Microfiber Shedding at Home Laundering: Evaluation of Washing Options for Clothing Made of Synthetic Materials

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Introduction and Background. Microfibers, residues of plastic or synthetic fibers with a dimension of 0.1µm to 5mm, have an adverse effect on the environment and become a global concern for polluting the environment (Carr, 2017). Clothing made of synthetic materials (e.g., polyester, nylon, acrylic) is one of the major sources of microfibers' shedding during the home laundering process (Hernandez et al., 2017; Napper & Thompson, 2016). Microfibers are too tiny to trap into the filter of a home laundering machine that eventually flows out with rinse water and falls into oceans or rivers (Dris et al., 2016). Microfibers then form bonds with chemical pollutants of water which are consumed by marine lives, affecting physiology and health of marine lives through disturbing into their food-chain (Napper & Thompson, 2016). Microfibers also have been found in human lung biopsies, lakes, drinking water, and soil samples (Machado et al., 2018; Prata, 2018; Wagner et al., 2014). It is critical to revisit the home laundering process of synthetic clothing for the betterment of people and the planet.

Previous studies (Frost et al., 2020; Hartline et al., 2016; Zambrano et al., 2019) found the influences of laundry detergent types, washing temperature options, use of fabric softeners on microfiber shedding at home laundering. However, consumers also use different washing options such as washing bag, laundry ball, and lint trap during the laundering process. Each option is used (a) for protecting garments from snags, tears, or stretch; (b) as a detergent alternative which performs cleaning through friction with garments; and (c) to catch foreign materials produced during the home laundering process, respectively (Lamichhane, 2018). Limited research exists to showcase the significance of using these different washing options on microfiber shedding while laundering. Thus, the purpose of this study was to examine the effects of different washing options on microfiber shedding during the home laundering process of synthetic clothing with different washing cycles.

Method. An experimental research design, consisting of 4 (washing options) x 3 (polyester clothing types) x 3 (washing cycles) x 2 (repetition) was used for this study. Specifically in this experiment, washing options are the treatment with four levels, including the control group with polyester clothing, polyester clothing with washing bag, polyester clothing with laundry ball, and polyester clothing with lint trap. Three types of 100% polyester clothing were polyester fleece blanket, polyester knitted cover-up, and polyester sportswear. Three washing options used in this experiment included mesh laundry wash bag (38.10cm x 45.72cm), laundry ball (8cm diameter), and nylon lint trap (0.63cm x 9.65cm x 13.97cm). A top loaded portable washing machine was used for laundering with 2 liters of water at 30°C temperature. Filter papers with 9cm diameter were used for filtering the discharged water from the washing machine using a vacuum filtration system, consisting of 500ml vacuum filtering flask, 60cm

length of plastic vacuum tubing, 200ml Buchner funnel, and hand vacuum pump with pressure gauge. A digital scale was used to weigh the filter paper in order to measure the microfiber content in milligram per liter.

SAS 9.4 was used for statistical analyses at the significance level of $p < .05$. A *F*-test in ANOVA was used to determine the significant effects of four washing options on microfiber shedding. A *t*-test was used to check the effect of an individual washing option on microfiber shedding. A pairwise Tukey adjustment method was used to compare the washing options. A *Z*-test was also conducted to determine the significance of two covariance parameters, which are (a) the effects of different types of synthetic clothing within the same washing option and (b) the effects of different washing cycles within the same washing option and the same type of synthetic clothing.

Results and Discussion. The *F*-test in ANOVA revealed the statistical significance of four washing options on microfiber shedding ($F(3,8) = 25.61$, $p = .0002$). It demonstrates that four washing options (control group with polyester clothing, polyester clothing with washing bag, polyester clothing with laundry ball, and polyester clothing with lint trap) have the significant effects on microfiber shedding of three types of 100% polyester clothing at different washing cycles. The *t*-test also revealed the significant effects of washing options on microfiber shedding of polyester clothing at different washing cycles with the control group ($t(8) = 14.73$, $p < .0001$), with washing bag ($t(8) = 17.44$, $p < .0001$), with laundry ball ($t(8) = 26.12$, $p < .0001$), and with lint trap ($t(8) = 16.60$, $p < .0001$).

The Tukey's pairwise comparisons revealed no significant difference of the control group with laundering with washing bag ($t(8) = -1.92$, $p = .2942$) and lint trap ($t(8) = -1.33$, $p = .5732$). On the other hand, a significant difference was found between laundering with laundry ball and the control group ($t(8) = 8.06$, $p = .0002$). Specifically, washing synthetic clothing with laundry ball produced 36.44mg/L more microfiber contents than the control group. This presents while laundering different types of synthetic clothing at different washing cycles, washing synthetic clothing with laundry ball produces higher microfibers whereas laundering synthetic clothing with washing bag and lint trap produce approximate same amounts of microfibers compared to the control group.

The *Z*-test revealed that the effect of different types of synthetic clothing within the same washing option was insignificant ($Z = .69$, $p = .2439$), demonstrating the similar quantity of microfiber shedding while laundering 100% polyester fleece, knit, and sportswear within the same washing option (e.g., washing bag). The effect of different washing cycles within the same washing option and the same type of synthetic clothing was significant ($Z = 2.75$, $p = .0029$), indicating that different washing cycles have different effects on microfiber shedding while laundering 100% polyester clothing (e.g., fleece blanket) using laundry ball, washing bag, or lint trap.

Conclusion. This experimental study examined the effects of different washing options on microfiber shedding of synthetic clothing at different washing cycles during the home laundering process. The use of washing bag, laundry ball, and lint trap did not reduce microfiber

shedding of synthetic clothing. In fact, the use of laundry ball accelerated microfiber shedding. The findings of this study also presented the effects of different washing cycles on microfiber shedding of synthetic clothing. The findings provide great insights for industry professionals and academic researchers on the urgent needs of educating consumers to choose right washing options to minimize microfiber shedding. Since different types of washing bag, laundry ball, and lint trap are commercially available in the market, further research is recommended to verify their effects on microfiber shedding compared to the findings of this study.

This research only focused on 100% polyester clothing which does not represent the entire synthetic clothing, which is one limitation of this study. Future research is suggested to examine microfiber shedding of synthetic clothing with various fiber types (e.g., nylon, acrylic, blended). Despite the study limitations, the findings of this study contribute to the overall body of knowledge related to microfiber shedding and its negative impact to the environment. The findings also have implications for industry professionals and academic researchers to develop effective washing options which can facilitate the laundering process as well as minimizing the negative environmental impact by controlling microfiber pollution at home laundering.

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References

Carr, S. A. (2017). Sources and dispersive modes of micro-fibers in the environment. *Integrated Environmental Assessment and Management, 13*(3), 466-469.

Dris, R., Gasperi, J., Saad, M., Mirande, C., & Tassin, B. (2016). Synthetic fibers in atmospheric fallout: a source of microplastics in the environment? *Marine Pollution Bulletin, 104*(1-2), 290-293.

Frost, H., Zambrano, M. C., Leonas, K., Pawlak, J. J., & Venditti, R. A. (2020). Do recycled cotton or polyester fibers influence the shedding propensity of fabrics during laundering? *AATCC Journal of Research*, *7*(1), 32-41.

Hartline, N. L., Bruce, N. J., Karba, S. N., Ruff, E. O., Sonar, S. U., & Holden, P. A. (2016). Microfiber masses recovered from conventional machine washing of new or aged garments. *Environmental Science & Technology*, *50*(21), 11532-11538.

Hernandez, E., Nowack, B., & Mitrano, D. M. (2017). Polyester textiles as a source of microplastics from households: a mechanistic study to understand microfiber release during washing. *Environmental Science & Technology, 51*(12), 7036-7046.

Lamichhane, G. (2018). Analysis of microfibers in waste water from washing machines (Unpublished Thesis). Metropolia University of Applied Sciences, Finland.

Machado, A. A., Kloas, W., Zarfl, C., Hempel, S., & Rillig, M. C. (2018). Microplastics as an emerging threat to terrestrial ecosystems. *Global Change Biology*, *24*(4), 1405-1416.

Napper, I. E., & Thompson, R. C. (2016). Release of synthetic microplastic plastic fibres from domestic washing machines: effects of fabric type and washing conditions. *Marine Pollution Bulletin, 112*(1-2), 39-45.

Prata, J. C. (2018). Airborne microplastics: consequences to human health? *Environmental Pollution, 234*, 115-126.

Wagner, M., Scherer, C., Alvarez-Muñoz, D., Brennholt, N., Bourrain, X., Buchinger, S., Fries, E., Grosbois, C., Klasmeier, J., Marti, T., & Rodriguez-Mozaz, S. (2014). Microplastics in freshwater ecosystems: what we know and what we need to know. *Environmental Sciences Europe*, *26*(1), 1-9.

Zambrano, M. C., Pawlak, J. J., Daystar, J., Ankeny, M., Cheng, J. J., & Venditti, R. A. (2019). Microfibers generated from the laundering of cotton, rayon and polyester based fabrics and their aquatic biodegradation. *Marine Pollution Bulletin*, *142*, 394-407.