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Addressing Challenges in promoting the use of animal-origin Textile Fibers for mitigating microplastic pollution on Earth

Abstract

The aim of this review is to address the issue of textile-origin microplastics and to provide possible solutions that can be propose through a scientific and development program. The constant expansion of textile production and consumption, driven by population growth and the ubiquity of fast fashion, has triggered environmental contamination resulting from the release of fiber fragments during the washing and use of clothing and household textiles. These fragments, ranging in size from 1 µm to 5 mm, pose a novel source of pollution that not only threatens the health of aquatic animals when ingested but also risks human food safety by infiltrating the food chain. Despite the growing awareness of the environmental impacts of these plastic microfibers (MP) from synthetic textiles, this study departs from conventional actions focused on mitigating microplastic pollution. Instead, it focuses on proposing specific measures to reduce MP emissions and addresses the even greater challenge of replacing these plastic microfibers with animal-origin textile fibers. This approach emerges as a promising and sustainable alternative to counteract the negative environmental impact of the contemporary fashion industry. The essence of this challenge lies in determining the competitiveness of animal-origin textile fibers against MP. To achieve this goal, specific actions are proposed, including the need to reduce both the environmental impact and costs associated with processing animal fibers. The study also emphasizes the importance of effectively highlighting the biological and textile advantages of these fibers to encourage their acceptance and adoption in the competitive textile market. This project addresses concrete strategies to promote the use of animal-origin textile fibers. It suggests optimizing the cleaning process and genetically improving these fibers, considering key aspects such as quality and color. The research also highlights the potential contribution to sustainability certification and well-being associated with the use of animal-origin textile fibers, providing a solid foundation for their adoption in the textile industry. In conclusion, this work not only departs from traditional measures focused on microplastics to address MP release but ventures into more ambitious territory by proposing increased use of animal-origin textile fibers as a path to a more sustainable fashion. Specific actions are outlined to enhance the competitiveness of these fibers in the current market, emphasizing their potential contribution to reducing textile pollution and thus strengthening the transition to more environmentally responsible practices in the fashion industry.

Keywords: animal-origin textile fibers, wool, natural fibers, fashion industry

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Introduction

Ongoing Project is on enhancing the quality and marketability of Wool, Cashmere, Alpaca/Llama Fiber through Technological Innovation. In response to the significant pollution caused by artificial textile fibers, particularly microfibers, which contribute to 38% of plastic pollution, a new textile paradigm is proposed. This paradigm revolves around the use of natural fibers processed through organic methods, aiming to compete with and replace microfibers in textile applications. The primary goal of the project is to showcase the textile quality of camelid fibers from the Jujuy highlands, employing innovative technologies to mitigate unfavorable factors such as objectionable fibers, diameter variability, and fiber types.

The project anticipates a substantial impact on improving the income of llama producers in the specific study area and, subsequently, across all regions involved in domestic camelid fiber production in Argentina. By implementing advanced technologies for individual fiber quality classification and precise geographical location, the marketing of fibers of less favored areas of our Country and neighboring Countries is expected to be significantly enhanced. These areas, which have been relatively understudied to date, will benefit from a trustworthy methodology that includes error mitigation.

The project places emphasis on the development of modern metrological technology for fiber type identification and laboratory testing. This approach not only improves the prediction of the textile performance of accumulated llama fiber but also represents a paradigm shift in the fiber processing method, specifically in the dehairing process to enhance the quality of Argentinean llama fiber. In conclusion, the project aims to revolutionize the Animal fiber industry in Argentina by integrating organic processing methods and cutting-edge technology, ultimately promoting sustainable practices and improving the socio-economic conditions of fibre producers in the region.

The aim of this review is to address the issue of textile-origin microplastics and to provide possible solutions that can be propose through a scientific and development program that can enhance the textile quality of animal fibers and mitigate some adverse effects associated with their extraction and processing.

Strategic approaches to alleviating microfiber pollution: a preliminary synthesis

Some authors, offers a preliminary synthesis of strategies aimed at mitigating the pervasive issue of microfiber pollution, categorizing them into three primary areas[1]:

1) **Reducing production and consumption of clothing**

Implementing sustainable fashion practices to minimize the environmental impact of textile production. Encouraging the adoption of circular economy models, emphasizing durability, and discouraging fast fashion trends. Promoting responsible consumerism by advocating for quality over quantity, thereby reducing the demand for new garments. This category underscores the importance of addressing the issue at its source by reevaluating the current fashion industry's production and consumption patterns.

2) **Improving consumer practices during the use phase of synthetic garments**

Educating consumers on proper garment care to reduce shedding of microfibers during washing and drying. Encouraging the use of specialized filtration systems in washing machines to capture released microfibers. Promoting the use of microfiber-catching laundry bags to prevent microfiber release into water systems. Focusing on consumer behavior is crucial, as it directly impacts microfiber release during the lifecycle of synthetic garments. Empowering consumers with knowledge and practical tools is a key aspect.

3) **Replacing the use of synthetic fibers with natural fibers when possible**

Advocating for the increased use of natural fibers such as cotton, wool, and hemp in textile manufacturing. Supporting the development and market adoption of innovative, sustainable alternatives to synthetic fabrics. Raising awareness about the environmental benefits of choosing natural fibers and their biodegradability. This strategy emphasizes the shift towards sustainable materials as a fundamental solution, steering away from synthetic fibers to reduce the long-term impact on ecosystems. Within this last strategy lies our area of interest, focusing on the development with animal textile fibers. This statement indicates a specific focus within the broader strategy of replacing synthetic fibers with natural alternatives. By honing in on the development of textiles derived from animal fibers, such as wool, llama/alpaca, cashmere, there is a targeted effort to contribute to sustainable practices while offering an alternative to synthetic materials in the textile industry. This approach aligns with the broader goal of reducing microfiber pollution and highlights the potential of animal textiles as a viable and eco-friendly option in the market. The outlined strategies form a comprehensive approach to address microfiber pollution, spanning from production practices and consumer awareness to a fundamental shift towards sustainable material choices. It requires collaboration among industry stakeholders, policymakers, and consumers to effect meaningful change in combating the environmental repercussions of microfiber pollution.

Impact of textile production on microfiber pollution: factors and mitigation

The continuous growth of the population and the fast fashion industry has led to a steady increase in textile production and consumption. Fiber fragments (1 μm–5 mm) released from clothing and household textiles during washing, drying, and use are now recognized as a new source of environmental contamination and health hazards. These fiber fragments, if ingested by aquatic animals, can substantially threaten their metabolic activities. Moreover, smaller fiber fragments can enter our food chain through the consumption of marine creatures, sea salt, and drinking water.

Various crucial parameters regarding the release of fiber fragments from clothing and household textiles. Factors such as fabric type, weave/knit structure, detergent type and concentration, temperature, pH, centrifugation speed, and the duration of washing and drying processes are examined. The influence of various mechanical and chemical textile finishes on fiber fragment release is explained. Any process that reduces fiber strength and interactions, such as sanding, brushing, and bleaching, can potentially increase fiber fragment release in consecutive wet processes.

Also highlights some of the most significant environmental regulations regarding the release of microplastics and fiber fragments into the environment. Additionally, a series of recommendations are provided to mitigate the impact. These recommendations encompass strategies to minimize fiber fragment release during textile manufacturing and consumer use, as well as the importance of adopting environmentally friendly textile finishes. Overall, the article emphasizes the need for comprehensive measures to address the growing issue of microfiber pollution resulting from textile production and consumption.[2]

Plastic microfiber emissions: understanding, estimation, and mitigation strategies

Plastic microfibers (PMFs) are ubiquitous worldwide, found in terrestrial environments, oceans, surface waters, and sediments. Ingestion and toxic effects of PMFs on organisms have been detected, with PMFs released from synthetic textiles during washing believed to be a significant contributor to the current overall burden of microplastics (MPs) in the environment. Given the rapid growth of the synthetic textile market and the continuous release of PMFs, this review aims to present measures to reduce PMF emissions into the environment.

To achieve this goal, existing data and knowledge on PMFs are summarized to elucidate (a) the definition of PMFs, (b) PMF release during textile washing and influencing factors, and (c) PMF retention in wastewater treatment plants (WWTPs) at different treatment stages and subsequent emission into aquatic environments. Based on existing data, it is estimated that the annual release of PMFs from washing synthetic textiles ranges from 50.6 to 1180 kg per 100,000 inhabitants. This release could lead to a total emission of 2.53 to 59 kg of PMFs per year through WWTP discharges (serving 100,000 residents), assuming a 95% removal efficiency in WWTPs.

In light of these findings, proactive solutions and suggestions are explored to avoid and reduce PMF release and emission, considering reduction, reuse, recycling, and end-of-pipe strategies. The study emphasizes the importance of addressing the issue comprehensively, taking into account various stages of the textile life cycle to develop effective mitigation strategies for the environmental impact of PMFs.[3]

Some considerations for reducing the use of microplastics replaced by natural fibers: wool, Cashmere, Llama, Alpaca, Mohair

The growing demand for natural and renewable textile products from consumers, brands, and retailers. 'Environmentally friendly' is not enough on its own, and garments must still meet consumers' basic requirements for quality, fashion, functionality, performance, and value. The merits of different environmental claims, such as "eco-" and "organic," are discussed, emphasizing the value of Type

1 eco-labels, such as the EU Ecolabel, to validate environmental statements and help consumers discriminate against "greenwashing." The increasingly powerful role of European legislation in shaping global environmental practices and increasing information flows in textile processing is acknowledged. The International Wool Textile Organization has added some clarity to wool supply chains by adopting definitions for eco-wool and organic wool.[4]

Animal textile fibers present a promising alternative to plastic microfibers, yet several questions demand thorough investigation and resolution within the realm of sustainability. Addressing the fundamental queries—are they competitive? What steps should be taken?—is pivotal to pave the way for their wider adoption and utilization.[5]

The first critical consideration revolves around the competitiveness of animal textile fibers. To establish their prominence, attention must be directed towards mitigating environmental impacts and reducing processing costs. Achieving a lower environmental footprint entails scrutinizing and optimizing every stage of production, from raw material extraction to manufacturing and disposal. Simultaneously, minimizing processing costs is imperative for the economic viability of animal fibers, ensuring their cost-effectiveness compared to synthetic counterparts.[6]

Another key aspect in enhancing the competitiveness of animal fibers involves bringing to light their inherent biological and textile advantages. Effective communication and education are essential to enlighten consumers and industry stakeholders about the superior qualities of animal textiles, such as their biodegradability, breathability, and luxurious texture. Establishing a comprehensive understanding of these benefits is crucial for fostering acceptance and fostering the transition toward a more sustainable textile market.

In the pursuit of making animal fibers more competitive, concrete actions are proposed. First and foremost is the optimization of the cleaning process, ensuring that animal fibers maintain their integrity and quality throughout various stages of production. Genetic improvement constitutes a significant strategy, addressing both the quality and color aspects of animal fibers. By enhancing these attributes, animal textiles can match or even surpass the aesthetic and functional qualities of synthetic counterparts.[7]

Moreover, contributing to the certification of sustainability and well-being is crucial for legitimizing the environmental and ethical credentials of animal textile fibers. This involves adhering to rigorous standards and practices that certify the sustainable and humane production of these fibers, thereby instilling confidence in consumers and industry partners.

Nevertheless, the transition from plastic microfibers to animal textile fibers is a complex but promising endeavor. By addressing questions of competitiveness and strategically implementing measures to optimize production processes, improve genetic qualities, and contribute to certification initiatives, animal fibers can emerge as a compelling and sustainable choice in the evolving landscape of textile materials.

The alarming increase in microplastic pollution has sparked growing interest in reducing its use through sustainable alternatives, focusing on natural fibers such as wool, cashmere, llama, alpaca, and mohair. These fibers, derived from animals, possess unique properties that position them as promising replacements for synthetic textiles.[5]

Wool, known for its durability and strength, has historically been used in the production of high-quality garments. Its ability to retain heat and resistance to moisture make it a valuable choice, especially in varied climates. Cashmere, extracted from Cashmere goats, stands out for its softness and lightweight, offering a luxurious and comfortable alternative to synthetic textiles.

Llama fiber, exhibits exceptional thermal properties and a soft texture, making it ideal for outerwear. Meanwhile, alpaca, with its strength and softness, has become popular in sustainable fashion, highlighting its versatility and ability to adapt to diverse weather conditions. Another noteworthy option is mohair, sourced from Angora goats, known for its luster and wear resistance. Its use in textiles provides an elegant and durable alternative, reducing dependence on synthetic materials.[5]

The adoption of these natural fibers as substitutes for microplastics in textile manufacturing not only implies environmental benefits but also promotes sustainable agricultural practices and supports communities dependent on raising these animals. However, addressing potential challenges such as production efficiency and consumer awareness is crucial to ensure a successful transition to more sustainable materials.[8–11]

Conclusion

In conclusion, exploring and promoting natural fibers like wool, cashmere, llama, alpaca, and mohair as alternatives to microplastics in textiles are significant steps toward a more sustainable fashion. With a deeper understanding of the properties and benefits of these fibers, a positive shift in the textile industry can be encouraged, contributing to environmental preservation and animal welfare.

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Conflicts of interest

Authors declare that there is no conflict of interest.

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