Synthetic Textiles and Microplastics

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Abstract

Microplastics, tiny plastic particles less than five millimeters in diameter, pose significant environmental and health risks due to their pervasive presence and resistance to degradation. Synthetic textiles are a major source of microplastics, shedding microfibers during washing and drying processes. These microfibers can absorb and transport toxic chemicals, causing harm to aquatic organisms and entering the human food web. This paper explores the impact of synthetic textiles on microplastic pollution, the adverse effects on the environment and human health, and current mitigation strategies. The research highlights the importance of adopting sustainable practices and fabric choices to reduce microplastic pollution and protect ecosystems.

Introduction

Microplastics, defined as plastic particles smaller than five millimeters, have become a pervasive environmental contaminant, posing significant threats to both ecosystems and human health. Synthetic textiles are a major contributor to microplastic pollution, releasing microfibers into the environment during washing and drying processes. These microfibers, due to their small size and persistence, can easily infiltrate water bodies, soil, and air, leading to widespread contamination. This paper delves into the sources and impacts of microplastics originating from synthetic textiles, examines the detrimental effects on organisms and the environment, and evaluates current mitigation efforts. By understanding these aspects, we can better address the challenges posed by microplastic pollution and work towards more sustainable solutions.

Importance of the Issue of Microplastics

Microplastics are extremely difficult to degrade, which increases the potential harm they could cause in the environment. According to a peer-reviewed report by Jatinder Singh Randhawa, "Microplastics have a long shelf life and are challenging to degrade..." (Wang et al, 1). They also possess incredible variability when it comes to their toxicity, such as their size and structure affecting different organisms differently. "They have a wide range of attributes that influence how deadly they are, including their size, composition, and structure" (Pirsaheb et al. 2020).

Primary microplastics are tiny particles designed for commercial use, such as cosmetics, as well as microfibers shed from clothing and other textiles, such as fishing nets (IUCN 20). These represent between about 15% and 31% of the microplastics found in oceans (IUCN 20). Secondary microplastics are particles that result from the breakdown of larger plastic items, such as plastic water bottles or bags (IUCN 8). These represent between 69% and 85% of the microplastics found in the ocean.

Studies reveal that microplastics have a ubiquitous presence in different environmental settings such as water, sediment, terrestrial soil, and biota (Carney 1191). Studies show that, in terms of plastic contamination in tap water by region, the United States and Lebanon had the highest percentage of plastic detected at 94% each, with other locations being studied like Europe or Lebanon having at least a 70% contamination rate (Kosuth et al.). Microplastics have been detected on beaches and in subtidal sediments worldwide (De Falco et al. 917). They present a global threat to marine biota as plankton or other marine organisms can ingest microplastics, eventually entering the human food web (De Falco et al. 917). Studies have also shown that a human can ingest between 39,000 and 520,000 microplastics per year through food and beverages (Šaravanja et al. 9).

Effects of Synthetic Textiles on Organisms and the Environment

The release of microplastic-sized fibers as a result of washing textiles has been widely reported as a potential source of microplastic (Napper and Thompson 39). The main sources of microplastic fibers released from textiles are textile manufacturing and industrial and household washing (Šaravanja et al. 5). Afterward, the waste effluent from washing machines that contain microplastics will then travel via wastewater to sewage treatment plants (Napper and Thompson 40). Due to the small size of the fibers, a considerable proportion could then pass through preliminary sewage treatment screens, which are more than 6 mm, and be released into the aquatic environment (Napper and Thompson 40).

Microplastics can absorb and transport toxic chemicals. When ingested by organisms, these chemicals may leach, causing toxicity and potential disruptions to endocrine systems. Microplastic ingestion has been related to developmental disorders, changes in behavior, lower food intake, and other physiological problems. Data show that nearly 700 aquatic organisms worldwide are threatened by microplastic ingestion (Šaravanja et al. 1).

Microplastics have a long shelf life and are resistant to degradation. Once released into the environment, they persist for extended periods, contributing to continuous pollution (Randhawa). Microplastics take a long time to degrade because these types of polymers do not exist in nature, resulting in a lack of organisms/enzymes that can break them down. Microfibers can also travel through the air and deposit on land or water surfaces where humans and animals can inhale them. This can cause respiratory problems, inflammation, and oxidative stress in the lungs (Lee et al. 305).

Altering the soil structure and porosity can affect water infiltration, drainage, and aeration. Interfering with the soil microbial community and activity can affect decomposition, nutrient cycling, and soil health. The synthetic fiber industry exemplifies potential workplace exposure to microplastics through inhalation (Lee et al. 306). Microplastic inhalation can lead to respiratory and lung diseases among workers in factories using synthetic fibers (Lee et al. 306). It has been proven that microplastics are ubiquitous in the atmosphere. Microplastics are potentially transferred to air and are easily transported by wind, because of their small size and low density (Chen et al.).

Compared to microplastics in other ecosystems, microplastics in the air can be directly and continuously inhaled into the human body, posing a health risk (Chen et al.). Those who spend several hours every day at home and in the office may face an even greater threat than those who spend time in an outdoor environment, where microplastic pollution is much more serious (Chen et al.). In fact, on average, humans might inhale 26–130 airborne microplastics a day based on studies in Paris, Dongguan, Shanghai, and Hamburg (Chen et al.). Microplastics contain metals and other flame retardants which are very harmful to the environment and nearby animals exposed. "Metals (such as Cr, Cd, Hg, Sb, and Pb) and also flame retardants are typically found in e-waste plastics at percent (%) concentrations by weight" (Li et al. 2019; Turner et al. 2019; Singh et al. 2020).

Current Mitigation Efforts

Several mitigation strategies have been proposed to reduce the release of microfibers from synthetic textiles. People are advised to do laundry less often and wash full loads instead of partial loads to reduce the release of microfibers because garments are exposed to less friction during the wash cycle (Weis). In addition, cold water is being used to do laundry since it releases fewer microfibers than hot water (Weis). Furthermore, front-loading washing machines are often made for laundry use since their tumbling action produces less microfiber release (Weis). As an alternative to the dryer, people are drying laundry on the clothesline since running clothes in dryers releases additional microfibers into the air from the dryer vent (Weis).

The addition of a filter for their washing machines can reduce the levels of microplastics before they enter the drain, which would eventually go to sewage systems and then aquatic ecosystems. As a consumer, deciding to wear more natural and sustainable clothing with plastic-free fabrics serves as an effective alternative to its synthetic counterparts. Separating clothes based on their material to reduce friction may help minimize the environmental impact of synthetic textiles by washing rough or coarse clothes like jeans separately from softer items like polyester T-shirts and fuzzy fleece sweaters. This way, people can reduce the friction caused by rougher materials crashing into more delicate ones. Less friction means your clothes won’t wear out as fast and the fibers will be less prone to premature breakage.

Running short cycles instead of long ones will effectively limit the opportunity for fiber breakdown due to the reduction in time. Reducing the speed of the cycle can decrease friction even further since it is shown by studies to reduce microfiber shedding by 30 percent. Instead of powder, utilizing liquid detergents is gentler and less abrasive, reducing the amount of microfibers that are released into the wastewater. Solid detergents contain more microbeads than liquid detergents and these microbeads could wash down the drain and contribute to microplastic aquatic pollution, harming the many marine organisms living in these environments. Others choose to air dry their clothing because “dryers generate about 40 times more microfibers than washing machines, with a single household dryer releasing up to 120 million microfibers into the air every year” (Perch Energy). On the other hand, air drying will create fewer microfibers.

Other simpler solutions include buying fewer new clothes because those are more likely to shed microfibers than older clothing that has been washed and worn down. Others are starting to use less water with every load when washing their clothes.

Different Fabric and Yarn Types

Different fabric and yarn types can affect how much microplastics are released during washing, making a better impact on the environment. For example, according to Periyasamy (2020), “Many factors influence the generation and release of microfibers in synthetic garments during domestic washing, including the type of fabric.” There is a new treatment process using Enzymatic Treatment. To summarize, this research indicates that by modifying a fabric’s surface level we could attain less microfiber and plastics in the cloth by using a process known as biopolishing. Biopolishing involves the “Cellulase enzyme and removes fibrils or microfibrils from the fabric’s surface, offering the reduction of microfiber releases.” (Periyasamy, 9). This would mean that there would be fewer piling properties and the fabric would result in a cleaner and more treated fabric. However, there is very little research to prove how this solution would stick up to the longevity of wash cycles and therefore was rejected as a solution for the issue.

It is important to note, however, that these current solutions are not adequate and do not ensure the sustainability of microplastics in the environment. For example, in the instance of composting these microplastics, Zhanqing Cao states that “Current technologies remain inadequate for the complete elimination of microplastics” (Li et al. 2022; Mahon et al. 2017).

Factors Contributing to the Reduction of Microplastics in Synthetic Textiles

Avoiding Microfibers: Microfibers are tiny threads that are shed from synthetic fabrics and are released into the water and air during washing and drying. These microfibers contribute to microplastic pollution in the environment, affecting aquatic life and the food chain. Avoiding synthetic fibers is one of the best solutions for addressing the microfiber pollution problem (Microfibers, 2023). By choosing natural fibers, such as cotton, wool, silk, or linen, consumers can reduce the amount of microplastic pollution in the environment.

Choosing Sustainable Brands: Some brands have taken proactive steps to address the issue of microfibers by designing clothes with minimal microfiber release. For example, Patagonia has invested in research to develop fabrics that shed fewer microfibers. Other companies, such as Guppyfriend and Cora Ball, have created products that capture microfibers during the washing process, preventing them from entering waterways.

Recycled Materials: Synthetic fibers made from recycled materials, such as post-consumer plastic bottles or ocean plastic, can reduce the demand for virgin plastic production. By choosing clothing made from recycled materials, consumers can support a circular economy and help reduce plastic waste. Additionally, some recycled fabrics are designed to shed fewer microfibers compared to conventional synthetic fabrics. These are possible new methods that could be pursued to reduce microplastics.

Blends: Natural-synthetic fiber blends can offer a compromise between durability and environmental impact. For example, a cotton-polyester blend can provide the strength and durability of synthetic fibers while reducing the overall amount of microplastic pollution. However, it is important to note that blended fabrics can still shed microfibers, so consumers should choose blends with a higher percentage of natural fibers and follow proper care instructions to minimize shedding.

Conclusion

In conclusion, microplastic pollution is an ongoing issue in the environment and there is still no adequate solution to the issue. However, by taking proactive measures, such as avoiding synthetic fabrics and microfibers, choosing sustainable brands, supporting recycled materials, and opting for natural-synthetic fiber blends, consumers can contribute to reducing microplastic pollution. Additionally, adopting proper care practices, such as using liquid detergents and air drying, can further minimize microfiber shedding. While these steps may not completely eliminate microplastic pollution, they represent important strides toward a more sustainable and environmentally conscious approach to textile consumption. By making informed choices and supporting brands that prioritize sustainability, we can collectively work towards a cleaner, healthier planet for future generations.

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