Marina Chim. Acta. 20 (2), pp.38-44, 2019

MARINA CHIMICA ACTA

Jurnal Tiga Bahasa Tentang Kimia Laut

p-ISSN : 1411-2132
e-ISSN : 2620-6145

Open Access Journal at : http//journal.unhas.ac.id/index.php/mca

MR

THE EXISTENCE OF PLASTIC WASTE MANAGEMENT IN THE SEA ENVIRONMENT SEEN FROM CHEMICAL SCIENCE ANGLE

Alfian Noor*, La Kolo, Khadijah, Ida Ifdaliah Amin, Sarni, Sernita

Department of Chemistry, Faculty of Mathematics and Scienes, Hasanuddin University,
Kampus UNHAS Tamalanrea, Makassar 90245
**Corresponding author: alfiannoor744@gmail.com*

ABSTRACT

Plastic waste from year to year in the marine environment continues to increase. This is due to its wide application and its resistance to degradation making it difficult or impossible to decompose. Plastic waste has been found in various sizes and accumulated in the body of marine life. The existence of plastic waste in the body of the marine biota even causes death. This review discusses the latest advances in research and development of methods for handling plastic waste in the marine environment.

Keywords: Plastic waste, marine biota, handling methods

Received: 3October 2019, Accepted: 31October 2019, Published online :31 December 2019

1. INTRODUCTION

Plastic waste is the type of waste that has the most impact on the environment. This is due to its wide application and its resistance to degradation making it difficult or impossible to decompose [1, 2] even accumulating in living bodies. As a result, plastic waste from 1950-2015 continues to increase and will reach 25,000 million metric tons in 2050 [3]. Some of the problems of plastic waste are caused if not properly disposed of it will enter the water body and everything will lead to the sea continuously and the amount in the ocean has increased from year to year. The fact of this plastic waste is thought to be the cause of the death of whales in Indonesia, which is found about 6 kg of plastic waste in the belly of the whale [4]. This assumption is acceptable because plastic waste is one of the components of waste that is harmful to the environment and living things around it [5]. Therefore, efforts to reduce plastic waste need to be done.

2. PLASTIC TRASH IN THE OCEAN

As much as 80% of plastic waste in the sea comes from land. Plastics from the mainland will enter the ocean through poor management related to waste disposal, especially plastic waste and enter through the river [6]. The remaining 20% comes from human activities at sea [7]. Our oceans function as absorbers of plastic particles and an estimated 5.25 trillion micro and nanoplastics pollute the entire sea surface [8]. Plastic waste allows it to accumulate over time in marine environments and form floating debris forming rubbish islands. A relatively high level of plastic waste islands are found in the sea in the eastern part of the North Pacific Subtropical Coast. This garbage island is formed from 1.8 trillion pieces of plastic waste and as much as 8% micro size [9]. As a result of primary and secondary disturbances by UV photodegradation, mechanical action, hydrolysis and biological degradation of plastics, microplastics having dimensions of less than 5 mm and nanoplastics of sizes 1 to 100 nm released into the sea [10,11].

3. MICROPLASTIC BIOACCUMULATION IN THE BODY OF MARINE BIOTA

When microplastics are in the ocean they will float depending on the density of the polymer and its interaction with biota [12]. Polymers that are denser than seawater such as PVC will settle while those with low densities such as PE and PP will float. During being in the waters of plastic particles undergo biofouling, colonized organisms so that they sink. Microplastics can also be degraded, fragmented and release adhesives so that the particles will change their density and are distributed between the surface and the bottom of the waters [13].

In the body of marine biota, the presence of microplastic has been identified. In the body of mesopelagic and epipelagic fish species in the North Pacific Ocean, an average of 2.1 microplastic particles are found in the digestive tract [14]. In Indonesia, microplastics are found in mackerel, flying fish, herring, fish of the Carangidae species and also baronang fish. The largest number of microplastics was found in fish from the Carangidae family with an average number of microplastics of 5.9 ± 5.1 particles per fish. Microplastics found in the digestive tract of fish have the form of fragments, films, styrofoam, and monofilament. The presence of microplastics is also found in fish sold in markets in California (USA) [15]. In the body of microplastic shrimp identified as much as 1.23 ± 0.99 particles per shrimp. As many as 63% of prawns assess the mecroplastic accumulation which is dominated by synthetic fibers [16].

In addition to fish, microplastics are also found in bivalves, which are filter feeder organisms, so it is possible to be polluted by microplastic pollutants. Bivalves of the Mytilus endulis species found in coastal areas in China, both those captured directly on the beach or cultivated have been shown to contain microplastics in varying amounts, ie 0.9 - 4.6 items / g and 1.5 - 7.6 items / individual [17]. Similar research was also carried out on shellfish taken from waters in Brazil and showed the presence of microplastics in shellfish [18].

4. ROLE OF CHEMISTRY IN OVERCOMING PLASTIC WASTE IN THE SEA

Method of direct appointment

This method is done by looking for garbage at sea by boat, netting it, and transporting it back ashore.

Biodegradation Methods Using Organs Organizing

Degradation studies include the isolation of new microbes that break down synthetic polymers in the marine environment and innovative ideas that involve cloning specific enzymes. Microorganisms involved in plastic degradation and how they work to degrade synthetic polymers such as HDPE, LDPE, polyvinyl-alcohol (PVA), PP, PE, Polycaprolactone (PCL), low linear poly-ethylene (LLDPE) and nylon PVAs are presented in Table 1.

Table 1. Organisms decomposing plastic of the marine ecosystem

Plastic	Microorganisms	Source
HDPE	Aspergillus sp.	Marine coastal habitats
	Brevibacillus borstelensis	Marine water and sediment
	Pseudomonas sp., Arthrobacter sp.	Marine ecosystem
LDPE	Kocuria palustris, Bacillus pumilus and Bacillus subtilis	Pelagic waters
	Vibrio alginolyticus and Vibrio parahaemolyticus	Benthic zones
LLDPE	Lysinibacillus and Salinibacterium	Marine water
Nylon	Bacillus cereus, Bacillus sphericus, Vibrio furnisii and Brevundimonas vesicularis	Marine water
PCL	Pseudomonas, Alcanivorax and Tenacibaculum	Deep sea sediment
	Pseudomonas sp., Clonostachys rosea, Trichoderma sp. and Rhodococcus sp.	Arctic soil
PE	Zalerion maritimum	Marine environment
PP	Bacillus sp. and Rhodococcus sp.	Mangrove sediment
PVA	Thalassospira povalilytica	Marine environment
PVA-LLDPE	Vibrio alginolyticus and Vibrio parahaemolyticus	Benthic zones
PVC, LDPE and HDPE	Bacillus sp.	Coastal water
LDPE and HDPE	Bacillus sphericus and Bacillus cereus	Marine water
PE and PP	P. palmate and A. esculenta (macroalgae)	Benthic zones
PET	Muricauda sp. and Thalassospira sp.	Marine water

Various types of enzymes play an important role in the degradation of plastic polymers. At present, microbial enzymes are considered as a potential source for the conversion of plastic polymers into monomers. Enzymes (Table 2) adapted from marine microorganisms fulfill a higher probability for biotechnology

Table 2. Chemical degradation enzymes of plastics

Microorganisms	Enzymes	Plastic
Aspergillus clavatus	PHB depolymerase	Polyethylene succinate
Alcaligenes faecalis AE122		Poly-3-hydroxybutyrate (PHB)
Streptomyces sp. SNG9		PHB and poly-3-hydroxy butyrate-co-3-hydroxy valerate (PHBV)
Candida antarctica	Lipase B	Polyurethane (PUR)
Ideonella sakaiensis	MHETase and PETase	PET
Paraglaciecola agarilytica and Marinobacterium	Styrene monooxygenases	Styrene
Penicillium sp. and Geotrichum fermentans WF9101	Oxidase, Hydrolase and Dehydrogenase	PVA
Pestalotiopsis microspora	Serine hydrolase	Polyester
Pseudomonas chlororaphis	Polyurethanases	PUR
Pseudomonas protegens	Lipase	PUR
Sphingomonas terrae	PEG-Dehydrogenase	Polyethylene glycol (PEG)
Thermobi?da fusca	Hydrolase	PET
Bacillus cereus and Bacillus sphericus	Peroxidase	HDPE and LDPE

Source [6]

exploitation and new insights to overcome environmentally friendly solutions to plastic pollution. Promising enzymes involved in biodegradation of plastics are tabulated in [6].

One effort to prevent plastic waste from entering the sea is to use a method of recycling plastic waste. The process of recycling plastic waste begins and ends with consumers. Waste is collected by dump trucks along with all other recycled materials such as metals, paper, organic materials, and glass which are then taken to the Material Recovery Facility (FPM) [19]. In FPM, waste is separated according to other types of waste and impurities (glass, metal, paper and organic waste) [20]

Methods for Preventing Garbage Entering the Sea

One effort to prevent plastic waste from entering the sea is to use a method of recycling plastic waste. The process of recycling plastic waste begins and ends with consumers. Waste is collected by dump trucks along with all other recycled materials such as metals, paper, organic materials, and glass which are then taken to the Material Recovery Facility (FPM) [19]. In FPM, waste is separated according to other types of waste and impurities (glass, metal, paper and organic waste) [20]

Recovered plastic waste is then crushed and shaped into plastic pellets which can be sold to plastic processing plants (plastic industry). The use of plastic samaph as an additional material in the manufacture of composite boards, asphalt, clay tiles, and paving blocks does not need to go through the plastic recovery stage. This will certainly reduce the cost of processing and can increase the added value of plastic waste, as well as being an alternative to the prices of conventional building materials such as cement and steel which continue to increase [4]. In addition, this use is also an effort to overcome the problem of plastic waste in the environment.

5. CONCLUSIONS

Plastic waste has polluted the marine environment and has been found in most of the digestive system tissue and accumulated in the body of marine biota. The most astonishing thing and needs special seriousness to start thinking about is that the accumulation will certainly enter and accumulate in the human body through the food chain system. Some environmentally friendly chemical methods have been discussed in this paper. The method of preventing plastic waste from entering the sea is a very environmentally friendly and promising method.

REFERENCES

[1] Barnes, D. K. A. Galgani, F., Thompson, R. C. Barlaz, M. 2009, Accumulation and fragmentation of plastic debris in global environments. Philos.Trans.R.Soc.B364, 1985–998.

[2] Agyeman, S., Obeng-Ahenkora, N. K., Assiamah, S., and Twumasi, G. (2019). Exploiting recycled plastic waste as an alternative binder for paving blocks production. Case Studies in Construction Materials, 11, e00246.

[3] Geyer, R., Jambeck, J. R., and Law, K. L. (2017). Production, use, and

fate of all plastics ever made. Sci. Adv., 3(7), e1700782.

[4] Akinwumi, I. I., Domo-Spiff, A. H., and Salami, A. (2019). Marine plastic pollution and affordable housing challenge: Shredded waste plastic stabilized soil for producing compressed earth bricks. Case Studies in Construction Materials, 11, e00241.

[5] Sya'diah S. H., 2014, Characteristics and Consumers' Knowledge of the Reduce and Reuse Principle and Participation in Using Shopping Bags Instead of Plastic Bags at the Carrefour Medan Fair, Universitas Sumatera Utara, Medan.

[6] Kumar, A. G., Anjana, K., Hinduja, M., Sujitha, K., dan Dharani, G. (2019). Review on plastic wastes in marine environment – Biodegradation and biotechnological solutions. Marine Pollution Bulletin, 110733.

[7] Mattsson, K., Hansson, L.-A., Cedervall, T., 2015. Nano-plastics in the aquatic environ- ment. Environ. Sci. Proces. and Impacts. 1–17.

[8] Eriksen, M., Lebreton, L.C.M., Carson, H.S., Thielm, M., Moore, C.J., 2014. Plastic pol- lution in the world's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea. PLoS One 9 (12), 1–15.

[9] Lebreton, L., Slat, B., Ferrari, F., Sainte-Rose, B., Aitken, J., Marthouse, R., Hajbane, S., Cunsolo, S., Schwarz, A., Levivier, A., Noble, K., Debeljak, P., Maral, H., Schoeneich- Argent, R., Brambini, R., Reisser, J., 2018. Evidence that the great pacific garbage patch is rapidly accumulating plastic. Sci. Rep. 8, 1–15.

[10] Vered, G., Kaplan, A., Avisar, D., Shenkar, N., 2019. Using solitary ascidians to assess microplastic and phthalate plasticizers pollution among marine biota: a case study of the Eastern Mediterranean and Red Sea. Mar. Pollut. Bull. 138, 618–625.

[11] Song, Y.K., Hong, S.H., Jang, M., Han, G.M., Jung, S.W., Shim, W.J., 2017. Combined e ects of UV exposure duration and mechanical abrasion on microplastic fragmen-tation by polymer type. Environ. Sci. Technol. 51 (8), 4368–4376.

[12] Lusher, A. L., Peter H dan Jeremy M. (2017). Microplastics in Fisheries and Aquaculture. Roma: Food and Agriclture Organization of The United Nations.

[13] Widianarko B., Hantoro I., (2018), Microplastic in Seafood from the North Coast of Java, Soegijapranata Catholic University, Semarang.

[14] Boerger, C. M., Lattin, G. L., Moore, S. L., dan Moore, C. J. (2010). Plastic ingestion by planktivorous fishes in the North Pacific Central Gyre. Marine Pollution Bulletin, 60(12), 2275–2278.

[15] Rochman, C. M., Tahir, A., Williams, S. L., Baxa, D. V., Lam, R., Miller, J. T., Teh, F.-C., Werorilangi, S., dan Teh, S. J. (2015). Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption. Scientific Reports, 5(1), 14340.

[16] Devriese, L. I., van der Meulen, M. D., Maes, T., Bekaert, K., Paul-Pont, I., Frère, L., Vethaak, A. D. (2015).

Microplastic contamination in brown shrimp (Crangon crangon, Linnaeus 1758) from coastal waters of the Southern North Sea and Channel area. Marine Pollution Bulletin, 98(1– 2), 179–187.

[17] Li J., X. Qu., L. Su., W. Zhang, D. Yang, P. Kolandhasamy, D. Li, and H. Shi. 2016. Microplastics in mussels along the coastal waters of China. Environmental Pollution, 214: 177 – 184

[18] Santana, M. F. M., Ascer, L. G., Custódio, M. R., Moreira, F. T., dan Turra, A. (2016). Microplastic contamination in natural mussel beds from a Brazilian urbanized coastal region: Rapid evaluation through bioassessment. Marine Pollution Bulletin, 106(1), 183-189.

[19] Rudolph N., Kiesel R., dan Aumnate C., 2017, Understanding Plastics Recycling; Economic, Ecological, and Technical Aspects of Plastic Waste Handling, Hanser Publishers, Madison.

[20] University of Cambridge and University of Cambridge-MIT Institute. 2005.The ImpEE Project: Re cycling of Plastics. Department of Engineering, University of Cambridge, Cambridge, UK.