transformation of the chemical content of plastic into the body, and intestinal microbima disorders (Wright and Kelly, 2017)

Therefore, it is necessary to conduct research on microplastic content to determine the content and characteristics of microplastics in refill drinking water using gravimetric filtering methods and FTIR analysis.

MATERIALS AND METHODS

Survey and data collection

Data collection was carried out first to determine the number of depots for drinking water refill. The survey was conducted by looking at the data on the number of drinking water depots in Gunung Anyar which had been previously studied and surrounding the entire Gunung Anyar sub-district. recording depot locations are marked using the Google Maps application by marking the depot coordinates, then the data from the maps are displayed in the form of a map of the distribution of refill drinking water depots.

Sample Collection

After the number of depots is known the determination of the sampling point is done using the total sampling method or sampling point as a whole means that the sampling is carried out in all refill drinking water depots in Gunung Anyar sub-district. The water sample was taken from the faucet with a volume of 19 liters. This volume was taken because in purchasing refill drinking water, people used gallons with a volume of 19 liters.

Sample Filtration

The sample is filtered as much as one gallon or 19 liters. Filtering is done using membrane filter paper with pores of 0.25-0.45 microns. Samples were filtered using cellulose nitrate membrane filter paper (Li *et al.,* 2016). There is a microplastic content with a size of 1-5 µm in water from drinking water treatment (Pivokonsky *et al.,* 2018). So that the use of paper is very appropriate. The filter paper is placed on the filter holder then the sample is gradually inserted and then sucked using a vacuum pump until all the sample is filtered.

Fourier Transform Infra Red (FTIR) Analysis

The analysis was carried out by taking representatives of the 6 particles contained in the filter paper. where the particles are taken randomly by classifying the particles according to their shape and color. From 25 samples, 6 particles were randomly selected which could present other particles to be tested using FTIR (Güven *et al.,* 2017). Each of these particles has a shape and color such as red fiber, blue fiber, red fiber, black round particles, clear fragments, and blue fragments. Then the particles are analyzed by FTIR. The detected wave absorption spectrum is then equated with the wavelength spectrum of plastic particles that has been studied previously

RESULTS AND DISCUSSION

From the survey results, the number of refill drinking water depots was 25 units, from the results of a previous survey research that there were 23 drinking water depots in Gunung Anyar sub-district, meaning that there were 2 additional water depots from the previous year. The distribution of the locations of 25 refill drinking water depots is spread across almost all areas of the Gunung Anyar sub-district.

Fig. 1. Map of distribution of drinking water depots

Prigen

From the results of the FTIR analysis, it is known that there are plastic particles with different types, including 2 blue and red fiber particles which are high density polyethylene (HDPE) microplastics, 1 clear fiber particle is a type of polyvinyl chloride (PVC) microplastic, and 1 yellow fiber particle. is a type of polyethylene (PE) microplastic, whereas 2 particles are not microplastic particles because they do not show any plastic functional groups.

HDPE Microplastic Content

The HDPE functional group has consecutive wave numbers: 3913-3604; 2905 cm^{-1} represents $C-CH_3$, 2635; 1470-1539 cm^{-1} represents C = C, 1304-1367 cm-1 represents C-H, 1175; 1081 cm^{-1} represents CH2 (Arum and Kasmujiastuti, 2012). Meanwhile, according to Harahap, the pure HDPE functional group has wave numbers, namely: 2851-2926 cm^{-1} which is CH_2; 1462-1472 cm^{-1} which is C-H; and 3607 cm^{-1} represents OH (Harahap, 2009).

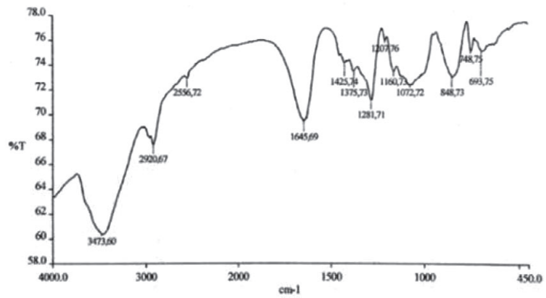

Fig. 2. HDPE Spectrum of JD Particle

Fig 3. The appearance of the JD particles

The JD particle describes the presence of the absorption band in the wave area 3479; 1279-1379 cm^{-1} is the OH stretching alcohol, 2920 cm^{-1} C-H asymmetric stretch of CH2, 1651 cm^{-1} is C = C, 1376 cm^{-1} is the C-H asymmetric bend of CH3 and 845; 740 is the C-H stretching.

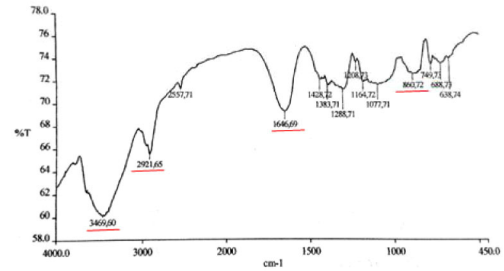

Fig. 4. HDPE Spectrum of ND Particel

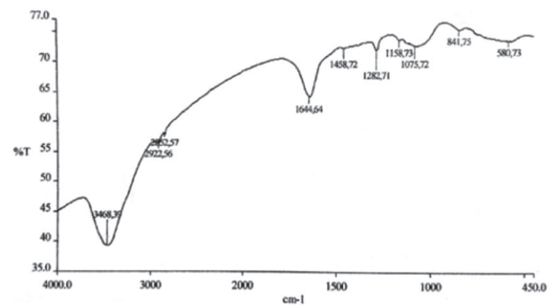

Fig. 5. The appearance of the ND particles

Table 1. Refill Drinking Water Depots List

No	Sample Code	Treatment Process		Raw Water
		First	Desinfection	
1	AD	Filtration	UV	Pacet
2	BD	Filtration	UV	Trawas
3	CD	Filtration	UV	Trawas
4	DD	Filtration	UV	Trawas
5	ED	Filtration	UV	Prigen
6	FD	Filtration	UV	Prigen
7	GD	Filtration	UV	Prigen
8	HD	Filtration	UV	Prigen
9	ID	Filtration	UV	Prigen
10	JD	Filtration	UV	Prigen
11	KD	Filtration	UV	Prigen
12	LD	Filtration	UV	Trawas
13	MD	Filtration	-	Prigen
14	ND	Filtration	UV	Prigen
15	OD	Filtration	UV	Prigen
16	PD	Filtration	UV	Prigen
17	QD	Filtration	UV-Ozone	Prigen
18	RD	Filtration	UV-Ozone	Prigen
19	SD	Filtration	UV-Ozone	Prigen
20	TD	Filtration	UV-Ozone	Trawas
21	UD	Filtration	UV-Ozone	Trawas
22	VD	Filtration	UV-Ozone	Trawas
23	WD	Filtration	UV-Ozone	Trawas
24	XD	Filtration	UV-Ozone	Prigen
25	YD	Filtration	Ozone	

ND particles depicting the absorption band of the wave area 3469 cm^{-1} is OH from alcohol; 2921 cm^{-1} represents C-H asymmetric stretching of CH2, 1646 cm^{-1} represents C = C, 1383 cm^{-1} represents C-H asymmetric stretching of CH_3 and 860; 749 cm^{-1} represents C-H. With the absorption band of the wave area, JD and ND particles are HDPE type microplastics.

PVC Microplastic Content

There is one particle known as a PVC type microplastic, this is found in the VD sample, in the FTIR spectrum the PVC particle has an absorption band in the wave area of 1272; 2959 cm^{-1} represents C-H stretching from CH-CL, 2929 cm^{-1} represents C-H stretching from CH_2, 1461; 1430; 1072 cm^{-1} represents a CH_2 flick. 1332 cm^{-1} represents CH2. 703; 639 are C-CL stretching.

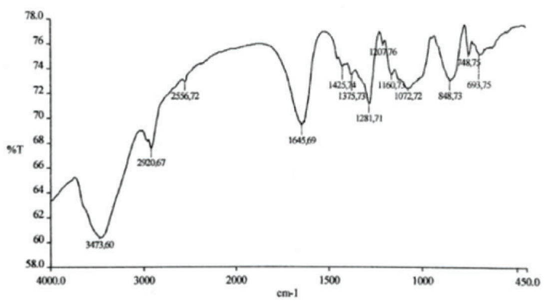

Fig. 6. PVCSpectrum of ND Particel

Fig. 7. The appearance of the VD particles

The spectra of PVC particles in the VD sample where there was an absorption band in the 2920 cm-1 wave area was CH asymmetric stretching from CH_2, 1375; 1425 cm^{-1} was CH streching from CH_3, 1160; 1281 cm^{-1} was CH_2 and 748 cm^{-1} is C-CL. These particles can be known as PVC because there are chloride compounds in their composition.

PE Microplastic Content

PE plastic has an absorption band in the wave area of 2920 cm^{-1} which is C-H asymmetric, 2852 cm^{-1} which is symmetric stretching CH2 1466 cm^{-1} which is C-H, and 723 cm^{-1} which is C-C (Güven *et al.*, 2017).

Particles from SD samples have absorption bands in the wave area of 2922; 2852; 1458 cm^{-1} which is CH2, 1644 cm^{-1} which is C-C, and 841cm^{-1} which is

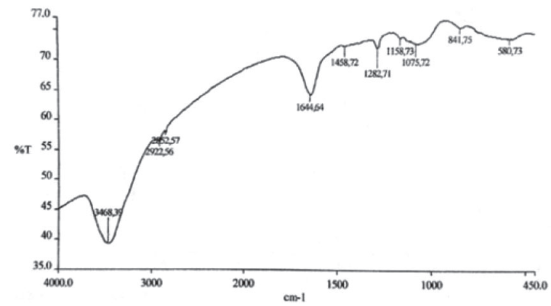

Fig. 8. PE spectra of SD particles

Fig. 9. The appearance of the SD particles

Table 2. HDPE Spectrum Comparison of JD and ND particles

Wave area (cm^{-1})	Functional			
	Arum*	Harahap**	JD Sampel	ND Sampel
3913-3604; 2905	3607	3479; 1279-1379	3469	OH
1081	2851-2926	2920	2921	CH_2
2635; 1470-1539	-	1651	1646	C=C
3913-3604; 2905	-	1376	1383	CH_3
1304-1367	1462-1472	845;740	860;749	C-H

*Arum and Kasmujiastuti, (2012).
** Harahap, (2009)

Table 3. PVC Waves Comparison

Wave area (cm^{-1})	Functional	
	Yuniari*	Sampel VD
1272; 2959, 2929, 2929	2920, 1375;1425	C-H
1461; 1430; 1072, 1332	1160;1281	CH_2
703;639	748	C-CL

C-H. By reading the wave area, the SD sample is a particle with a PE type microplastic composition.

Qualitative Analysis

Qualitative analysis is carried out by matching the particles contained in the sample with particles that have been tested using FTIR, but in this study the particles that can be analyzed are those that are visible to the eye, this occurs due to limitations of microscopy equipment so that small particles cannot be analyzed. Based on manual calculations as a whole there are 3 types of microplastics found in 25 refill drinking water samples. From the results of the sample analysis, it can be seen that all samples contained HDPE type microplastics, 13 samples contained PVC type microplastics and 11 samples contained PE type microplastics.

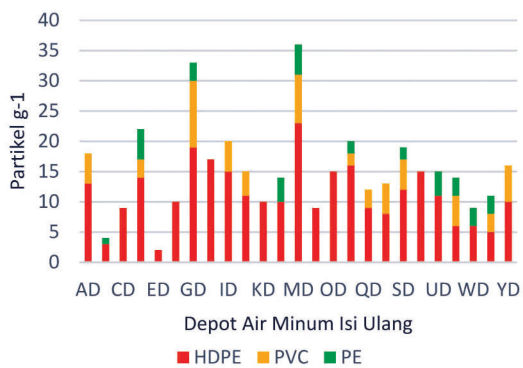

Fig. 10. Comparison Graph of the Number of Microplastics

Shape and Color of Microplastics

To see the shape of the microplastic analysis was carried out using a Cannon 1100D camera. From the analysis, it is known that there are 3 types of particles that are known, namely in the form of fibers, fractions, and irregular shapes. Microplastics have been identified as having three forms, namely fiber, spherical, and fractional (Pivokonsky *et al.*, 2018). All particles identified by microplastics are in the form of fibers with various colors, including yellow, red, blue, and clear. Yellow fiber particles were identified as PE microplastic, red and blue particles were HDPE microplastic, and clear colored particles were PVC microplastic.

Table 4. Wave PVC Comparison

Wave area (cm^{-1})	Functional	
	Guven*	SD Sampel
2,920;1466	841	C-H
2,852	2,922;2,852;1,458	CH_2
723	1644	C-C

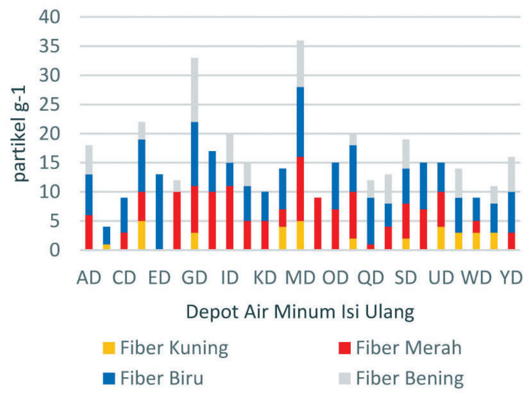

Fig. 11. Graph comparison of Shape and Color of Microplastics

CONCLUSION

From the research, it was found that all samples analyzed identified microplastic content. Of the 25 samples that were filtered, it was found that all particles contained HDPE type microplastic, 13 samples contained PVC type microplastic, and 11 samples contained PE type microplastic. The microplastics identified from the refill drinking water samples were all in the form of fibers with various colors, namely blue and red which were HDPE type microplastics, clear colors were PVC type microplastics and yellow was PE type microplastics.

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