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article

Impact of Microplastics in the Environment on Health Protection

Yan Wang[1], Ziyuan Zhou [2], Xiaofen Liu[3], Li Chen[4], Yangfeng Shao[1], Shandan Ma[1], Siyan Chen[1], Zhiqu Le[1], Jieyao Chen[1], Chuxuan Gao[1], Hanyu Chen[1], Mengyao Zhang[1], Xiaohua Wang[1], Jiaxuan Li[1], Yitian Chen[1], Jianghang Yu[1], Tong Tong[1], Shiming Tang[1]*

[1] Hangzhou Normal University, 311121，Zhejiang, China
[2] Sun Yat-Sen University, 510275，Guangdong, China
[3] Wenzhou Ouhai District Xian Yan First Primal School, 325062, Zhejiang, China
[4] Hangzhou Wickham International School, 310056，Zhejiang, China

Abstract: This review examines the issue of microplastics in the environment, providing a comprehensive analysis of the concept, transmission routes and locations, effects on human health, and removal methods. Microplastics are plastic fragments with a diameter of less than 5 mm, which are commonly found in the environment such as the ocean, soil and air. These microplastics not only pollute the environment, but also may be potentially harmful to human health. Therefore, it is crucial to study the removal methods of microplastics in order to reduce their adverse effects on the environment and human beings. Further, from a health perspective, close to physical and psychological needs, Chinese traditional medicine including tea and wormwood may play a therapeutic role.

Keywords: Micro plastics; environment; health protection; physical and mental therapy.

With the widespread use and production of plastic products, microplastics have become a serious problem of environmental pollution today. The presence of microplastics has not only been widely detected in various natural environments, but has also been shown to negatively impact ecosystems and human health. The United Nations Environment Programmer (UNEP), in "Emerging Issues in the Global Environment 2016", states that plastic particles have spread across the globe and are increasing in number. The World Health Organization (WHO) in 2019 called for increased research on microplastics and to combat plastic pollution. The aim of this paper is to explore the concept of microplastics, how and where they are transported in different environments, their impact on human health, and current methods of removal. An in-depth understanding of these aspects will help us to

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better understand and address microplastic pollution in order to protect our environment and health.

1. Concept of microplastics

The concept of microplastics was first proposed by Richard Thompson in 2004, that is, plastic fragments, films or particles with a particle size of less than 5 mm, and microplastics with a particle size of 1-100 nm are called nanoscale microplastics, which include microplastics from the original production of small-sized particles, including those from the original production of small-sized particles[Thompson *et al.*, 2004]. Microplastics with a particle size of 1 to 100 nm are referred to as nanoscale microplastics, which include primary sources from the primary production of small-sized particles and secondary sources from the degradation or fragmentation of larger plastics. Depending on the physical form, micro plastics include fragments, fibers, particles, spheres, films and foams. The main chemical compositions of microplastics are polyethylene (PE), polystyrene (PS), polyvinyl chloride (PVC), polypropylene (PP), polyamide (PA), and others[Gan, Cui and Jin, 2023]. According to the source of microplastics can be divided into primary microplastics and secondary microplastics. Primary microplastics mainly refer to the microplastic particles that are directly discharged into the environment during people's production and life; secondary microplastics refer to the microplastic particles that are generated by the decomposition of plastic wastes through physical, chemical and microbiological effects. Compared with ordinary plastics, microplastic particles can cause pollution of soil, water, atmosphere and food chain, and increase the cost and difficulty of environmental pollution control. Because of their large surface area and lipophilicity, microplastics are easy to enrich heavy metals and organic matter in the environment and become an important carrier of heavy metals in the soil. Microplastics can adsorb pollutants such as triclosan and reduce their bioavailability[Zhu *et al.*, 2019]. In the aquatic environment, microplastics not only provide good carriers for microorganisms[He *et al.*, 2022], but also enhance the transport capacity for pathogenic microorganisms and promote the horizontal transfer of resistance genes[Imran, Das and Naik, 2019]. Microplastics have been detected in a variety of environmental media such as agricultural soils, industrial salt, and bottled water. Microplastics have also been detected in a variety of seafood tissues, such as fish, and in agricultural crops, implying that microplastics can enter human tissues[L. Li *et al.*, 2020]. Although the environmental hazards of microplastics are still uncertain, the health risks posed by their widespread presence should be taken seriously.

2. Migration pathways and locations of microplastics in different environments

2.1 Microplastics in the water environment

At present, a large number of studies have confirmed that microplastics can enter the food chain through adsorption and ingestion after entering the aquatic environment, causing potential toxic effects on aquatic organisms at various trophic levels, and transferring with the food chain, affecting the stable development of the whole aquatic ecosystem.

According to their sources, microplastics in the aquatic environment can be broadly divided into two kinds - primary and secondary microplastics[Wright, Thompson and Galloway, 2013]. Primary microplastics mainly include abrasive plastic beads in personal care products or industrial materials[Zitko and Hanlon, 1991], while secondary microplastics are small plastic particles formed by the decomposition of larger plastics due to mechanical abrasion or ultraviolet irradiation, etc[Thompson et al., 2004]. The sources of these microplastics are mainly fishing nets, plastic wrappings, chemical fiber garments, types, and other discarded industrial and household products, and they ultimately enter into the water bodies through surface runoff and other means. Sewage treatment plants are also one of the main sources of microplastics in water bodies, although sewage treatment processes can remove more than 80% of microplastics, but due to the huge amount of treatment, there are still a lot of remaining microplastics being discharged into water bodies[Hao et al., 2019]. According to Murphy et al. study of a wastewater treatment plant found that the average abundance of microplastics in the influent water (15.70±5.23) MP/L, the final effluent can be reduced to (0.25±0.04) MP/L, a reduction of 98.41%. Nevertheless, the plant still releases approximately 65 million microplastics per day into the receiving waters[Murphy et al., no date]. In addition, most of the microplastics removed by the sewage treatment process are retained in the sludge, and if the subsequent sludge is not disposed of properly, these microplastics can enter the soil and further enter the crops or re-enter the water bodies.

Freshwater is an important channel for the transfer of land-based microplastics to the ocean, 80% of land-based microplastics enter the ocean through freshwater , and a recent study shows that the amount of plastic entering the sea from major rivers around the world has reached 57,000-265,000 t[Mai et al., 2020]. A large number of land-based microplastics enter the water environment directly through sewage treatment plant discharges, runoff, atmospheric deposition and other pathways and accumulate, causing great potential risks to the terrestrial water environment, biodiversity and the environment [Wagner et al., 2014]. Moreover, freshwater is the main source of water for human consumption, and exposure to microplastics may pose a serious threat to human health.

2.2 Microplastics in soil

Microplastics in soil mainly come from human activities, including agricultural film cover, sewage sludge application and agricultural composting, and climatic processes, including atmospheric deposition and precipitation [Rillig, 2012]. Microplastics can use their adsorptive properties to undergo transport in the soil environment. For example, they can be transported in the soil through agitation, mixing and disruption of sedimentary particles around them by animals[Liu et al., 2019]. Small animals in the soil such as earthworms and hoppers can be transported by burrowing, diarrhoea and skin adhesion.[Maaß et al., 2017] Migration through plant root expansion and water uptake. Migration can also occur through human activities such as irrigation, drainage and ploughing[Zhang and Liu, 2018]. There are differences in the migratory properties of different microplastics, e.g. fibrous microplastics are more migratory than pieces of agricultural film and fragmented microplastics. Low-density microplastics are more likely to migrate horizontally through natural forcings in soil or water environments. Polyester microfibres (PMF) with a diameter of 3.7 μm in the surface soil of a cultivated field can be transported along the soil pore space to the deeper soil layer of 70 cm by biological activity or by rainwater infiltration

[Zhang et al., 2020].

2.3 Microplastics in the atmosphere

Atmospheric microplastics mainly come from re-suspension of urban dust, abrasion of synthetic rubber tyres and synthetic textiles, but also from construction processes (e.g., building materials, industrial emissions), end-of-life processes (e.g., incineration of rubbish wastes, recycling of plastics), and so on[Liu et al., 2019]. In addition, sea breeze and wave spray are important sources of MPs in coastal areas. It is estimated that about 136,000 tonnes of MPs are emitted from the ocean to the atmosphere in the form of wave spray every year[Allen et al., 2020].

Due to their small size and thinness, microplastics can be transported and transformed in three phases: the atmosphere, the water environment and the soil. Plastic products in industry and daily life are split into microplastics by weathering, ultraviolet irradiation and other factors and enter the atmosphere. Subsequently, microplastics can be transported to water bodies and soils by wind, dry and wet deposition in the atmosphere, human activities and other factors, and can also be transported to the food chain and food webs, which ultimately endanger human health. Factors affecting the behaviour and transport of microplastics in the atmosphere include: vertical pollution concentration gradients (higher concentrations near the ground); wind speed (increased wind speed reduces concentrations); wind direction (parallel or perpendicular to obstacles); and temperature (lower temperatures increase nucleation and condensation, reducing atmospheric concentrations of MPs)[Prata, 2018]. Widespread transport of atmospheric microplastics may also have an impact on global climate change and biogeochemical cycles. Atmospheric microplastics, as relatively stable carbon-containing compounds, can either affect plant photosynthesis by settling on tree leaves and influence carbon cycling in forest canopy ecosystems, or be used as a source of carbon by microorganisms, affecting atmospheric CO2 levels[Xu L. et al., 2022]. In addition, atmospheric microplastics can be rapidly fragmented and their surface area enlarged under sufficient ultraviolet light, which will greatly increase the ability of microplastics to adsorb higher concentrations of gaseous pollutant chemicals on their surfaces and can lead to the leaching or desorption of gaseous organic matter [Romera-Castillo et al., 2018]. In the long term, this will affect the global climate and distort the global biogeochemical cycle of carbon.

2.4 Microplastics in foods

Microplastics in food can be a source of microplastics in food, from food raw materials to manufacturing processes and food packaging materials. Microplastics trapped in food ingredients are one source of microplastics in food, and researchers have detected microplastics in several food ingredients. Water is an indispensable ingredient in food production, and studies have shown that microplastics are present in tap water, bottled water, drinking water, and groundwater. Of these, bottled water contains tens to hundreds of micro plastic particles per liter [Li et al., 2008]. Researchers have even found microplastics in salt, beer, milk, apples, pears, carrots, honey, sugar, and sea vegetables[Q. Li et al., 2020]. Microplastics may also be introduced into food during processing and production, such as from production and processing equipment, and from microplastics present in the atmosphere. Many of the production components used in the processing of food products are made of plastics, and microplastics can be introduced into food products during production due to mechanical effects such as friction, tearing, and ultraviolet irradiation, etc. Shruti et al.[Kutralam-Muniasamy et al., 2020] showed that sulfone polymers were introduced into milk during processing due to the wear and tear of ultrafiltration and microfiltration membranes. In addition, the presence of microplastics in the atmosphere is also of concern. Sources of microplastics in the atmosphere include road dust (e.g., tyres) and fires from synthetic textiles (e.g., workers' clothing, factory upholstery, etc.), and researchers have detected microplastics in atmospheric deposition in cities such as Hamburg, Germany; Shanghai, China; and Dongguan, China[Klein and Fischer, 2019]. Due to their light weight, these plastic particles are suspended in the air as "city dust" and fall to the surface of food during processing or consumption through atmospheric deposition. Recent studies have found that food packaging materials can also contribute to microplastic contamination of food[Ranjan, Joseph and Goel, 2021]. Plastic is lightweight, inexpensive, can bear and protect food, so that food in the entire circulation process from the outside world air, moisture, light, microbes and other influences, to avoid food in the transport, storage process due to external forces such as extrusion, impact and so on leading to breakage, deformation, in the field of food packaging materials are widely used. However, in the transport and use of food, food packaging materials in the protection of food at the same time, their own must withstand certain physical and chemical effects, these factors will aggravate the production of microplastics in food packaging materials. It has been established that common food packaging materials such as milk bottles[Zhou, Wang and Ren, 2022], tea bags[Hernandez et al., 2019], disposable paper cups[Ranjan, Joseph and Goel, 2021] and polyethylene trays produce[Lee et al., 2019] and release microplastics into food during use.

3. Impact of microplastics in the environment on human health

The human body is exposed to microplastics through ingestion, respiration and dermal contact, including consumption of microplastic-containing foods, inhalation of fragments of rubber tyres and synthetic textile fibres, and absorption of microplastics in hair follicles and wounds. Once dispersed in human organs, they can cause a variety of toxic effects, including oxidative stress, inflammation, immune dysregulation and neurological dysfunction

3.1 Effects of environmental microplastics on human organs

Existing studies have observed the presence of microplastics in human faeces and blood, which proves that the human body can indeed digest these plastic particles through the gastrointestinal tract, so that they reach the end of digestion and are eliminated with the faeces, but many of the plastic particles will still accumulate in human tissues and organs. Microplastics may penetrate the hepatic epithelial barrier as almost all blood from the intestinal tract needs to pass through the liver before it can be further distributed to the body. Nanoplastics with particle sizes below 100 nm may even be able to penetrate cell membranes and intestinal barriers and travel through the bloodstream to other organs [Schwabl et al., 2019].

The existing studies have shown that microplastics accumulate in the liver, spleen, kidney and other organs of the human body, and then cause inflammation, oxidative stress and immune response, resulting in biochemical changes, structural damage and dysfunction, and ultimately altering the normal biological functions, whose biological effects include enterotoxicity, hepatotoxicity, nephrotoxicity, neurotoxicity, etc. The main route of ingestion of microplastics is through the liver, spleen, kidney and other organs. Microplastics are mainly ingested through the mouth, so the gastrointestinal tract may be the main target organ for their toxic effects. Schwarzfischer et al.[Schwarzfischer et al., 2022] found that 50 nm PS could accumulate in the small intestine, spleen, liver and other organs of mice, confirming that nanoscale microplastics are capable of transcending the intestinal barrier and accumulating in the body. Many studies have shown that the accumulation of 0.5-50 μm PS particles in the normal mouse colon can disrupt the intestinal barrier function, reduce mucus production, inhibit the expression of tight junction proteins, and alter the composition of intestinal flora, even causing metabolic disorders. The liver and kidney, as the main metabolic organs of the human body, play an important role in metabolism. The presence of microplastics was also detected in the liver and kidneys of rodents, suggesting that microplastics entering the blood circulation can be received by the liver and kidneys [Shengchen et al., 2021]. It was found that 0.5 μm PS microplastics increased the infiltration of natural killer cells (NK) and macrophages into non-physical hepatocytes and induced an inflammatory response in the liver via the NF-κB signalling pathway[Zhao et al., 2021]. Regarding the kidney, Wang et al.[Wang et al., 2021] found that 5 μm PS could be accumulated in mouse kidneys, and also verified at the cellular level, and proposed that the possible mechanisms of kidney damage caused by microplastics include mitochondrial dysfunction of renal cells, endoplasmic reticulum stress and autophagy, and inflammation, which suggests that long-term exposure to microplastics may be a risk factor for kidney health.

3.2 Effects of environmental microplastics on the human respiratory system

Given the inhalable nature of microplastics, studies have also attempted to address the effects of microplastics on the human respiratory system. As early as 1998, Pauly et al.[Pauly et al., 1998] observed the presence of synthetic fibers in surgically resected lung tissue samples from patients with lung tumors, while in August 2021 Amato-Lourenço et al.[Amato-Lourenço et al., 2021] detected the presence of microplastics in 13 human lung tissue samples. The results of epidemiological studies showed an increased incidence of cancer in synthetic textile workers after 10-20 years of exposure to PP fibers compared to individuals not exposed to polypropylene, which was related to the intensity and duration of exposure; similarly, PVC workers had an increased risk of lung cancer, which was related to the number of years of work. Occupational health studies have also revealed that polyester and nylon fibers can cause symptoms such as coughing, dyspnea and wheezing, and may even contribute to the pathogenesis of diffuse interstitial lung disease [Atis et al., 2005]. A growing number of studies have shown that the presence of environmental microplastics in human respiratory specimens is associated with a higher incidence of malignant lung nodules, bronchial obstruction, and reduced lung function, although the levels of exposure in these studies may be different from those in the actual environment.

3.3 Effects of environmental microplastics on the human nervous system

Microplastics also have the potential to penetrate the blood-brain barrier, accumulate in the brain, and exhibit neurotoxicity [J.-L. Xu et al., 2022]. Lee et al.[Lee et al., 2022] detected 2 μm PS in the brains of mice exposed orally for 8 weeks, especially in the hippocampus, with altered expression of hippocampal synaptic genes and proteins, such as abnormal enhancement of the synaptic glutamate AMPA receptor, leading to specific learning and memory deficits in the mice. Similarly, Jin et al.[Jin et al., 2022] observed disruption of the blood-brain barrier, inflammation in the hippocampal region, and increased dendritic spine density levels in the brains of exposed mice with PS particles of different particle sizes (0.5, 4, and 10 μm), resulting in cognitive and memory deficits in the mice. Microplastic exposure has been shown to promote cognitive deficits and affect animal behavior, and exposure to micro-plastics and Nano plastics may alter neurotransmitter levels, which in turn disrupts neuronal systems and ultimately leads to behavioral abnormalities[Prüst, Meijer and Westerink, 2020].

3.4 Effects of environmental microplastics on the human reproductive system

The toxic effects of microplastics in the reproductive system are also increasingly being explored. Liu et al.[Liu et al., 2022] exposed female mice to 0.79 μm PS for 35 days, which resulted in bioaccumulation in the uterus, ovaries and blood, as well as induced inflammatory reactions in the ovaries and reduced oocyte quality, and even females may be more susceptible to microplastics than males in terms of reproduction and fertility. Using an ex vivo perfusion model, D'Errico et al.[D’Errico, Fournier and Stapleton, 2019] demonstrated that 20 nm PS could cross the placental barrier of mice and enter the maternal uterine artery through the umbilical vein and into the foetal compartment within 90 minutes of perfusion, suggesting that microplastics can be transferred from mother to offspring causing transgenerational effects and leading to developmental abnormalities or disorders in the offspring[Luo et al., 2019]. Maternal exposure to high concentrations of PS Nano plastics during gestation and lactation resulted in abnormal brain development and increased the risk of neurodevelopmental defects in the offspring[Jeong et al., 2022].

4. **Removal of microplastics**

4.1 Electro-flocculation

Electro-flocculation is a technique in which metal cationic flocculants are produced at the expense of anode metal electrodes under the action of electric field, and combined with suspended particles in water to form flocs to retain suspended solid particles, which is mostly used in industrial wastewater treatment. Its mechanism mainly includes three stages: (1) under the action of electric field anode (mainly aluminium and iron) dissolved, resulting in metal cations; (2) hydrolysis of metal cations to generate hydroxide, as a flocculant, and suspended pollutant particles to form micro-flocs; (3) hydrolysis of water into H2 at the cathode, so that the removal of light and heavy flocs, respectively, through the flotation and precipitation[Ingelsson, Yasri and Roberts, 2020]. Compared with traditional chemical coagulation, the advantages of electro-flocculation technology do not require the addition of chemicals such as aluminium sulphate or ferric chloride, it is more environmentally friendly and highly efficient, has a low sludge volume, and is transferable and replicable in the laboratory and industry[Perren, Wojtasik and Cai, 2018]. However, the cost of electrical energy consumption is also one of the challenges in the commercial application of the electrocoagulation process, which increases the operating cost of electrocoagulation. In addition, electrode contamination sometimes develops during the electrocoagulation process due to the long electrolysis time, which needs to be optimised to further reduce power and electrode consumption[Shen et al., 2022].

4.2 Magnetic separation

Magnetic separation is the use of magnetic nanoparticles as adsorbents to bind to the hydrophobic surface of microplastics, and then the magnetised MPs can be separated and removed by the magnetic field. 1.3 g/L of Fe3O4 nanoparticles was added to each environmental water sample by Shi Xiahong's team[Shi et al., 2022], and the sample was magnetised for 150 min at 25 ℃ for 180 r/min. The magnetised MPs were removed by the attraction of magnets and the residual Fe3O4 nanoparticles were recovered by a strong magnet. The results showed that the average removal rates of four common MPs, namely PE, PP, PS and PET, were as high as 62.83%~86.87%. The pH value of seawater solution was higher than the zero-charge point of the MPs used in the experiments, which made the surface of microplastics negatively charged and the surface of nano-Fe3O4 positively charged. The electrostatic attraction between the two can enhance the adsorption and magnetism of MPs, which makes the removal rate of MPs in seawater higher than that of pure water and fresh water. Since other impurity particles (e.g. soil particles) in the pollutant samples would prevent the magnetic nanoparticles from combining with microplastics, the magnetic separation technique is very suitable for the removal of microplastics in water bodies, and can effectively remove MPs from river water, domestic sewage water, natural seawater and other environmental water bodies, and it has a certain prospect of application for the control of microplastic pollution under the circumstance of ensuring that the residual magnetic adsorbent is removed cleanly. Magnetic separation technology is time-consuming and easy to operate, but we need to find more economical and environmentally friendly magnetic nanomaterials, and pay attention to the residual magnetic materials in the treated water.

4.3 Filtration

Filtration is divided into conventional membrane filtration, rapid sand filtration and membrane bioreactor (MBR) filtration.

Conventional membrane filtration technology is mostly used in the depth treatment of drinking water, that is, the use of different pore sizes of the membrane selective permeability to retain impurities. According to the pore size of the retained particles, they are divided into four categories: microfiltration (MF), ultrafiltration (UF), nanofiltration (NF) and reverse osmosis (RO). Among them, ultrafiltration has been proven to be the most effective microplastic removal technology. Conventional membrane filtration technology has the advantages of simple structure, low energy consumption and high removal efficiency, and it is one of the mainstream technologies for removing microplastics because different sizes of microplastics can be retained by selecting membranes with different pore sizes. However, there are some disadvantages, such as pore clogging and membrane wear. The small size of NP/MP can easily cause membrane pore clogging and reduce membrane flux[Enfrin, Dumée and Lee, 2019].

Rapid sand filtration is the rapid filtration of water using granular filter media such as quartz sand to retain impurities, and is widely used in water and wastewater treatment. Sembiring et al.[Sembiring, Fajar and Handajani, 2021] used a rapid sand filtration reactor to study the removal of man-made microplastic samples made from tyre flakes and plastic bags. The results showed that the removal efficiency of microplastics usually varied with the effective size of the filter media. The removal efficiencies ranged from 90.6% to 97.7% using silica sand of 0.39 mm in size, and from 85.2% to 94.3% using silica sand of 0.68 mm, respectively. The advantages of the rapid sand filter are relatively low operation and maintenance costs, suitable for the removal of large-size microplastics, but it is difficult to remove small-size microplastics (<10 μm), which can be combined with activated carbon, biochar and other improvements in the filtration media.

Membrane Bio-Reactor (MBR) is a new type of wastewater treatment technology that combines membrane separation technology with traditional biological treatment technology. According to Xuemin Lv et al.[Lv et al., 2019] the removal rate of MPs by membrane bioreactor was more than 97% in a wastewater treatment plant in Wuxi City, Jiangsu Province, for example, which was more effective than single biological treatment or conventional membrane treatment, and the microplastics were mainly accumulated in the sludge after removal. The membrane bioreactor can effectively remove microplastics from the contaminated water, and its removal rate of organic matter and ammonia may fluctuate in the early stage of microplastic contamination, but it will return to a stable state in a few days. The disadvantage is that the membrane pollution is serious, most of the microplastics that cause membrane pollution can be removed by flushing, but the small size of microplastics will lead to irreversible pollution and thus reduce the service life of the membrane.

4.4 Photocatalytic oxidation

Photocatalytic oxidation is the use of light and semiconductor oxides to degrade organic pollutants, of which TiO_2 is the most widely used due to its high oxidizing capacity for many organic pollutants under ultraviolet light. Photon bombardment of semiconductors such as TiO_2 under illumination generates positively charged holes, which subsequently react with water and oxygen to produce hydroxyl (-OH) and superoxide width=51,height=13,dpi=110 reactive radicals. These reactive species attack the MP and lead to polymerization chain breaks, which ultimately mineralize the micro-plastics adsorbed on the semiconductor surface into CO_2 and H_2O[Zhao et al., 2007].The photocatalytic degradation of polystyrene (PS) and polyethylene (PE) on TiO_2 nanoparticle films under UV irradiation was investigated by Iqra Nabi et al.[Nabi et al., 2020]. Among them, TXT synthesized films have better performance compared with ET and WT. Its surface hydrophilicity enhances the interaction between semiconductor and plastic, and the film structure leads to charge transfer and separation, resulting in rapid degradation of microplastics. Abdusalam Uheida et al.[Uheida et al., 2021] catalyzed the degradation of PP microplastic particles suspended in water using zinc oxide nanorods (ZnO NRs) on glass fiber substrates under visible light irradiation. The volume of PP particles was reduced by about 65% on average compared with that of fresh PP particles. After 2 weeks of irradiation, the average reduction in particle volume was 65%. The main photodegradation by-products were identified by GC/MS and most of them were non-toxic (formaldehyde, acetaldehyde, acetone, butyraldehyde and various organic radicals).Maria Camila Ariza-Tarazona et al.[Ariza-Tarazona et al., 2019] performed degradation experiments on PE microplastic particles extracted from facial scrubs under visible light irradiation by using a porous N-TiO2 semiconductor based on mussel protein. The photocatalytic degradation efficiency was significantly affected by the reaction conditions such as solution pH, temperature, humidity and porosity. The dehydration of the samples caused by low humidity would reduce the generation of hydroxyl radicals, which would lead to the stagnation of the reaction. Acidic conditions would stimulate the binding of H+ ions to the surface of the microplastics to promote the degradation, and the high porosity would increase the contact area between the microplastics and the N-TiO2, which would lead to a higher degradation efficiency. Photocatalytic degradation technology uses light (ultraviolet light, sunlight) as a clean energy source, and the by-products produced in most cases are non-toxic, and there is a hope that microplastics can be converted into fuels through photocatalysis in the future. However, the light time required for degradation is too long and the conditions are harsh, so it is necessary to design more effective photocatalysts to further improve the degradation rate.

4.5 Biodegradation

Biodegradation, i.e., the isolation and cultivation of plastic-degrading bacteria and fungi from wastewater, sludge, certain organisms and landfill waste, is the most economical and environmentally friendly technology for the removal of MPs. Pseudomonas spp. have attracted attention for their ability to degrade different types of plastics. Nanda et al.[Nanda, Sahu and Abraham, 2010] treated natural and synthetic polyethylene with Pseudomonas spp. collected from three different regions and found that Pseudomonas spp. from sewage sludge piles were the most effective, with degradation rates of 46.2% for natural polyethylene and 29.1% for synthetic polyethylene. Pseudomonas aeruginosa from domestic waste dumps showed the lowest biodegradation rates of 31.4 per cent and 16.3 per cent for natural and synthetic polyethylene, respectively. Pseudomonas aeruginosa isolated from textile wastewater showed a degradation rate of 39.7%. Skariyachan et al.[Skariyachan et al., 2017] showed a weight loss of about (55±2)% and (43±3)% of LDPE and HDPE particles, respectively, after 120 d of treatment at elevated temperatures using microbial communities formulated with Bacillus sphaericus, Bacillus sphaericus-like organisms, Maltophilic Narrow-feeding Mononucleotide (NFM) and Pseudomonas aeruginosa. Dang et al.[Dang et al., 2018] treated three kinds of plastic bags made of different materials with Bacillus sphaericus isolated from agricultural compost residues for 30 d at 55 ℃, and found that the molecular weight of the bags was significantly reduced, and the surface morphology was also changed. The reason was that Bacillus could secrete MPs hydrolysis enzymes, mainly including protease, xylanase, carboxymethyl cellulase, lipase and chitinase. In addition, some algae also have the ability to remove microplastics. For example, algae can remove more than 84% of three kinds of microplastics, including polystyrene (PS), polymethylmethacrylate (PMMA) and polypropylene lactate (PLA), through heterogeneous aggregation and enhanced adsorption [Cheng and Wang, 2022]. Biodegradation is green and environmentally friendly, but there are also the problems of low degradation efficiency and long degradation time, low degradation degree, and difficult to be applied industrially, which can be further combined with genetic modification technology to cultivate the advantageous bacterial flora and determine its optimal environmental conditions.

5. Creative Thinking

5.1 Refreshing Therapy

The study of traditional Chinese medicine plays key role in modern problem solving. Current research results of this team reflect that tea and wormwood can be innovatively developed into physical and mental healing involving above issues. For example, if people have seen the bluest and boundless sky, they may love the thick soil under their feet more. Having heard the most heartwarming music, one will appreciate the simple and agile notes even more. The clinical healing of tea, which comes with tea, gives people a refreshing, elegant, leisurely, carefree, friendly and natural feeling. [Tang et al, 2023]

5.2 Detoxifying Therapy

In the meantime, wormwood leaves are used as medicine. They have the effects of regulating blood, expelling dampness and cold, stopping bleeding and pacifying the fetus, and are also often used in acupuncture. Being known as "medical herb", mugwort leaves can moxibustion various diseases. The "Material Medical from New" states: "mugwort leaves are can penetrate various meridians and various diseases." This indicates that using mugwort leaves has the effects of clearing meridians and activating collaterals, reducing swelling and nodules to save adverse reactions. [Tang et al, 2023]

5.3 Multiple Countermeasurse

As an important part of environmental pollution, microplastics have a wide and far-reaching impact on the environment and human health. Understanding how and where microplastics are transported is key to understanding their role in the ecosystem. In particular, the possible impacts on human health require enhanced research and monitoring. At the same time, the development of efficient microplastic removal technologies is one of the keys to solving this problem. Taken together, integrated management measures for micro plastic pollution are imminent.

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