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2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

MICROFIBRE RELEASE AND SURFACE PROTRUSION OF WASHED WOVEN FABRICS

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Abstract: Textile care such as washing and drying are among the activities that a garment undergoes for cleaning and maintenance purposes. However, washing has been reportedly to give negative impacts to the environment through microfibre release and causes impairs to the appearance of a garment. The protrusion formed on the textile surface would cause microfibre removal into the washing wastewater and causes change on the fabric surface. Therefore, the ultimate goal of the current study is to determine the microfibre release from woven cotton, rayon and polyester fabric with sequential washes and to see the effect of the action on the surface protrusion of the fabrics. The three types of woven fabrics were brought to series of washing procedures at lab scale. The microfibre released from the washings were determined and the protrusion formed on the fabric surface were observed with Scanning Electron Microscopy (SEM). It was discovered that fabric which is composed of cellulose based and staple yarn releases great amount of microfibres, supported with severe protrusion on the fabric surface. On the other hand, filament based with high density construction releases a little amount of microfibres with minimal protrusion on the fabric surface.

Keywords: *Microfibre, textile care, washing, protrusion*

INTRODUCTION

Microfibre can be defined as any natural or synthetic fibrous materials of threadlike structure with length ranging from 1 μm to 5 mm, a diameter less than 50 μm, and length to diameter ratio greater than 100 (Liu et al., 2019). Washing activity was claimed to be one of the sustainability issues faced by the clothing and fashion industry, where microfibres have been released, and these microfibres enter the environment as primary and secondary sources of the particles (Henry et al., 2019). The main factor of fibre shedding from textiles is due to the entanglement of small fibres on the fabric surface during wearing or care activities that raised on the surface of the textiles (Hussain et al., 2008). It is usually started with fibre protrusion, when small fibres merging on the textile surface from loose fibre ends which can be created due to fibre weakening and abrasion (Wang & Qian, 2017).

The causes of microfibre release were discovered due to two main groups of microfibres (Belzagui et al., 2019). The first group belongs to the entangled fibres which already present on the yarn or fabric surface, while the second group corresponds to the microfibres which are ripped-off from the yarns as a consequence of the mechanical stress throughout the washing process. Other researchers supported this claim by reporting that the fibres which are poorly attached with the yarn and fabric structure will be released into the washing effluent especially in the first washing cycle (Kelly et al., 2019; Özkan & Gündoğdu, 2020). This is sensible, as loose fibres tend to be easily detached when given some forces, exposing the textile surface underneath the fibres layer. Hence, it can be said that during the first few cycles of washing, the fabric surface quality is not really affected by the second group of microfibres. This also explains the decreasing number of released microfibres with the increment number of washing cycles as reported in the previous studies (De Falco et al., 2019; Napper & Thompson, 2016; Sillanpää & Sainio, 2017; Zambrano et al., 2019). However, as the number of washing cycles goes up, the yarns in the fabric starting to expose the loose fibres and being ripped-off to contribute to the microfibre release.

In the current research, the mass of the microfibres released are measured supported by the fabric images acquired from Scanning Electron Microscope (SEM). The outcome of this work can be a guideline for consumers and washing machine producers in creating a safer environment while maintaining the quality of the textiles. It can also be the reference for textile manufacturers to produce materials with better protrusion resistance towards mechanical stress during domestic care.

Therefore, this work aims to determine the microfibre release of cotton, rayon and polyester fabric throughout 25 consecutive washings and to examine the fabric protrusion that relate with the release through microscopic image observation. It was proven that after a few first washing cycles, the microfibre release is decreasing. However, the textile surface which is affected by the fibre detachment or causing the fibre detachment is still unidentified. Hence, this situation needs a clearer explanation through image examination to confirm that the protrusion from washings really has an effect on the fabric microfibre release properties or vice versa.

MATERIALS AND METHODS

The materials used in the study were commercial grade of 100% cotton, 100% rayon and 100% polyester of different weights which were acquired from physical and online stores (refer Table 1). The three samples selected were commonly used for clothing such as blouse, head scarf and school uniform which need frequent washings.

Table 1. Fabric samples weight

Fabric Sample	Weight (g/m^2)	Weight (g/m)	Structure
Cotton	112.40	285.50	Woven
Rayon	107.60	163.98	Woven
Polyester	157.60	240.18	Woven

The fabric samples were washed which correlates to International Standard ISO 6330, Textiles – Domestic Washing and Drying Procedures for Textile Testing using QuickWash Plus® by SDL Atlas at Faculty of Applied Sciences, UiTM Shah Alam. All the fabric specimens were washed without detergent or any washing products. Washing Program Number 9 was selected with 2 minutes of washing, 45 seconds of rinsing, and 35 seconds of spinning with 6 litres of filtered tap water. The washing was repeated for 25 cycles with the determination on the released microfibres and the fabric surface were carried out for every 5 cycles interval. The samples were dried at 85°C for 45 minutes before the evaluation was made, with the samples turned to the other side after the first 30 minutes have elapsed to ensure even drying.

The collection of the microfibres were conducted with 80 threads/cm polyester mesh count. The wastewater from filtration was poured slowly through this filter and drained out. The fibres collected were dried with the fibres still intact on the filter at 85°C for 40 minutes. The weight of the released microfibres was determined by using Mettler Toledo electronic microbalance which can measure up to 0.000 mg weight of fibres.

The images of the washed samples were captured with Quanta FEG 450 Scanning Electron Microscopy (SEM) at Faculty of Pharmacy, UiTM Puncak Alam. The photographic images of the sample surface were taken with low vacuum, chamber pressure of 110 Pa and high voltage at 10.0 kV. The images were set at 50x magnification.

RESULTS AND DISCUSSION

During the 25 cycles of washing, cotton and rayon have released a considerable amount of microfibres with an average of 1.345 mg and 1.664 mg of fibres per gram of fabric. Cotton was found to release 47.62% from the total microfibres in the first five cycles before reduced to 10.42% in the cycle 11-15. Similarly, rayon fabric emitted about 41.89% of microfibres in the first five washes and 14.36% in cycle 11-15. The microfibre release was then stabilized for the rest of the washing cycles. This is aligned with past research which reported that the number of

microfibre release during washing is normally reduced with the increased cycles of washing until a constant figure is achieved (Carney Almroth et al., 2018; Napper & Thompson, 2016; Sillanpää & Sainio, 2017; Zambrano et al., 2019). Polyester in contrast has released 0.094 mg of fibres for the same size of samples (refer Figure 1).

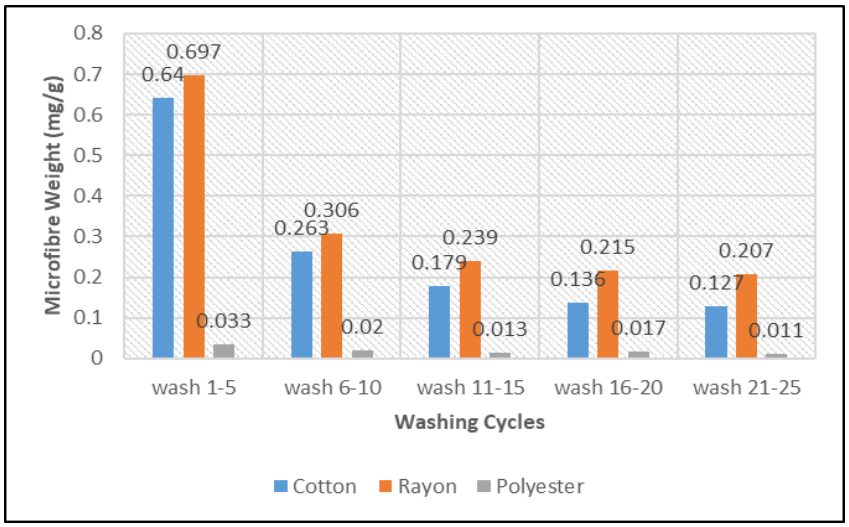


Figure 1. Microfibre release weight per mass of fabric for cotton, rayon and polyester

The water during washing has lubricated and softened the amorphous regions of the cotton and rayon fibres by the disruption of the hydrogen bonds between the cellulose chains. Eventually, there were spaces generated in the structure for the migration of the broken fibres and enhanced the protrusion formation due to the shear forces during washing process (Zambrano et al., 2019), which is shown in Figure 2 (a-d). At zero washing, there were gaps between yarn interlacements observed, whereas a denser structure with more protrusion found on the fabric surface after 25 washings. As the washing cycle numbers going up, more forces applied which allows fibre mobilization towards the fabric surface accommodating the spaces between fibres protrusion. As a result, more compact fibres clusters occupying the fabric surface.

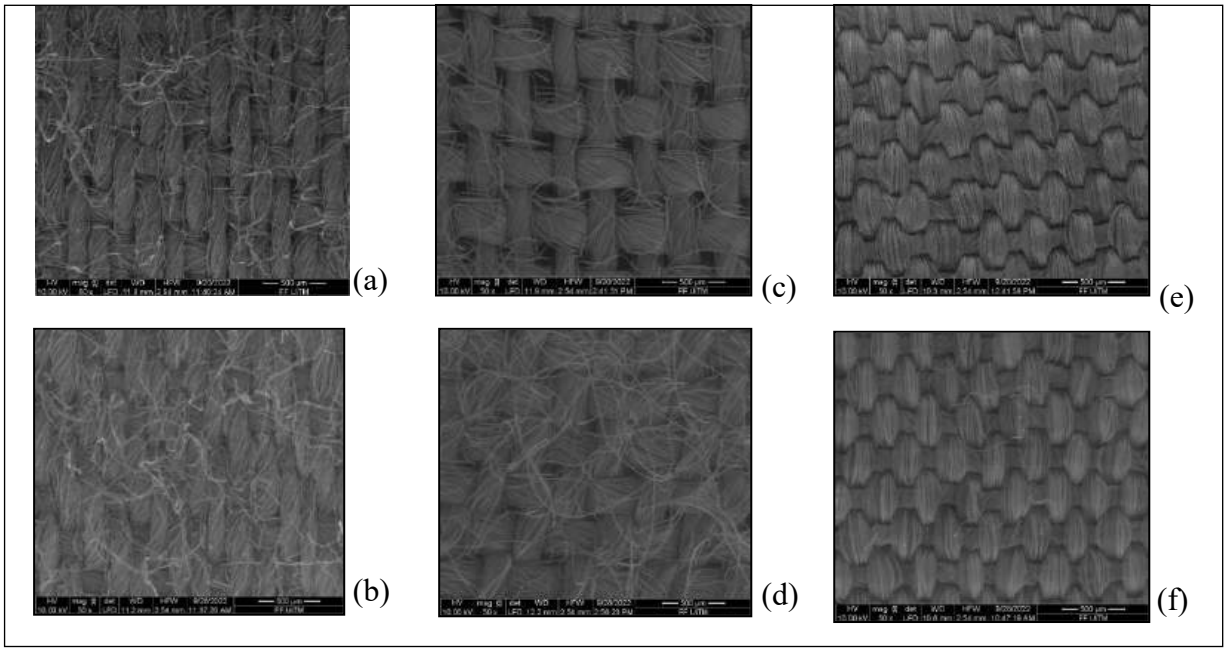


Figure 2. Microscopic image at 50x magnification of (a) zero washing (cotton), (b) 25 washings (cotton), (c) zero washing (rayon), (d) 25 washings (rayon), (e) zero washing (polyester), (f) 25 washings (polyester)

Other possible reason of the event was due to the fibre types, where cotton and rayon fabric which were composed of short staple fibres have shown higher microfibre release as compared to polyester fabric which was made of filament yarns (De Falco et al., 2018). The protrusion formation of polyester in Figure 2 (e-f) was not as much as cotton and rayon may be due to the nature of polyester fibre which is hydrophobic which is not affected by moisture.

CONCLUSIONS

It can be concluded that the tested fabrics release the highest amount of microfibres during the first five cycles of washing. For cotton and rayon, the amount of the escaped microfibres started to stabilise at washing cycle number 11 onwards. Less microfibre release from polyester fabric was recorded because of the less protruding fibres observed on the surface. Hence, further investigation is needed to explore the image of the protrusion as a representation of the microfibre release such as on the protrusion density and the protrusion length. The outcome of this effort is important as to help manufacturers in developing textile materials with minimum tendency in releasing microfibres and with pleasant appearance even after several number of washings.

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Sekian, terima kasih.

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Setuju.

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PROF. MADYA DR. NUR HISHAM IBRAHIM
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