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Quantification of Microfiber Shedding from Synthetic Garments: A Case Study of the Sri Lankan Retail Market

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I. Introduction

Synthetic textiles specially polyester dominate the global fashion market due to their durebility, affordability, and commonness [1]. However, the laundering of those textiles release microscopic plastic, which we called microfibers. It is a primary subset of microplastics, affects to water bodies posing a massive environmental issue [2]. While this issue is well documented globally, there is a huge research gap in developing nations, mainly in Sri Lanka. Here, in Sri Lanka, presents a unique case due to mixed laundering habits (hand washing vs washing machines) and the growing market of affordable synthetic garment import, which is different than the Western contexts, where most data is available from [3]. Therefore, this introductory research aims to provide a quantitative analysis of microfiber pollution comes from Sri Lankan fashion retailers. Our goal is to measure the scale of microfiber shedding from local garments and identify key factors from fabric factors/qualities to consumer laundering habits, to establish the baseline for future mitigation strategies in Sri Lanka.

II. Literature Review

The existing scientific researches have identified the local laundering process of the synthetic fabrics as the primary pathway for the microplastic pollution for water bodies [4]. This foundational research by Napper and Thompson quantified this phenomenon by revealing that a synthetic garment can release thousands of fibers per wash [2]. A similar study by De Falco et al. [5] further demonstrated that fabric structure, fiber type, and washing conditions are the significant variables that affects the microfiber shedding rate. Globally, the mitigation strategies have explored, including washing machine filters and low shedding fabrics etc. However these solutions are away from the practical reality in developing nations like Sri Lanka. To understand the scale of this issue, we have to quantify it using reliable methodologies for wastewater analysis [5], [6]. There are now such methods That are directly relevant and suitable for Sri Lanka, currently exists to track microplastic release from consumer everyday garments.

III. Materials and Methods

A. Research Design and Sampling

We have selected a trending fashion retailer, focused on activewear and sportswear as the case study. Firstly, a consumer survey (n=50) was conducted to investigate the domestic washing habits. Those questions focused on preferred clothing categories, washing methods, sequence, and settings. Based on the results, fifteen brand new, unworn garments under five categories (T shirts, jerseys, sport bras, shorts, and shirts) were selected. Selection was stratified by the Stock Keeping Unit (SKU) to ensure, a representative collection of the retailer's high volume polyester and poly blend categories.

TABLE I. GARMENT SAMPLE WEIGHTS

Garment Type	Fiber Content/ Fabric structure	Sample Weight (kg)			Average Weight (kg)
		Sample 1	Sample 2	Sample 3	
T-shirt	100% Polyester/ Knitted	0.31	0.32	0.33	0.32
Jersey	100% Polyester/ Knitted	0.35	0.36	0.37	0.36
Sport Bra	Polyester-Spandex/ Knitted	0.23	0.22	0.21	0.22
Shorts	Poly-Cotton Blend/ Woven	0.29	0.28	0.27	0.28
Shirt	Poly-Cotton/ Woven	0.26	0.27	0.28	0.27

B. Laundering Simulation and Test Method

The consumer survey revealed that 52.8% of consumers wash their clothes using domestic home washing machines, and using tap water streams at room temperature. Furthermore, it was revealed that a garment undergoes an average of 40 minutes laundering time per month, over four cycles. Based on these results, a lab based laundering simulations were conducted using a domestic LG front load washing machine. Each garment underwent four individual 40 minute wash cycle at 30°C, the average room temperature. To capture the sheded microfibers, the machine's effluent was filtered through a custom 0.45µm pore size mesh filter. The collected residue was air dried in a controlled environment. Dried particulate matter from each representative garment type was analyzed using Optical Particle (OP) Microscopy to confirm composition and characterize morphology, and quantified using a gravimetric method, as shown in (1).

$$Microfiber\ Release\ (\%) = \frac{Avg.\ Shedding\ (mg)}{Avg.\ Garment\ Weight\ (mg)} \times 100 \quad (1)$$

IV. Results and Discussion

A. Microfiber Shedding Analysis

The laundering simulations revealed significant microfiber shedding across all samples per single wash cycle. As summarized in Table I, knitted garments made of 100% polyester were the highest shedders, releasing up to 40% more fibers than woven or blended garments. The average shedding rate was 130.6 mg per garment per wash. For instance, the highest shedding garment, a knitted T-shirt (194 mg), released over twice the mass of fibers compared to the woven poly-cotton shirt (85 mg), starkly illustrating the impact of fabric structure.

Currently, no global ISO standard defines an "acceptable" limit for microfiber release (though the industry ideal remains zero emission); however, the shedding rates observed here aligns with the high emitting types mentioned in similar studies[5], suggesting an urgent need for industry benchmarks. Optical analysis further estimated a release of approximately 120,000 individual fibers per garment in a single wash cycle. Microscopic examination revealed that fibers were predominantly brittle and translucent with sharp, fragmented ends, confirming breakage from mechanical agitation. Additionally, polyester garments require frequent washing in the local context due to Sri Lanka's tropical weather, increasing opportunities for release.

TABLE II. MICROFIBER SHEDDING BY GARMENT TYPE

Garment Type	Shedding per Cycle (mg)			Average Shedding (mg)	Average Garment Weight (kg)	Microfiber Release (%)
	Cycle 1	Cycle 2	Cycle 3			
T-shirt	225	185	172	194	0.32	0.061%
Jersey	200	170	158	176	0.36	0.049%
Sport Bra	115	98	96	103	0.22	0.047%
Shorts	108	91	86	95	0.28	0.034%
Shirt	95	82	78	85	0.27	0.031%

B. Consumer and Industry Factors

Interviews with retailer representatives highlighted these three main factors: polyester composites are favored for affordability and durability; no environmental impacts are currently considered in material selection; and sustainability programs are in beginning stages. These findings emphasize a huge lack of readiness in the local retail sector to tackle environmental concerns [7]. This further highlights the risk of achieving UN Sustainable Development Goals (SDGs) in local contexts by 2030, where consumer behavior also plays a critical role [8].

V. Conclusion

This study provides foundational evidence regarding the microfiber release potential of the Sri Lankan textile and apparel sector. These findings confirm that the local fashion retailers rely heavily on high shedding polyester materials due to market demands and affordability. Therefore, an urgent need exists for a multi-pronged intervention strategy, including a industry led material innovation and enhanced consumer awareness programs.

While this study is limited by a sample size of n=15 and does not calculate downstream ecotoxicity, it provides a crucial baseline dataset for the local retail sector, warranting future lifecycle assessment (LCA) research.

VI. Recommendations

Based on the findings, the following actions are recommended:

- **For Retailers:** Prioritise low-shedding fabrics, improve care labels with eco-friendly washing instructions, and offer microfiber-capturing laundry bags to consumers.
- **For Consumers:** Adopt sustainable laundry habits, such as washing in cold water, using shorter cycles, and use line drying garments when possible.
- **For Policymakers:** Develop eco labelling standards that include microfiber shedding information, improve awareness and support research into sustainable textile innovation.

Such a collaborative approach is essential to mitigate this growing environmental threat and building a sustainable fashion industry in Sri Lanka.

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