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Biodegradation of Microplastics in Drinking Water, A review

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ABSTRACT

Microplastics are emerging as an ever-increasing threat to the environment and are becoming an issue of concern among researchers. Microplastics are often detected in the environment, the risks they pose are debated and largely unknown. One important challenge in determining the threats of microplastics to humans and the environment is the heterogeneity of the physical and chemical properties, the nature and concentration of the particles and the difficulty in identifying standardized detection systems. Microplastics can reach drinking water supplies from surface run-off, degraded plastic waste, atmospheric deposition, and wastewater effluent. The effluent from wastewater treatment plants is one of the most important factors behind the contamination of microplastics. Microplastics in drinking water supplies have recently been detected. This article presents an analysis and review of available literature on the effects of microplastics on freshwater, agriculture, and ecosystems, as well as emerging treatment methods with an emphasis on microplastic biodegradation. The article will display a model used to measure the export of microplastic waste from land to sea. Finally, the policy and regulation and the way the Sustainable Development Goals will reduce microplastic emissions will be addressed.

Keywords: Microplastics; Biodegradation of microplastics, Circular economy and Sustainable development goals (SDGs).

1. INTRODUCTION

The term microplastics (MPs), first coined in the scientific literature by Thompson et. al., (2004), describe very small plastic particulates and fibers. Microplastics are frequently present in freshwaters and drinking water are non-uniform and include: > 1.6 µm (Ng and Obbard 2006), < 1 mm, nano-plastic (Browne et al., 2007, 2010; Claessens et al., 2011 and Koelmans et al., 2015), < 2 mm (Ryan et al. 2009), 2–6 mm (Derraik 2002), < 5 mm (Barnes et al. 2009; Betts 2008), < 10 mm (Graham and Thompson 2009). Microplastics are generally characterized as water-insoluble, solid polymer particles that are < 5 mm (Bergmann et. al., 2015). Microplastics consist of carbon and hydrogen atoms bound together in polymer chains. Chemicals, such as phthalates, polybrominated diphenyl ethers (PBDEs), and tetrabromobisphenol A (TBBPA), are typically also present in microplastics, and many of these chemical additives leach out of the plastics after entering the environment. Microplastics are divided into two types: Primary microplastics found in cosmetic products, plastic pellets used in industrial manufacturing, and plastic fibres used in synthetic textiles.

Secondary microplastics formed from the breakdown of larger plastics undergo a weathering process e.g. wind, wave, and sunlight (Browne, 2015; Browne et. al., 2007; Fendall and Sewell, 2009). Many of these products readily enter the environment in wastes. The world population approach 8 billion and they generate 8,3 billion tons of plastics since 1950s. Worldwide plastic consumption is worrying and is constantly growing, in fact, 10 tons of plastic are produced each second in the world. Production of plastic needs 8% of global oil production. The production of plastics has undergone a vertiginous boom. In 1950 only two million tons of plastics were produced and in 2015 around 400 million tons were produced. It is the third product that is the most manufactured after cement and steel. Of these massive quantities, 6,3 billion tones have now become waste of which just 9% were recycled, 12% incinerated and 79% deposited in landfills and open dumps (Geyer et al., 2017). The plastic takes between five hundred and one thousand years to degrade. The everyday use of plastics has become the source of massive waste, which is poorly treated (Geyer et al., 2017). Plastic can have different types of compositions which can influence its lifetime. In the 1800s first polymers have ben synthesized such as polystyrene (PS) and polyvinyl chloride (PVC). However, it was to brittle to be marketed. First polymers marketable appeared at the beginning of 20th century with Bakelite, a phenol-formaldehyde resin developed in Belgium by Leo Baekeland. However, the progress was fast, in 1930s more processable polymers are created like modern forms of PVC, polyethylene terephthalate (PET) and polyurethane (PUR). Then, in 1950s high-density polyethylene (HDPE) and polypropylene (PP) are born. In 1960s, plastics derived from the bacterial fermentation of sugars and lipids make their appearance like polylactides (PLA) and polyhydroxyalkanoates (PHA). More research has been carried in recent years to determine the various origins of microplastics and their relative environmental impacts. (Corradini et al., 2019; Auta et al., 2017; Bläsing and Amelung, 2018; He et al., 2018; Ng et al., 2018; Pinto da Costa et al., 2018). Microplastic are a bigger threat to the plants, animals, and humans. People may be exposed to microplastics in several different ways which include using plastic applicants, cosmetics containing microplastics, dust and food. Indeed, the problem is that these particles are entering the food chain. Microplastic have been found in seafood, salt, sugar, beers and in drinkable water. Nowadays, microplastic are part of our food. Humans use daily plastic and so can allow oral, dermal and inhalation exposure to chemical components, resulting in the widespread presence in the human body of chemicals associated with plastics such as nano-silica and nano sliver compounds that have the property to reduce the weight of plastics and improve the mechanical strength (Wagner 2019; Galloway 2019). This article presents an analysis and review of available literature on the effect of microplastics on freshwater, agriculture, and ecosystems, as well as emerging treatment methods with an emphasis on microplastic biodegradation. In addition, the article will display a model used to measure the export of microplastic waste from land to oceans/seas. Finally, the policy and regulation and the way the SDGs will reduce microplastic emissions will be addressed.

2. MICROPLASTIC OCCURRENCE

2.1. Microplastic Occurrence in Oceans

Microplastics in the ocean is a growing global problem. Half of the population of the planet lives on the coast, which makes it easier to dump plastics into the oceans/seas. Plastics that end up in the sea ultimately go through a fragmentation process and become smaller and smaller pieces and eventually become microplastics. It is estimated that there are between 27 and 67 million tons of plastic in the ocean and that microplastic particles are by far the largest quantity of plastic waste. The field that most contributes is the synthetic textile industry. Plastic is currently used in a wide range of industries, including clothing, bags, shoes, etc. Cheap brands use a lot of synthetic fabrics or nylon to minimize production costs. Moreover, clothing use has recently doubled, with significant environmental effects. Synthetic clothing fabrics reject plastic micro-particles during washing, which are too fine to clean in wastewater treatment plants (WWTPs). WWTP release a lot of microplastics in rivers. In Europe, estimations show that rivers carry between 1,15 and 2,41 million tons of plastic wastes. These microplastics come from personal care products (PCP), household dust (HD), laundry textiles (LT) and tyre and road wear particles (TRWP).

To quantify the exportation of microplastics pollution from land to sea, a model was set (Siegfried et al., 2017). This model shows that pollution of microplastics depends on socio economic context, on technologies and density of population connected to a treatment plant. This model is based global nutrients export from watershed (NEWS) model for calculating source points of nutrients in river sewage. In the model the source points of nutrients replaced by source points of microplastics generated by human activities on earth. This model is built on four main equations:

$$Yld_{MP} = \sum_{i=1}^{n} \quad (FE_{riv,i} \times RS_{pnt,i}) \ (1)$$

Equation (1) gives the yield of microplastics which is the average of microplastics from a source point which is exported to the mouth of the river by basin area unit (kg.km^{-2}.year^{-1}).

MP means microplastics of type n. Here n worth 4: PCP, HD, LD and TRWP.

FE$_{riv,i}$ is the input fraction of microplastics that is exported by rivers and aquatic systems for type i MPs. RS$_{pnt,i}$ is the input of microplastics in rivers from the point source for type i MPs (kg.km^{-2}.year^{-1}).

$$L_{MP} = Yield_{MP} \times A \qquad (2)$$

Equation (2) focusses on microplastics load (kg. year^{-1}).

Yield MP is microplastic yield from (1) in (kg. km^{-2}.year^{-1}). A is the surface of a pond (km^{2}).

$$RS_{pnt,i} = (1 - hw_{frem,i}) \times PConDen \times WShw_{cap,i} \ \ (3)$$

Equation (3) allows to obtain RSpnt, i from equation (1). hw$_{frem,i}$ is fraction for type i MPs in sewage waters which is removed via sewage treatments. Moreover, PConDen is the density of population connected to a treatment plant (inhabitant.km^{-2}). WShw$_{cap, i}$ input of microplastics in rivers basin per capita (kg. capita^{-1}.year^{-1}) .

$$FE_{riv,i} = (1 - Ret,_{i}\ ) \times (1 - FQ_{rem,i}) \qquad (4)$$

Equation (4) gives the input fraction of microplastics that is exported by rivers and aquatic systems for type i MPs. Reti is the fraction of retention for type i MPs sources. FQrem,I is fraction for type I MPs eliminated by water consumption. These equations allow to get a quantitative assessment of the MPs transport from land to oceans/seas on a continental scale. The model calculated a total 14.4 kilotonnes of microplastics were exported from point-sources to the North Sea, Baltic Sea, Black Sea, Mediterranean Sea and the European river basins draining into the Atlantic Ocean in 2000 . The total loads differ by sea. Microplastic export to the Mediterranean Sea was 5.6 kilotonnes, to the

Black Sea 4.1 kilotonnes, to the European part of the Atlantic Ocean 2.7 kilotonnes, to the North Sea 1.1 kilotonnes, and to the Baltic Sea 0.9 kilotonnes microplastics, see figure 1.

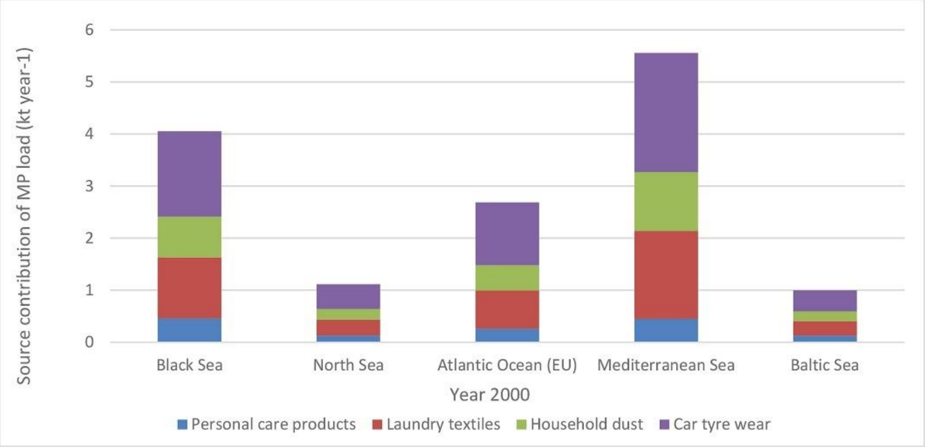

Figure 1: River export of microplastics by relative point-source contribution (Siegfried et al., 2017).

2.2. Microplastic Occurrence in Drinking Water

Safe and readily available water is crucial for public health, whether it is used for drinking, domestic use, food production or recreational purposes. The United Nation (UN) and the World Health Organization (WHO) recognized access to water and sanitation as a human right and everyone has the right to sufficient, continuous, safe, acceptable, physically accessible, and affordable water for personal and domestic use. Also, the SDGs 6.1 calls for universal and equitable access to safe and affordable drinking water. However, ensuring safe access to water has become increasingly challenging due to several reasons. Among the challenging reasons, one of the most recent is microplastics in water sources. Microplastics may enter drinking-water sources from surface run-off, combined sewer overflows, industrial effluent, degraded plastic waste and atmospheric deposition. WHO identified surface run-off and wastewater effluent as the two main sources of microplastics, though better data are required to quantify the sources and associate them with more specific plastic waste streams. Microplastic distribution is largely influenced by meteorological, temporal, and geographical factors that may compromise reproducibility of the results. For drinking water and implications of microplastics for human health, the presence of microplastics has been reported by (Koelmans et al., 2019; EFSA, 2016; Gasperi et al., 2018; Lusher et al., 2017; Van Cauwenberghe and Janssen, 2014; Yang et al., 2015; Wright and Kelly, 2017; Eerkes-Medrano and Thompson, 2018; Li et al., 2018; Wagner et al., 2014; Kooi et al., 2018).

2.3. Microplastics In Sewage and Sewage Treatment Plants

Reuse of wastewater in agriculture, or in other economic sectors could protect our natural resources from depletion and overuse. Currently, the quality of the wastewater is rarely taken into consideration, because almost 90% of this wastewater is discharged and dumped directly into natural receivers (rivers, basins, open lands…) and without any treatment. However, WWTPs potentially played an important role in releasing microplastic to the environment. It may remove some of the microplastics depending on the treatment units employed. Treatment plants are essentially taking the microplastics out of the wastewater and concentrating them in the sludge (Zubris and Richards, 2005). Studies of microplastic in sewage treatment plants shows that the retention efficiency depends on the size of the particles, while the shape of the particles is of little importance. More than 99% of microplastics ≥300 µm end up in sludge (Carlos et al., 2019). Particles in the size range of 20 to 300 µm constitute about a third of the particles. All the available studies have counted the number of particles, although none of the studies have determined the total weight of the particles up to this date. Synthetic fibers and textile materials are a primary source of sewage microplastics (Corradini et al., 2019; Gatidou 2018; Hernandez et al., 2017; Horton et al. 2017; Henry et al., 2019; Mahon et al., 2017; Napper and Thompson, 2016; Ziajahromi et al., 2017). Personal care products e.g. toothpaste, soaps and facial scrubs contain are also believed to contribute to microplastic pollution which could potentially reach aquatic environments through WWTPs (Napper et al., 2015; Duis and Coors, 2016). The pollution from microplastic particles form other forms e.g. dust from tires, paint polishing and degradation of microplastics in sewage treatment plants was not yest exploded (Corradini et al., 2019; Mahon et al., 2017; Kase et al., 2016; Klimisch et al., 1997; Schneider et al., 2009).

2.4. Microplastic Effects in Agriculture

Water is important for agriculture and food security. With about 70% of the world's use of freshwater, irrigation is the main water consumer (FAO, 2017). According to recent Food and Agriculture Organization (FAO) data, only 30 to 40% of the world’s food comes from irrigated land, comprising 17% of the total cultivated land. In the future, water availability for agriculture will be threatened by the increasing domestic and industrial demand (FAO, 2017). The water deficit can be filled mainly by treated wastewater. The quality of wastewater is influenced by the type of treatment technology used. Possible problems related to recycled wastewater used in common agricultural practices have begun to raise concerns, such as the disposal of plastic mulching, water pipes and greenhouse plastic covers. Hence, treating wastewater should be controlled before use for irrigation (Brodhagen et al., 2017; Steinmetz et al., 2016; Tallou et al., 2020; Zhang and Liu, 2018). In several countries around the world, this sewage sludge is still used as fertilizer on agricultural soils as it has a beneficial impact on soil fertility. The use of sludge, however, may lead to soil degradation and provide a pathway for microplastics and synthetic fibers to infiltrate agricultural soils and may settle in soils. However, no studies have been performed to determine the impact of sludge on agricultural fields (Coors et al., 2016; Li et al., 2018; Mahon et al., 2017; Schmidt et al., 2006; Zubris and Richards, 2005).

2.5. Microplastic Effects in Ecosystems

The composition of plastics and their inherent association with human activities can have important effects on the functioning of ecosystems. In 2015, around 25.8 million tons of plastic waste are generated in Europe every year, less than 30% of such waste is collected for recycling (Machado et al., 2017). At the same time, landfilling and incineration rates of plastic waste remain high - 31 % and 39 %, respectively - and while landfill has decreased over the past decade, incineration has grown. According to estimates, 95 % of the value of plastic packaging material is lost after a very short first-use cycle. The global recovery of plastic is even lower, and it is estimated that about 32% of plastic waste could find its first receptacle in soils or continental aquatic ecosystems. In terrestrial systems, microplastics first interact with biota, potentially altering geochemistry and the biophysical environment that may subsequently cause environmental toxicity. For organisms living in a liquid environment, microplastics can be particulate targets for ingestion, solid surfaces for transporting contaminants, or potentially causing physical damage. Continental microplastics could play a role in vector for the emergence of recently observed diseases, as in the marine environment. In soils, microplastics can persist for more than 100 years due to low light and oxygen conditions (Horton et al., 2017). Thus, microplastics could also interact with soil fauna by changing their biophysical environment, with potential consequences on their shape and function in the soil. The earthworms, exposure to microplastics was associated with structural changes in their burrows whereas, for collembola, changes in the biophysical environment affected their activity, which resulted in effects on their intestinal microbiomes. Recent studies proved that some sea birds eat plastics because of dimethyl sulfide emission from polyethylene and polypropylene pearls, smell plays an important role in the fact that birds can confuse waste with food (Hermsen et al., 2018; Koelmans et al., 2019).

3. POLICY, REGULATION, AND SUSTAINABLE DEVELOPMENT GOALS

Public awareness and legal action are rising because of the global plastics pollution crisis. Several countries in the world call for legislation banning individual plastic products, reforming waste disposal, and preserving our environment. Prevention is the first step to reduce microplastic before use of technologies. Prevention is a challenge based on regulation and management. Microplastic is an ecological and social problem. This challenge exists because of the complexity of particles like their chemical and physical heterogeneity. This problematic begins to be known from people and they want action from political class like climate manifestations. It is difficult to know which politic field must act first. Actions can be taken at the international, national, and regional level. Most of international regulations are conventions, agreements, strategies, action plan and many others. Every signatory country to a specific international regulation must respect it. These regulations are put in place by global organizations such as United Nations (UN), The Group of seven (G7) and World Bank. The UN adopted on the September 25, 2015 the resolution “no. A/RES/70/1” called “Transforming Our World: The sustainable Development Agenda by 2030” which contains 17 SDG. The purpose is to create a sustainable development in three dimensions: economic, social, and environmental. While none of the 17 SDGs has plastic pollution as the main theme, the relationship between the SDGs and the need to curb plastic pollution is clear. Several goals and targets related to the plastic pollution to be solved by the year 2030 was set., the goal 12 calls for the establishment of sustainable consumption and production patterns in order to achieve environmentally sound management of products chemicals and all wastes throughout their life cycle and to minimize their negative effects on health and the environment or significantly reduce the production of waste through prevention, reduction, recycling and reuse. The goal 14 calls to conserve and sustainably exploit oceans, seas and marine resources for sustainable development. The priorities are to prevent and significantly reduce marine pollution of all types or manage and sustainably protect marine and coastal ecosystems. The SDGs has set several targets, goals and indicators related to marine environment by the year 2030. The goal 6 target 3 calls to improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally. In the goal 12 target 1 calls to implement the 10-year framework of programmes on sustainable consumption and production, all countries acting, with developed countries taking the lead, taking into account the development and capabilities of developing countries. In the goal 12 target 4 achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment. In the goal 12 target 5 substantially reduce waste generation through prevention, reduction, recycling, and reuse.

The G7 countries admitted that plastic is big issue and a global challenge. For the reason they have set an action plan. The action plan stated that its necessary to improve national systems of wastes management, reduce waste production and encourage reuse and recycling; support the setting up of pilot projects; conduct research of sustainable solutions to reduce microplastic in sewage waters; and, to promote relevant methods and instruments to reduce the use of single-use disposable objects with an impact on the environment. Finally, to encourage industries to develop sustainable packaging and eliminate some toxic ingredients like plastic pellets (Wagner et al., 2017). World Bank enacted the Environmental and Social Framework (ESF) in October 2018. The purpose is to finance and promote the sustainable use of resources, including energy, water, and raw materials. Tools to solve problem of microplastic can be regional programs or agreements. Serval policy and Act's has been issued with an aim to reduce consumption of plastic, recycle more waste and manage emissions e.g. in EU; European Water Framework Directive (WFD), Authorization and Restriction of Chemicals (REACH), European Chemical Agency (ECHA), Environmental Protection Act (EPA).These policies handled several problems such as packaging, industrial emissions, save substances, limitation of animal testing, use of plastic, pan of plastic bags or waste legislation.

4. METHODOLOGY, IDENTIFICATION ANDTREATMENT

4.1. Identification Method of Microplastic

The growing public and scientific interest in microplastic contamination in the environment is leading to high demand for simple, effective, comparable, and robust methods for microplastic analysis. The analysis of microplastics depends strongly on suitable analytical methods. The small size of the microplastics makes their determination difficult. Microplastics are heterogeneously distributed in the environment, and this prevents representative sampling of sediments and water. Appropriate methods for the extraction of samples and an analytical method for the identification and confirmation of plastic particles are therefore mandatory to obtain reliable results. A wide variety of different sampling methods, sample treatments and detection methods have been defined in most studies, microplastics are first identified visually, before an identification of the polymer type is undertaken. Larger particles can be identified with the naked eye, whereas small microplastics are identified using state of the art vibration microscopy techniques and scanning electron microscopy, and associated multivariate image analysis techniques (Mahon et al., 2017; Lassen et al., 2015; Volkheimer et al., 1974). Depending on the efficiency of the sample treatment and particle size, the visual identification is considered not state of the art and often insufficient resulting in false-positive results. For this reason, further spectroscopic or spectrometric methods are needed to ensure the unambiguous identification of particles made from synthetic polymers microplastics have different sizes, colors, and compositions. Combinations of microscopy and spectroscopy analyses are generally used at present. However, new methods to minimize identification time and effort and to detect sub-micron plastics in samples need to be improved and produced. When the size of the microplastics is < 1 mm and the minimal cut-off size is tens of microns, microscopic analysis should be combined with chemical analysis such as spectroscopic or thermal analysis. The two key characteristics in microplastic analysis are physical (size, shape and color) and chemical (polymer type) features. Any method that reliably measures both is suitable for microplastic analysis. Because it is difficult to obtain both types of characteristics using only one analytical tool, the combination of multiple methods is applicable. The wide size range of microplastics and complex nature of their shapes, colors, and polymer types have prevented researchers from developing a consistent classification of microplastic data, which makes data comparison more difficult (Connors et al., 2017; Burton, 2017; Eerkes-Medrano and Thompson, 2018; Hermsen et al., 2018; Koelmans et al., 2019; Koelmans et al., 2016; Li et al., 2018). However, different method can be used to for MP identification please see table 1.

Table 1: Identification method of microplastic.

No.	Method	Size	Advantages	References
1	Stereomicroscope	20 µm - 5 mm	Simple, fast, and easy	Erni-Cassola et al., 2017
2	Fourier transform infrared spectroscope (FT-IR)	>500µm- 10 µm	infra-red polychromatic source	Veerasingam et al., 2020
3	Michelson interferometer	nanoparticles	Popular, cheap, high resolution	Teresa et al., 2017
4	Raman spectroscopy	>0.5 µm< 20 µm	Time saving	Araujo et al., 2018
5	Surface Enhanced Raman Spectroscopy (SERS)	nanoparticles	low concentrations, high cost	Guanjun et al., 2020
6	Thermal analysis	50-100 µm	cheap, easy, well explore methodology	Peñalver et al., 2020

4.2. Treatment Methods of Microplastic

Microplastic end life was studies and several methods were suggested for treatment. Plastic materials can degrade by a variety of mechanisms such as physical photo- and thermo-oxidation, hydrolysis, chemical and biological degradation. Total decomposition is long and take many years. Physical degradation is the first step of the plastic degradation. Abiotic agents such as sun, water, wind, or soil do the first step of the process and cause profound modification of the molecular structure which leads to a loss of mechanical proprieties of the starting product. Degradation modifies many physical and chemical properties e.g. size, shape, charge etc. which affects important properties such as buoyancy, hydrophobicity, biofouling. The photodegradation has a main role in decomposition of plastics molecule under the actions of photons generated by the sun. Molecules of plastic move from a ground state to an excited state. The chemical degradation can happen to microplastic through oxidation and hydrolysis. Oxidative degradation is an important process that affects the distribution and fate of plastics in the marine environment. The durability of the material can vary greatly depending on the environmental conditions and design and quality of the product. Oxidative degradation of PE leads to formation of degradation products such as ketones, aldehydes, alcohols, carboxylic acids and low molecular mass hydrocarbon waxes. Once the molecular weight of the polymer is sufficiently reduced, the degradation products can be utilized by microorganisms as nutrients to produce CO2, water and biomass. Degradation creates also a much more attractive surface for biofouling and the formation of biofilm which causes the material to sink. Biotic agents such as bacteria, microorganism and their enzymes can destroy plastic too (Glaser 2019; Liu et al., 2014; Wagner et al., 2017).

4.3. Microorganisms and Enzymes

Enzymes are a new and environmentally friendly option for developing biodegradation strategies. Enzymes are non-toxic, biodegradable and can be produced in large amounts by microorganisms. Microorganisms and/or enzymes can be applied to biodegrade/decompose plastic waste and to resolve end-of-life issues of plastics, one of the major threats to our ecosystem. The plastics industry is increasingly applying eco-design principles when producing plastics, ensuring an appropriate end of life by recycling, degrading, or composting. Where these principles cannot be applied, industry needs to establish different systems to close the circle of plastic material in the end-of-life phase. This will avoid plastic littering land and sea and reduce plastic waste diverted to landfill or incineration. Scientists have recently found that some microbes (bacteria and fungi) have evolved the ability to break down plastics (Schuhen et al., 2019). Other scientists have discovered plastic-eating bacteria that can break down PET (Wagner et al., 2017). Applying microorganisms and/or enzymes in the end-of-life phase of plastics could result in new feedstock for the bio-based industry. They may even be applied to all sorts of residual streams without any preliminary separation or sorting operations. The specific challenge is to exploit the potential of microorganisms and/or enzymes to resolve end-of life issues with plastics. 335 million tons of PET waste is collected globally. If we can make use of just a few percent of that waste, that will quickly make a good business case." A round 480 billion plastic bottles are produced worldwide each year. Less than half of these are recycled. Even though Denmark and other countries have a deposit scheme where bottles are recycled, these bottles also eventually end up being discarded. Furthermore, only 30% of all the PET in the world is used in bottles. The other 70% are used for synthetic clothing fibres—polyester. Today, a negligible fraction of PET waste is used to produce new products. The rest is burned, buried, or ends up in the oceans, where degradation can take hundreds of years. Table 2 list the bacteria and enzyme that used to end several types of plastics life (Anderson et al., 2017; Baldwin et al., 2016; Catarino et al., 2016; Cole et al., 2014; Hermsen et al., 2018; Estahbanati and Fahrenfeld, 2016; Hendrickson et al., 2018; Hoellein et al., 2017; Hurley et al., 2018; Koelmans et al., 2019; Kühn et al., 2017; Munno et al., 2018; Löder et al., 2017; Pivokonsky et al., 2018; Vermaire et al., 2017; Ziajahromi et al., 2017) . Table 2 list the bacteria and enzyme that used to end several types of plastics life. Mostly these are enzymes are secreted by microorganism to degrade plant polymers. The most prominent enzyme classes are cutinases, lipases and proteases. Some of these enzyme monomers can be recovered and re-used.

Table 2: Microplastic degradation bacteria and enzyme.

No.	Microorganism	Plastic	Reference
1	Ideonella Sakaiensis- Mono(2-hydroxyethyl) terephthalic acid	PET	Yoshida et al., 2016
2	Fusarium Oxysporum Strain - p-nitrophenyl butyrate	PET	Nimchua et al., 2007
2	Fusarium Solani Pisi Cutinase - p-nitrophenyl butyrate	PET	Nimchua et al., 2007
3	Leaf Compost Cutinase - Thermobifida fusca Cutinase	PET	Wei et al., 2016
5	Shewanella, Moritella s., Psychtobactor sp., Pseudomonas sp.	PCL	Sekiguchi et al., 2010
6	Vibrio Alginolyticus, Vibrio Parahemolyticus	PVA-LLDPE	Raghul et al. 2014
7	Pseudomonas sp., Clonostachys Rosea, Trichoderma sp.	PCL,	Urbanek et al. 2017
8	Zalerion Maritimum - Carbonyl and hydrophobic	PE	Paco et al., 2017
9	Aspergillus Versicolor, Aspergillus sp.	LDPE	Parmila and Vijaya Ramesh 2011
10	Pseudomonas sp.	PCL	Sekiguchi et al., 2009
11	Pseudomonas sp., Alcanivorax sp., Tenacibaculum sp.,	PCL, PHB/V, PBS	Sekiguchi et al., 2011

5. CONCLUSION

Microplastic are widely distributed pollutant in the water bodies, agriculture, and food systems. A growing number of studies have shown an understanding of the impact mechanisms associated with microplastic exposure. This knowledge of smaller microplastic particles, however, is still limited.

The aim of the article was to review research that identify the impact of microplastic on freshwater, agriculture and ecosystems and the current treatment methods with focus on biodegradation of microplastics. The sources of microplastic are numerous and interact with many aspects of modern life, from the daily routine of individual citizens to the management of waste and accidental releases during industrial production, either on land or at sea. Recent scientific literature is still focused mainly on e.g. wastewater effluent, air and lacks almost completely the investigation of others, e.g. tires wear and paints. Research showed microplastics from WWTP as the main source from for microplastics to enter ecosystems. WWTPs potentially played an important role in releasing microplastics to the environment depending on the treatment units employed. Most of these microplastics accumulate in the sewage sludge. enhancement of WWTP facing the new micropollutants could be a challenge to maintain this promising alternative of reuse of treated wastewater in irrigation and food production. There are available technologies that can effectively remove microplastics during wastewater treatment, but they can be expensive, difficult to install in existing facilities and are only used when high-quality standards are required. Membrane bioreactors are an example after primary and secondary treatment, using crossflow filtration, diffusing only water and small particles. Another drawback of this technology is the high demand for energy and hence higher cost of operation, which could be a real barrier. The discovery of microorganisms capable of plastic degradation through enzymatic depolymerization has created growing interest in use of biocatalysis to reduce the number of microplastics released into the environment.

Politicians and people to be committed and to make conscious decisions until all plastic waste is permanently removed from the environment. Public awareness and legal action are rising because of the global plastics pollution crisis. Several countries in the world call for legislation banning individual plastic products, reforming waste disposal and preserving our environment. In summary, the origin of plastic pollution is due to the population growth and consumption habits that have been the same over the last 50 years. Instead of this linear economy focused on produce, use, throw, it is important to build a circular economy based on reuse and recycling of plastic. Human behavior and different compositions of plastic plays a main role in this excessive pollution and could influence its lifetime. Finally, there is a need for more accurate data on the emission of microplastic particles from various sources, such as buildings, paint, tyres, urban storm water and other sources, which should also receive more focus.

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