RESEARCH ARTICLE

Eurasian Journal of Medical and Biological Sciences
AN INTERNATIONAL JOURNAL
Eurasian J Med Biol Sci **3(2): 80-86**

Measuring The Awareness of University Students Educated in The Field of Health about Microplastics and its Effects on Human Health

Tiinçe Aksak*[1], Harika Topal Önal[1]

[1]*Department of Medical Services and Techniques Health Services of Toros University, Mersin, Turkey*

Received : 07/09/2023 Revised : 02/11/2023 Accepted : 05/12/2023

ABSTRACT: Microplastics, which are released by the breakdown of plastics, adversely affect health by accumulating in various tissues in the human body through packaging, transportation, water and air. In recent years, it is frequently preferred in every field in terms of cheap and comfortable use. The negative effects of microplastics on human health is an issue that needs to be developed in social awareness. It is important to raise awareness of people who will become health personnel in the future, both in terms of their own health and in raising awareness of other people. In this study, it was aimed to measure the awareness of the effects of microplastics on human health among students studying at Toros University Health Services. Microplastic Pollution Awareness Scale was applied to 410 students aged between 19-23 years, studying at Toros University Health Services Vocational School, by using appropriate sampling method to measure their microplastic awareness. The results were evaluated by statistical analysis. When the results of the survey were examined, there were significant differences in total scores between men and women, between the ages of 17-22 and those aged 20-23 and above, between those who use plastic bags and those who use paper or cloth bags ($p<0.001$). Especially through food, microplastics accumulate in various tissues and cause negative effects on human health. Larger studies are needed to raise public awareness of the negative health effects of microplastics.

Keywords: Attitude, awareness, behavior, health, microplastic, students.

INTRODUCTION

Today, the rapid increase in the population and accordingly the consumption has brought about the increase in the use of materials that can be used easily, easily cleaned and cheap. Plastics are the most preferred materials with these properties (Crawford and Quinn, 2016). At the same time, being flexible, durable and light is the reason for preference in food packaging. Plastic types such as polyethylene (PE), polypropylene (PP), polystyrene (PS), polyvinyl chloride (PVC) and polyethylene terephthalate (PET) are mostly used in food packaging (Koelmans et al., 2022). Sun rays and weather conditions cause plastics to break down into micro, meso or nano particles (Garcia-Vazquez and Garcia-Ael, 2021). Microplastics are particles smaller than 5 mm formed as a result of deformation of plastics by external factors. Water and food stored in plastics can be broken down to micro and nano size after a while and mixed with food (Karbalaei et al., 2018). Microplastics can penetrate and accumulate in many organs and tissues in the circulatory, digestive and reproductive systems. Bioaccumulation makes microplastics dangerous (Zolotova et al., 2022).

Microplastics can be found in water, on land, and in the air. Microplastics are called primary and secondary microplastics, depending on whether they are produced as a result of direct human activity or the breakdown of plastics produced in larger sizes over time (Prata et al., 2020). Primary microplastics are industrial raw materials that are melted and molded to produce larger plastics. They are mostly produced in the cosmetics industry in the form of microspheres and pellets, and they are used in personal care products such as toothpaste and cream, and in the production of clothes in the form of synthetic fibers. Microplastics are carried by wind, wastewater, fresh and salt water. Plastic, which has entered our lives for decades, has become available in every layer of the seas. Plastics are spreading into the ecosystem with many living things from plankton to marine mammals (Covernton et al., 2019). In addition, some studies have shown that microplastics are transferred to humans through the food chain (Jiang et al., 2022). However, invertebrates and vertebrates can directly consume these particles or receive them via trophic transfer (Chitalia, 2018). Secondary microplastics are particles formed as a result of the degradation of plastics in plastic bags, crates, plastic water bottles and carboys by UV light and mechanical means. Consumption of marine organisms exposed to microplastic pollution through food causes the accumulation of particles in the digestive tract. Although it is thought that the microparticles accumulated in the digestive system of the fish will not cause any negative effects unless the digestive part of the fish is consumed, especially the crustaceans such as mussels and mollusks, which are consumed as a whole with the digestive part, cause microplastic exposure in humans (Smith et al., 2018).

There is a wide range of microplastics that can be separated according to their shape and color. The color of microplastics can be a reagent that indicates how much microplastic contamination a substance has (Sharma and Chatterjee, 2017). For example, transparent or white microplastics are the most commonly ingested microplastics by sea creatures. In a study, it was

* tiince.aksak@toros.edu.tr

shown that 126 million nanoparticles were formed by exposing the lid of a coffee cup made of 1 cm2 polystyrene to 320-400nm UV light for about 2 months in a 30-degree environment (Ranjan et al., 2021). It has been shown that microplastic particles can easily reach all parts of the water and be perceived as food by sea creatures. Secondary microplastics (MPs) are mostly found in natüre (Prata et al., 2020). In the literature, there are studies showing the presence of microplastics in many foodstuffs such as tap water, plastic bottles, table salt, sugar, honey, tea bags, beer, packaged products and canned foods (Kedzierski et al., 2020; Kirstein et al, 2021; Mühlschlegel et al., 2021; Makhdoumi et al., 2023). Recently, research into the contamination of microplastics in the food chain has focused on rice, vinegar, milk wine, energy drinks and soft drinks (Dowarah et al., 2022). Studies conducted in some non-marine creatures have shown that microplastic contamination is high in the gizzards of chickens, especially in areas with high plastic pollution. Microplastics have also been shown to enter the food chain through soil contamination. Irrigation of agricultural areas with wastewater, use of organic fertilizers, tire wear and leakages from landfills are the main microplastic pollution in the soil (Karbalaei et al., 2018). The presence of microplastics in agricultural areas can cause them to be taken into the human body through the food chain (Dowarah et al., 2022).

Microplastics are passed to humans through the contaminated food they eat or the air they breathe. Some studies have shown the presence of microplastics in human blood, urine, and breast milk (López-Vázquez et al., 2022; Zhang et al., 2023). Although it is thought that most of the microplastics are excreted through the faeces after consumption, it is known that the microplastics absorbed from the intestinal epithelium are smaller than 150 µm. Smaller sized microplastics (less than 1.5 µm) are likely to penetrate tissues. However, there are not enough studies in the literature showing the effects of microplastics on tissues. For this reason, the negative effects of microplastics on human health have not yet been clarified (Önal and Ayaz, 2022).

Considering the widespread use of plastics today, it is known that the nutritional habits of university students who study far from their families focus on packaged and fast-food products. Such foods are preferred by university students because they are easily accessible. It has been observed that the existing studies in the literature mostly cover the field studies on microplastic-environmental pollution and microplastics on human health (Büyüköztürk et al., 2008; Gülesir and Gül, 2022). There are few studies showing the importance of awareness and education as much as the importance of fieldwork. It is important for the students who are educated in the field of health who will be the health professionals of the future to know the effects of microplastics taken with drinking water and food on human health both in terms of their own health and raising the awareness of other people. There is not enough information about this and similar studies in the literature. For this reason, in our study, the awareness of microplastics in drinking water and food on human health of students studying at Vocational School of Health Services will be investigated.

MATERIALS AND METHOD

The study was carried out in order to measure the microplastic pollution awareness of the students in Mersin province Toros University Vocational School of Health Services in the 2022-2023 second semester. In this study, the causal comparison method, one of the qualitative research methods, was used. Causal comparison studies identify variables that affect the causes of an existing or naturally occurring condition or event. In this context, the Microplastic Pollution Awareness Scale was used (Gülesir and Gül, 2022). There are 14 questions in total, with 5 negative and 9 positive questions in the scale. The scale, which has a Likert feature, consists of "No" (1 point), "I am not sure" (2 points) and "Yes" (3 points). The scale internal consistency coefficient was calculated (Cronbach Alpha).

After obtaining the consent of the authors, demographic information questions consisting of 3 questions (the department where the students are registered, age, gender) were added to the beginning of the scale. The next 6 questions were asked in order to learn the attitudes and behaviors of the participants in their plastic use habits. Approval was obtained from the Scientific Research and Publication Ethics Committee of Toros University in order to apply the scale to the students with the decision of 28.11.2022/176. The answers of the students who participated in the study using the microplastic pollution awareness scale were evaluated statistically. The lowest score was 14 and the highest 42 was evaluated in the scale consisting of "No" (1 Point), "I am not sure" (2 Points) and "Yes" (3 Points). The sample of the research consists of 410 students studying in different departments at Toros University, Vocational School of Health Services in the fall semester of 2022-2023.

Microplastic Pollution Awareness Scale was applied in order to measure the microplastic awareness of the participants determined by using the appropriate sampling method. The researchers informed the participants about the study prior to the implementation of the scale and coordinated the data collection process. 11.2% (n=46) of the participants were Child Care and Youth Services Department, 4.4% (n=18) was Dental Services Department, 1.2% (n=5) was Electronics and Automation Department, 3% (n=15) of them are from the Department of Therapy and Rehabilitation and 79.5% (n=326) of them are from the Department of Medical Services and Techniques. In addition, 78.3% (n=321) of the participants were women and 21.7% (n=89) were men. The age range of the participants participating in the study was calculated as 17-23 and the average age was calculated as 20.19 (S=1.46).

Data Analysis

As a result of statistical Skewness-Kurtosis analysis, normal distribution was found in the tested variables. As a result, parametric tests were performed. $p<.05$ significant groups were determined by ANOVA and t test. A statistically significant

difference was observed between female-male students, between students under the age of 19 and student groups aged 20 and over, and between the methods of transporting the foods they bought from the market.

RESULTS

Within the scope of this research, it was aimed to examine the microplastic awareness levels of students in terms of different variables. The independent variables of the research are gender, age, drinking water consumption habits, packaged food consumption habits, market food transportation habits, seafood consumption habits, pet glasses usage habits and bag tea consumption habits. The dependent variable is the students' microplastic awareness levels. After the t-test to compare the microplastic awareness levels of women and men, a significant difference was found between male and female participants in terms of microplastic pollution awareness (t=4.992). Accordingly, female participants' microplastic awareness ($\bar{X}$=35.57) is higher than male participants' microplastic awareness levels ($\bar{X}$=32.85) (Table 1). 51.4% of the students participating in the study are in the age range of 17-19, while the remaining 48.6% are in the age range of 20-23 and above. After the t test to compare the microplastic awareness levels of the participants aged 17-19 and those aged 20-23 and over, a significant difference was found between these two groups in terms of microplastic pollution awareness (t=2,585) (Table 2). One-way analysis of variance was used to determine whether there was a significant difference between the drinking water consumption habits (carboy, petbottle, purification) and microplastic awareness levels of the participants. After the one-way analysis of variance to compare the drinking water consumption habits (carboy, pet, treatment) and microplastic awareness levels, no significant difference was found between the groups and microplastic pollution awareness, F (3,409)=.894, p=.444 (Table 3). While 35.4% of the students participating in the study did not consume any packaged food, the remaining 64.6% said they consume packaged food. In addition, the microplastic awareness ($\bar{X}$=34.9767) of the participants who did not consume any packaged food was very close to the microplastic awareness levels ($\bar{X}$=35) of the participants who consumed packaged food. After the t-test to compare the microplastic awareness levels of the participants who did not consume packaged food with those who did, no significant difference was found between these two groups in terms of microplastic pollution awareness (t=-.053) (Table 4). t-test was used to determine whether there was a significant difference between the bag usage habits of the participants (plastic bags and paper bags or cloth bags) and their microplastic awareness levels during grocery shopping. After the t test for comparison, a significant difference was found between these two groups in terms of microplastic pollution awareness (t=-2.777). There is a difference between the microplastic awareness levels of the participants who use plastic bags ($\bar{X}$=34.6050), and the microplastic awareness levels ($\bar{X}$=35.8140) of the participants who use paper bags or cloth bags (Table 5). One-way analysis of variance was used to determine whether there was a significant difference between the frequency of seafood consumption and the microplastic awareness levels of the participants. No significant difference was found between these groups and microplastic pollution awareness, F (2,409)=1.437, p=.239 (Table 6). One-way analysis of variance was used to determine whether there was a significant difference between the frequency of use of plastic cups and the microplastic awareness levels of the participants. After the one-way analysis of variance performed to compare the frequency of use of plastic cups and the microplastic awareness levels of the participants, no significant difference was found between these groups and microplastic pollution awareness, F (2,409)=1.919, p=.148 (Table 7). One-way analysis of variance was used to determine whether there was a significant difference between the frequency of consumption of tea bags and the microplastic awareness levels of the participants. After the one-way analysis of variance to compare the frequency of consumption of tea bags with the microplastic awareness levels of the participants, no significant difference was found between these groups and microplastic pollution awareness, F (2.409)=1.982, p=.896 (Table 8).

Table 1. *T-test chart for Microplastic awareness levels of men and women*

Group	N	Average	Standard deviation	t	df	p
Women	321	35.5763	3.91567	4.992	123.653	<.001
Men	89	32.8539	4.71350			

Table 2. *T-test table for Microplastic awareness levels of participants under 19 years and 20 years and older*

Group	N	Average	Standard deviation	t	df	p
Under 19 years	145	35.6966	3.99883	2.585	317.213	.01
20 years and older	265	34.5962	4.33528			

Table 3. *One-way analysis of variance table for different drinking water consumption habits and Microplastic awareness levels of the participants*

Group	N	Average	Standard deviation	t	df	p
Never consume	258	34.9767	4.24349	-.053	408	.957
Consume	152	35.0000	4.26754			

Table 4. *T-test table for Microplastic awareness levels among those who never consume packaged food and those who consume packaged food*

Group	N	Average	Standard deviation	t	df	p
Never consume	258	34.9767	4.24349	-.053	408	.957
Consume	152	35.0000	4.26754			

Table 5. *T-test table for plastic bag, paper bag, cloth bag usage habits and Microplastic awareness levels*

Group	N	Average	Standard deviation	t	df	p
Plastic bag	281	34.6050	4.31490	-2.777	267.274	.006
Paperbag or clothbag	129	35.8140	3.98781			

Table 6. *One-way analysis of variance table for participants seafood consumption frequency and Microplastic awareness levels*

Group	Total of Squares	df	Average of Squares	F	p
Between Groups	51.730	32	25.865	1.437	.239
In-groups	7326.182	407	18.000		
Total	7377.912	409			

Table 7. *One-way analysis of variance table for the frequency of use of plastic cups and Microplastic awareness levels of the participants*

Group	Total of Squares	df	Average of Squares	F	p
Between Groups	68.907	2	34.453	1.919	.148
In-groups	7309.005	407	17.958		
Total	7377.912	409			

Table 8. *One-way analysis of variance table for the frequency of consumption of tea bags and Microplastic awareness levels of the participants*

Group	Total of Squares	df	Average of Squares	F	p
Between Groups	68.907	2	34.453	1.919	.148
In-groups	7309.005	407	17.958		
Total	7377.912	409			

DISCUSSION

In recent years, due to the increase in population and consumption around the world, interest in microplastics, which is a cheap and comfortable material, has increased. Microplastics are preferred in cosmetics, packaging and transportation of drinking water and food, thanks to their flexible, durable and light properties.

Since microplastics contain substances that cause toxicity such as phthalates and PCBs, and contaminants are easily absorbed on the surface, they pass into the human diet (Lassen et al., 2015). The ingestion of microplastics by sea creatures and their accumulation in their circulation have negative consequences for the health of people who consume these products. Health problems caused by the use of products such as face wash, body care, toothpaste have been evaluated by the German Federal Institute for Risk Assessment (BfR, 2015). Microplastic particles such as PE and PP larger than 1 μm have been found in skin care products such as peeling or face masks. It has been reported that these particles cause skin damage as a result of absorption in tissues. It has been reported that microplastics in toothpastes are absorbed in the gastrointestinal tract when swallowed. Continuous intake of microplastics with food can cause chromosomal infertility, obesity and cancer. Especially in women, the risk of developing breast cancer increases as a result of chemicals that mimic estrogen (Anderson et al., 2015).

Microplastic awareness rate in our study was 83.30%, and 74.4% in Malaysia (Aminrad et al., 2013), 74.32% in India (Dowarah et al., 2022), 74% in Hungary (Stevens, 2002), Singapore (70.9%) (Ivy et al., 1998) were found to be compatible with these studies. Microplastic awareness ($\bar{X}$=35.6966) of female participants participating in the survey was found to be higher than that of male participants ($\bar{X}$=34.5962). According to this result, it may be due to the fact that female participants are more sensitive and worried about microplastic awareness, and that women are more involved in environmental and health actions by raising awareness through education. It may also have an impact that women are pioneers in raising public awareness. The

subject of microplastic use and health effects is relatively new. Society should be made aware of this issue and it should be added to school education curricula. 51.4% of the students participating in the study are in the age range of 17-19, while the remaining 48.6% are in the age range of 20-23 and above. After the t-test to compare the microplastic awareness levels of the participants aged 17-19 and those aged 20-23 and over, a significant difference was found between these two groups in terms of microplastic pollution awareness ($p<0.00,1$). According to these results, those aged 17-18-19 and those aged 20 21 22 23 and over were found to be more sensitive to microplastic pollution in terms of scale total score. For this reason, we believe that individuals under the age of 19 will have a higher awareness of microplastic pollution and that future generations will adopt the concept of microplastic pollution more clearly and will reduce their attitudes and habits on this issue. Also, including the subject of microplastic pollution in the curriculum as part of formal education may encourage better environmentally friendly behaviour.

As seen in table V., a significant difference was found between these two groups in terms of microplastic pollution awareness after the t-test performed to compare the microplastic awareness levels of the participants who use plastic bags during grocery shopping and those who use paper bags or cloth bags ($t=-2.777$). We observed a significant relationship between the microplastic awareness levels of the participants using plastic bags ($\bar{X}=34.6050$), and the microplastic awareness levels ($\bar{X}=35.8140$) of the participants using paper bags or cloth bags. However, the use of microplastics in food packaging does not yet occupy the minds of students.

It is necessary for people to be aware of the risks of microplastics in terms of health and environment and to direct them to the use of alternative materials instead of the use of microplastics. Charitou et al. (2021), who made the first attempt to raise awareness of the public on the use of microplastics and controlled substances, stated in a circular that they would raise awareness of adults and families by making more publicity about European directives. In addition, it is aimed to increase awareness of microplastic pollution by integrating the subject into school curricula and to provide awareness in primary and secondary education (Charitou et al., 2021).

In our study, the Microplastic Pollution Awareness Scale was applied to 410 students aged between 19-23 years, studying in different departments at Toros University, Vocational School of Health Services in the 2023, using the appropriate sampling method to measure their microplastic awareness. We observed significant differences in the total score of the scale among males and females, between those aged 17-19 years, those aged 20-23 and over, and between those who use plastic bags and those who use paper bags or cloth bags. In the next study, Microplastic Pollution Awareness can be evaluated by increasing the sample size and the age range of the people participating in the survey. In addition, the questions in the questionnaire can be diversified and different scales can be developed.

CONCLUSION

Exposure to microplastics in various ways causes adverse effects on human health. People are more exposed to microplastics due to their ability to stay and accumulate in nature for a long time, and as a result, microplastics accumulate in tissues and cause various diseases. In the literature, information on the effects of microplastics on human health resulting from environmental and dietary intake is limited. According to the results of our study it is necessary to increase the awareness of individuals in terms of the increase and unconscious use of plastics in our environment. It is recommended to carry out studies with larger sample sizes and to increase the diversity of research in the future.

CONFLICT OF INTEREST

No conflict of interest was declared by the authors.

REFERENCES

Aminrad, Z., Zakariya, S. Z. B. S., Hadi, A. S., Sakari, M. (2013). Relationship between awareness, knowledge and attitudes towards environmental education among secondary school students in Malaysia. World Applied Sciences Journal, 22 (9), 1326-1333.

Anderson, A., Andrady, A., Arthur, C., Baker, J., Bouwman, H., Gall, S., Wyles, K. (2015). Sources, fate and effects of microplastics in the environment: a global assessment. GESAMP Reports&Studies Series, (90.Protection). Rep Stud GESAMP No. 90, pp 96.

Bfr. (2015) Microplastic Particles in Food. BfR Opinion No. 013/2015 of 30 April 2015. English summary of the report Mikroplastikpartikel in Lebensmitteln, Stellungnahme Nr. 013/2015 des BfR vom 30. April 2015. German Federal Institute for Risk Assessment.

Buyukozturk, Ş., Akgun, O. E., Karadeniz, Ş. (2008). Funda Demirel ve Ebru Kılıç Çakmak. Bilimsel araştırma yöntemleri, Ankara: Pegem Akademi, 185-187.

Charitou, A., Aga-Spyridopoulou, R. N., Mylona, Z., Beck, R., Mclellan, F., Addamo, A. M. (2021). Investigating the knowledge and attitude of the Greek public towards marine plastic pollution and the EU Single-Use Plastics Directive. Marine pollution bulletin 166, 112182.

Chitalia, R. (2018). Report on the Indian plastics industry.

Covernton, G. A., Pearce, C. M., Gurney-Smith, H. J., Chastain, S. G., Ross, P. S., Dower, J. F., Dudas, S. E. (2019). Size and shape matter: a preliminary analysis of microplastic sampling technique in seawater studies with implications for ecological risk assessment. Science of the Total Environment, 667, 124-132.

Crawford, C. B., Quinn, B. (2016). Microplastic pollutants. Elsevier Limited.

Dowarah, K., Duarah, H., Devuipriya, S. P. (2022). A preliminary survey to assess the awareness, attitudes/behaviours, and opinions pertaining to plastic and microplastic pollution among students in India. Marine Policy, 144, 105220.

Garcia-Vazquez, E., Garcia-Ael, C. (2021). The invisible enemy. Public knowledge of microplastics is needed to face the current microplastics crisis. Sustainable Production and Consumption, 28, 1076-1089.

Gulesir, T., Gul, A. (2022). Development of Microplastic Pollution Awareness Scale for Prospective Science and Biology Teachers. International Online Journal of Education and Teaching, 9 (2), 852-870.

Ivy, T. G. C., Road, K. S., Lee, C. K. E., Chuan, G. K. (1998). A survey of environmental knowledge, attitudes and behaviour of students in Singapore. International Research in Geographical and Environmental Education, 7(3), 181-202.

Jiang, Y., Yang, F., Kazmi, S. S. U. H., Zhao, Y., Chen, M., Wang, J. (2022). A review of microplastic pollution in seawater, sediments and organisms of the Chinese coastal and marginal seas. Chemosphere, 286, 131677.

Karbalaei, S., Hanachi, P., Walker, T. R., Cole, M. (2018). Occurrence, sources, human health impacts and mitigation of microplastic pollution. Environmental science and pollution research, 25, 36046-3

Kedzierski, M., Lechat, B., Sire, O., Le Maguer, G., Le Tilly, V., Bruzaud, S. (2020). Microplastic contamination of packaged meat: Occurrence and associated risks. Food Packaging and Shelf Life, 24, 100489.

Kirstein, I. V., Gomiero, A., Vollertsen, J. (2021). Microplastic pollution in drinking water. Current Opinion in Toxicology, 28, 70-75.6063.

Koelmans, A. A., Redondo-Hasselerharm, P. E., Nor, N. H. M., De Ruijter, V. N., Mintenig, S. M., Kooi, M. (2022). Risk assessment of microplastic particles. Nature Reviews Materials, 7 (2), 138-152.

Lassen, C., Hansen, S.F., Magnusson, K., Noren, F., Hartmann, N.I.B., Jensen, P.R., Nielsen, T.G., Brinch, A. (2015). Microplastics: occurrence, effects and sources of releases to the environment in Denmark. The Danish Environmental Protection Agency. http://www.eng.mst.dk/

López-Vázquez, J., Rodil, R., Trujillo-Rodriguez, M. J., Quintana, J. B., Cela, R., Miró, M. (2022). Mimicking human ingestion of microplastics: Oral bioaccessibility tests of bisphenol A and phthalate esters under fed and fasted states. Science of the Total Environment, 826, 154027.

Makhdoumi, P., Pirsaheb, M., Amin, A. A., Kianpour, S., Hossini, H. (2023). Microplastic pollution in table salt and sugar: occurrence, qualification and quantification and risk assessment. Journal of Food Composition and Analysis, 105261.

Muhlschlegel, P., Hauk, A., Walter, U., Sieber, R. (2017). Lack of evidence for microplastic contamination in honey. Food Additives & Contaminants: Part A, 34(11), 1982-1989.

Onal, H. T., Ayaz, F. (2022). Effects of microplastics on the biological systems. Advanced Engineering Days (AED), 4, 36-38.

Prata, J. C., Da Costa, J. P., Lopes, I., Duarte, A. C., Rocha-Santos, T. (2020). Environmental exposure to microplastics: An overview on possible human health effects. Science of the total environment, 702, 134455.

Ranjan, V. P., Joseph, A., Goel, S. (2021). Microplastics and other harmful substances released from disposable paper cups into hot water. Journal of Hazardous Materials, 404, 124118.

Sharma, S., Chatterjee, S. (2017). Microplastic pollution, a threat to marine ecosystem and human health: a short review. Environmental Science and Pollution Research, 24, 21530-21547.

Smith, M., Love, D. C., Rochman, C. M., Neff, R. A. (2018). Microplastics in seafood and the implications for human health. Current environmental health reports, 5, 375-386.

Stevens, E. S. (2002). Green plastics: an introduction to the new science of biodegradable plastics. Princeton University Press.

Zhang, Q., Liu, L., Jiang, Y., Zhang, Y., Fan, Y., Rao, W., Qian, X. (2023). Microplastics in infant milk powder. Environmental Pollution, 323, 121225.