The Sustainability and Environmental Impact of the Fashion Industry

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Abstract

Moving into the century of "fast fashion", leads to clothes being produced quickly and of overall poor quality, leading to a short duration of use for consumers. The fashion industry is also damaging our environment due to the rapidly increasing speed of getting the textile into the hands of consumers as a garment and then from the consumer to the landfill. The objective of this study is to test experimentally the top five most used textiles in the fashion industry and create ecoquality rankings for the textiles' overall sustainability. The materials tested in the experiment were a combination of organic textiles: cotton, organic cotton, and line; and the synthetic textiles: polyester, and rayon. The three experiments involved setting each textile in direct sunlight to measure the change in the coloring of the materials, testing the durability of the textiles in the wash, and they were also buried in the ground to determine decomposition rate. Each textile in the tests was ranked on a scale of 1-5 to determine an overall sustainability rating. The results of this study found that organic textiles were more sustainable, while the synthetic textiles had a longer useful lifetime.

Introduction

The fashion industry is damaging our environment due to the rapidly increasing speed of getting textiles into the hands of consumers and then from the consumer to the landfill. Every year there are 3.8 billion pounds of clothing consumed with about 85% of those textiles ultimately being thrown away (Bick, 2018). Approximately 500,000 tons of textiles are then sent

in compressed crates to Low and Middle Income Countries (LMICs) like Ghana, Bangladesh, and India. These are then sorted, resold, and if unsellable, thrown into the landfill; in 2015 in East Africa alone, they received $151 million worth of imports (Kuwonuk, 2017). In the past year, landfills received 11.2 million tons of textiles and every year this number has increased (EPA, 2019). In 2019, the percent of clothing being recycled was only about 1/13th of the total amount produced. We have moved into the century of "fast fashion", meaning that clothes are being produced quickly with an overall poor quality. This production mentality leads to short duration of use in the consumers' hands. "Fast fashion" and its impacts have been receiving media attention and recent documentaries have been created to make increase eco-concieness. In America, places like the Trans-America Trading Company provide locations for textiles to be recycled, shredded, and resold or turned into rags for industrial use (Claudio, 2007). These allow an easily accessible outlet for those looking to minimize their impact and help influence a more sustainable textile lifetime.

With so much textile waste, scientists have been trying to develop solutions that are not only more ethical, but also sustainable and easily biodegradable. Fabrics such as banana leather, hemp, seaweed, and coconut fiber, have emerged and have been taken on by small clothing businesses. While these have proven to be effective in meeting these new standards, they are expensive, and not appealing for large corporations to adopt. Some companies are also claiming that the products they are selling are "green" but are not complying with the Global Organic Textile Standard, which outlines the sustainable business practices, regulations, and manufacturing criteria (Bhajekar, 2016).

Sustainable textile discoveries will make profitable changes for companies who believe in making a difference for the environment. Brands using "fashion forward thinking" encourage

consumers to want to support them. Consumers are also retaliating by boycotting companies that do not use ecoconscious materials or practices leading to large stores going out of business or being forced to make changes (Lundblad, 2015).

Finding out what materials decompose readily, retain their color, and avoid deterioration in the wash are the keys to lengthening the lifespan of products and to avoiding being rapidly thrown away, and halting the fast fashion cycle. Further, the difference in sustainability of organic and synthetic fibers is more than just the initial ethical impact. Cotton requires 10 times the amount of water to produce than synthetic textiles although postproduction is better for the environment (Nayak et al., 2019).

The objective of this study is to experimentally challenge the top five most used textiles in the fashion industry and create rankings for the textiles overall sustainability.

Hypothesis

Hypothesis$_A$: Organic textiles will be more likely to deteriorate when washed repeatedly than the synthetic textiles.

Null Hypothesis$_A$: Organic and synthetic textiles will not differ in their deterioration after repeated washes.

Hypothesis$_B$: Organic textiles will be less likely to fade after a period of sitting in direct sunlight than the synthetic textiles.

Null Hypothesis$_B$: Organic and synthetic textiles will not differ in color change after a period of sitting in direct sunlight.

Hypothesis$_C$: Organic textiles will decompose faster when buried in soil than the synthetic textiles.

Null Hypothesis$_C$: The decomposition of organic and synthetic textiles will not differ when buried in soil.

Hypothesis$_D$: Organic textiles will be ranked more sustainable than synthetic textiles.

Null Hypothesis$_D$: There will be no difference in organic and synthetic textile rankings.

The independent variable in this study is the type of textile used in two groups: *Organic*: Cotton, Organic Cotton, Linen; and *Synthetic*: Rayon, and Polyester. The independent variable for the first experiment is the composition of the textile and the dependent variable is the degree of fading/color change. In the second experiment, the independent variable is the composition of the textile and the dependent variable is the change in mass. For the third experiment, the independent variable is the composition of the textile and the dependent variable is the percent decomposition. The constants were the size of each textile square treated, and the duration and exposure of each textile sample to each of the treatments.

Materials and Methods

The materials tested in the experiment were cotton, organic cotton, linen, polyester, and rayon. These fabrics were all collected and each cut into four 10.6 cm x10.6 cm squares for the varying experiments. The textile tests were conducted through the months of July through December 2019. One square of each fabric was placed aside in constant conditions to avoid any change in the fabric as the control for final comparison. These squares were each weighed at the beginning of the process to be compared at the end of the experiment. The first experiment set up one sample of each fabric in direct sunlight to measure the change in the coloring of the materials. The second test evaluated the durability of the textiles in the wash. Once a week one

of each fabric was placed in the laundry in a mesh bag and washed in normal conditions. To understand the decomposition process, one of each sample was buried under 1ft of rich soil. To create outside conditions similar to a landfill. The sample was then dug up after 5 months to see if any decomposition had occurred. Upon resurfacing, they were lightly washed to get rid of excess dirt.

After 5 months passed, the samples were all collected and analyzed. The textiles were taken into the lab to evaluate the difference in coloring from exposure to sunlight, the percent composition lost, and decomposition rate of the textiles. Images were taken with a Proscope HR microscope camera. The samples that were buried for decomposition were weighed and compared to the constant sample square using a scale. Those exposed to sunshine and the samples not exposed were studied under a microscope to see if color had faded. Photographs were taken for comparison. Samples placed in the wash were also examined under the microscope and photographed for comparison.

The data were collected, analyzed, and compared in graphs explaining the percent composition lost and percent faded. For the durability, sunlight, and decomposition experiment they were compared through a scale ranking, classifying the textile from 1-5 on an Ecoquality Index Rating, with 5 being the most sustainable and 1 being the least. The scale standardizes the results of each experiment qualitatively to assess the textile movement to sustainable outcome.

Results

After weekly repeated washes, the polyester was the least changed, losing only 0.180% of its weight. The organic cotton lost 1.784%, cotton lost 2.782%, rayon lost 5.695%, and the greatest amount lost was linen with 8.837%. Through the wash there was an unexpected variable, which was how the fabric wrinkled after the wash. It was found that the polyester was

resistant to wrinkling meanwhile; the cotton produced a large amount of wrinkles. There was almost a direct correlation with weight loss to the quality of the fabric. The higher the percent of weight loss the more likely the material was to be wrinkled, frayed, or have color alterations.

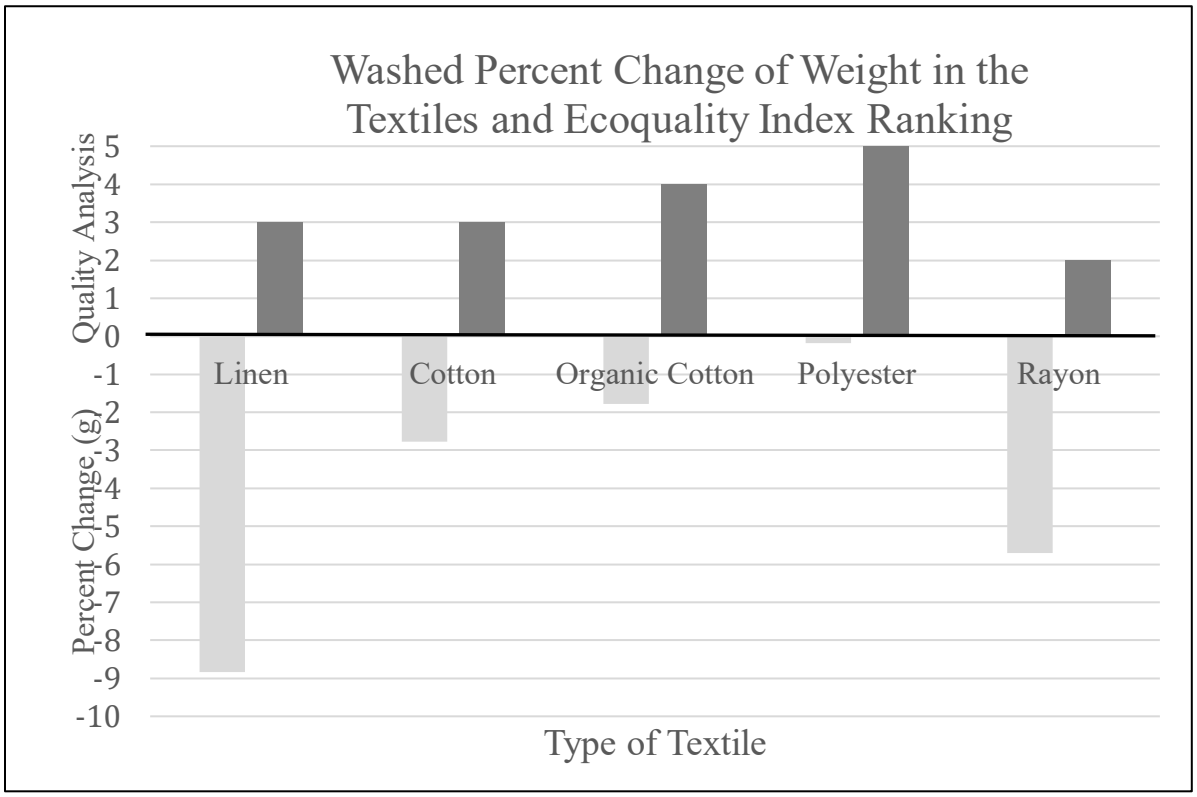

Figure 1. The x-axis demonstrates the textiles. The upper y-axis shows the ecoquality analysis ranking, a ranking of 5 means there was a miniscule amount of weight lost. The lower y-axis, below 0, shows the percent change in weight after repeated washes. Linen had the highest percent lost at 8.7% and a rank of 3, and polyester had less than 1g mas lost, and the highest rank of 5 for the ecoquality ranking.

The second experiment studied the textile change after constant exposure to sunlight. After being exposed for six months Linen, Polyester, Rayon were able to hold all of their color and received a ranking of five. Both of the cotton textiles faded very lightly. In the scale, cotton

was classified as a 4, meaning when compared to the original constant fabric a slight difference that could be seen while directly compared but otherwise it would not be noticed.

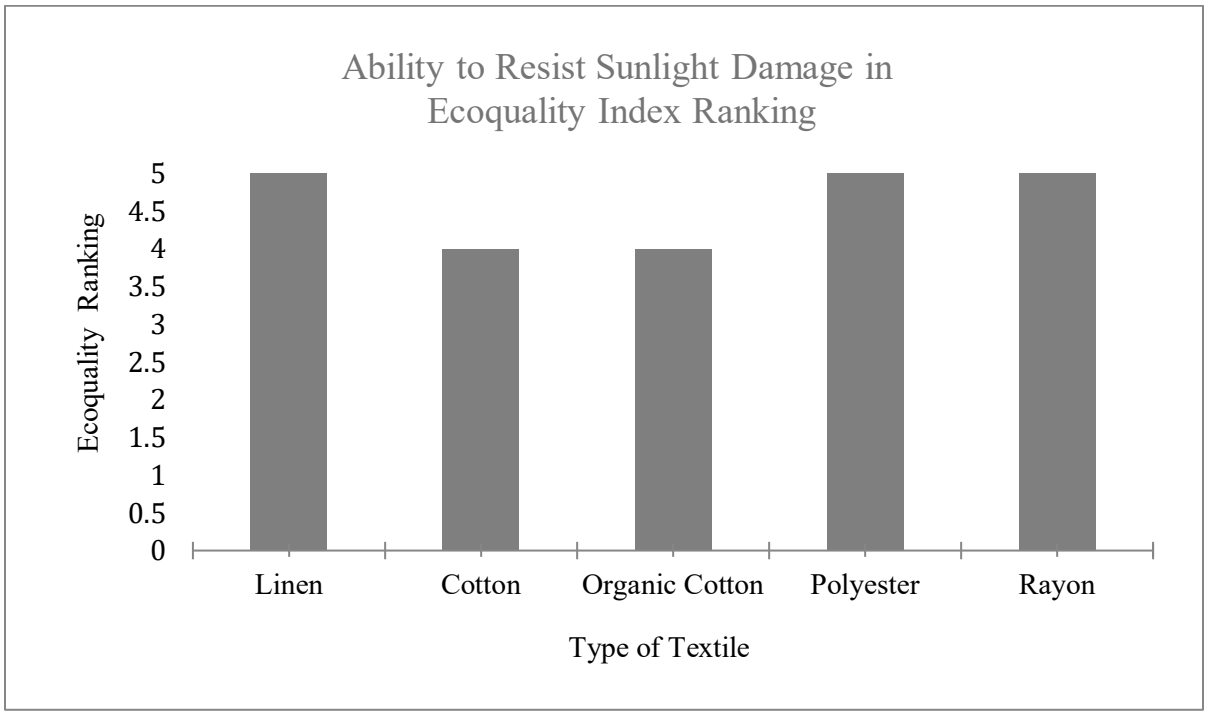

Figure 2. The ability to resist color change due to sunlight exposure. Measured on a scale of 1, being unrecognizable and 5, being the same color as the original. All of the tested textiles were able to maintain their color receiving a 4 or 5.

The textiles were buried from June to November. When they were uncovered only two of the textiles were remaining, polyester and rayon. Polyester was in perfect condition and looks exactly like the control sample despite being buried for over five months. The rayon on the other hand had lost all of its color and a 97.7% of its weight, all that remained was a small skeleton outline of it. It was able to be identified by the thread composure that could be compared to the original microscopic photographs. The remaining three including cotton, organic cotton, linen,

which were all of the organic fabrics, decomposed entirely. From there the final condition was ranked with a scale of 1 being in perfect condition and 5 being nonexistent.

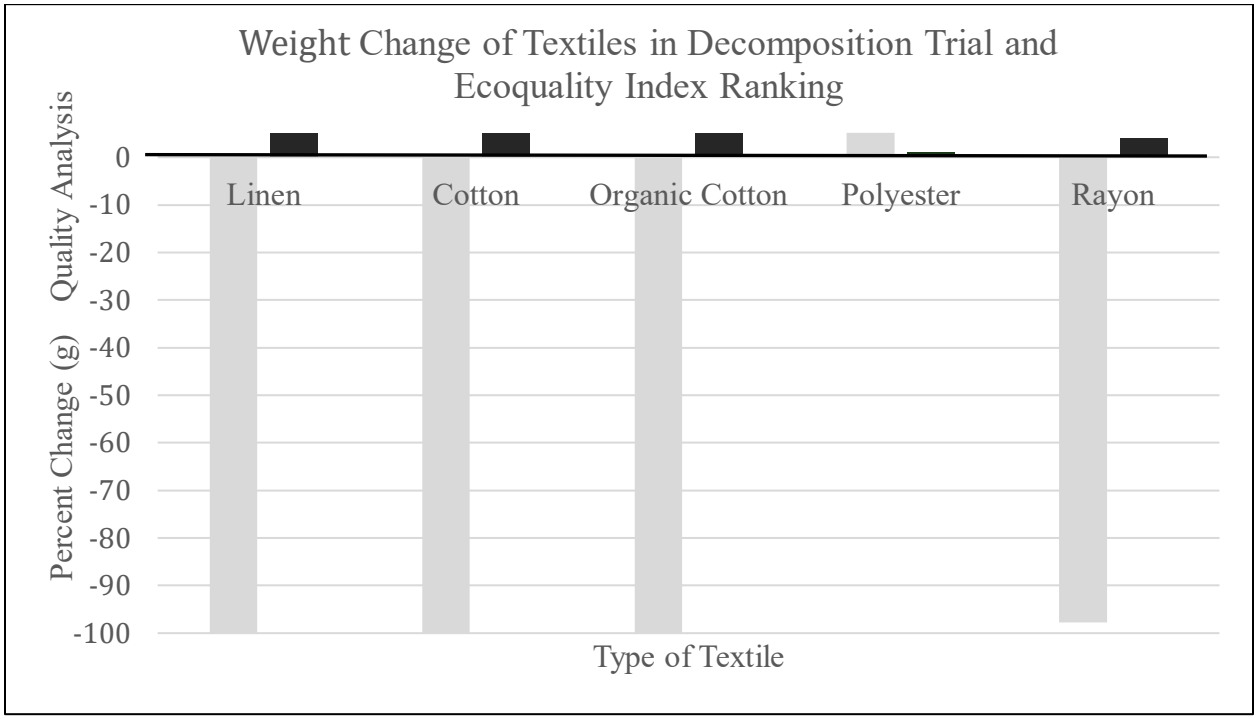

Figure 3. The percent weight lost on the lower y-axis in comparison to the ecoquality ranking which is on the upper y-axis. A 1 on the scale means the textile remained in the same condition as the origimal, while, 5 was completely decomposed. The polyester gained 9.747% of its weight due to it likely absorbing water or sediments due to the textiles refusal to break down, all other textiles were fully decomposed.

The final graph demonstrates the composite rankings among all the trials to solve the overarching issue of which fabric would be considered the most sustainable overall. In the end, linen and organic cotton tied for the highest total with cotton coming in right behind. The polyester and rayon ended up both amounting to the same total but the reasoning was entirely different. Due to polyesters inability to decompose it caused the almost perfect score to drop.

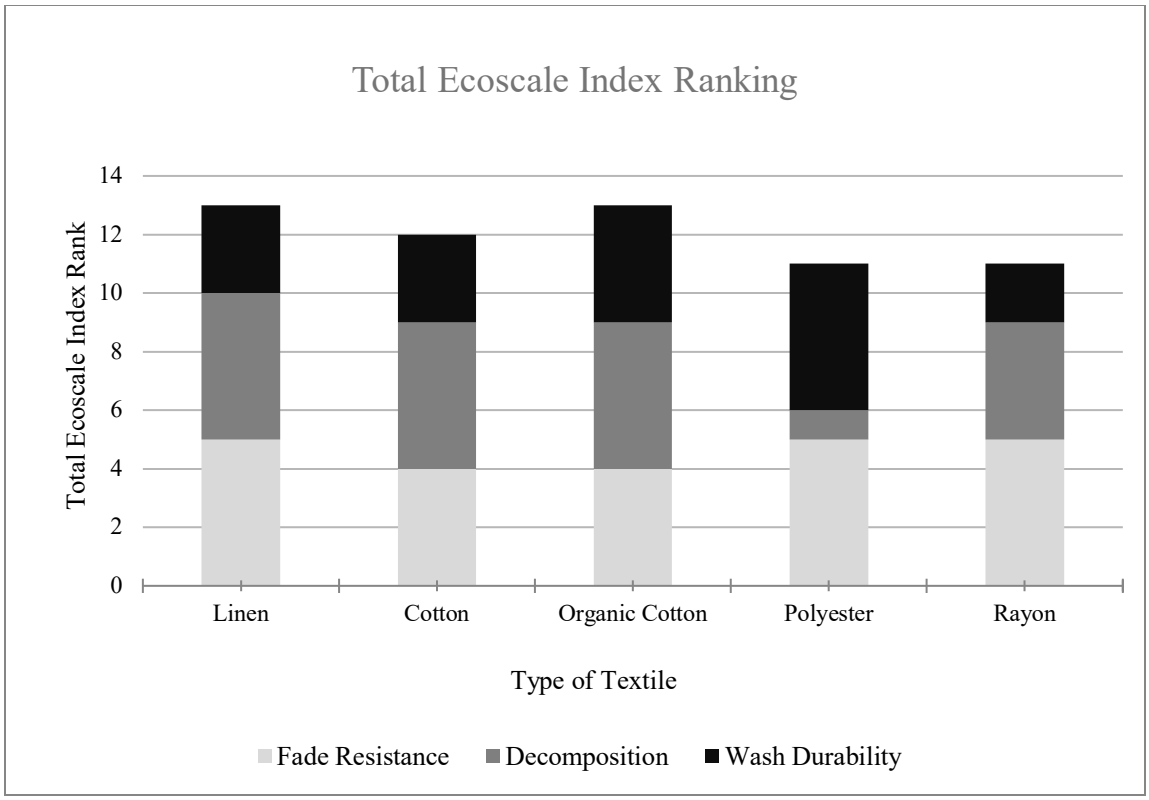

Figure 4. The total ranking among the tested textiles, including fade resistance, decomposition ability, and the wash composure. Linen and organic cotton tied for overall sustainability with a composite 13/15. Polyester and rayon had the lowest ranking of 11/15.

Conclusion

The results of the study show a benefit in using organic materials for short lifetime production. Based on these results the null hypotheses A&C can be rejected; *organic and synthetic textiles will not differ in their deterioration after repeated washes as well as decomposition of organic and synthetic textiles will not differ when buried in soil.* The alternative hypothesis B is rejected*; organic textiles will be less likely to fade after a period of sitting in direct sunlight than the synthetic textiles.* The organic textiles makeup creates an extremely fast decomposition, overall ability to resist fading, and capability to remain in composure in the wash makes them the perfect material for the fast fashion industry. The study

was originally created with the mindset of a higher ranking means the textile is more sustainable. Meanwhile, after evaluating the polyester it can be argued that polyester is actually more sustainable for clothing that are to be worn for a long time. Since it does not decompose easily, it means that it could be worn for a long time. This is a significant benefit of the textile that is often criticized for not being eco-friendly. The initial goal was to have the solution of the best fabric for the fast fashion industry but if the tables were shifted to find the best product to last a lifetime, based on this analysis, polyester would be the clear winner.

The results of this study were inconsistent with other studies such as "Biodegradation of Three Cellulosic Fabrics in Soil" which also studied the decomposition of textiles on a smaller sample scale (Warnock et al., 2009). In their study, they found that rayon decomposed quicker than cotton did which was opposite of what this study found.

If this experiment were to be extended, the study would require more trials. Having multiple tests would increase accuracy and support the experimental findings. In the decomposition study, checks throughout the months would be included to get a more exact value of how much has decomposed over time. This would improve accuracy in determining the best textile to decompose. This experiment demonstrated that the organic textiles decomposed but it would be beneficial to be aware of how quickly within the five months each of them decomposed.

Solutions to the overarching issue of fast fashion requires an international effort. Scientists are beginning to study practices in businesses that would allow the implementation of these textiles sustainably. Egels-Zandén was one of the first to introduce a 100% transparent and sustainable company method with Swedish Nudie Jeans, this gives businesses a model to follow and improve their brand (Egels-Zandén, 2016). By using the data in this study, businesses that

are large contributors to fast fashion can switch to produce their products out of linen or organic cotton. This allows fashion that can be worn for a short period but then can be thrown away without large repercussions due to the textiles ability to rapidly breakdown in nutrient rich soil. Contrary to popular belief, polyester, which is commonly used in fast fashion companies, is able to last a lifetime in great condition. Companies that intend for their product to be an item that will be able to withstand many years would need to switch to polyester. While polyester is often disregarded for being unsustainable since it requires 40% more energy than organic textile production, it has a lifetime that out ways the initial environment cost (Nayak et al., 2019). This would prevent a large buildup of polyester due to them remaining in the consumer's closet rather than sitting in a landfill.

Unfortunately companies cannot undo the damage they have already done, but that does not mean all hope is lost. The Textile Exchange Initiative helps voluntary companies learn to be transparent on how they are producing textiles and where they came from. Companies such as H&M Group, Levi Strauss & Co., Nike, and Patagonia have begun participating in the published ratings of the sustainability of their textiles as well as their process. Consumers can finally go online and actually see what brands are doing to become more sustainable. 85% of the 170 companies involved have reached their target goal for a sustainable material such as switching to organic cotton, recycled polyester, or bio-based nylon (Tan, 2020). The company anticipates that by the year 2030 at least 20% of our polyester in clothing circulation will be recycled.

With this growing awareness of sustainable fashion, the industry as well as consumers need to make a change. Companies need to pay attention to the impact that their small choices have on the environment. Understanding the overall sustainability of a textile can lead to a decrease in the overall consumption rate.

Work Cited

Peer Reviewed

Bick, R., Halsey, E. & Ekenga, C.C. The global environmental injustice of fast fashion. Environ Health 17, 92 (2018). https://doi.org/10.1186/s12940-018-0433-7

Claudio, L. (2007, September 1). Waste Couture: Environmental Impact of the Clothing Industry. Retrieved February 5, 2020, from https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.115-a449

Egels-Zandén, N. (2016). Not made in China: Integration of social sustainability into strategy at Nudie Jeans Co. Scandinavian Journal of Management, 32(1), 45–51. doi: 10.1016/j.scaman.2015.12.003

Lundblad, L., & Davies, I. A. (2015). The values and motivations behind sustainable fashion consumption. Journal of Consumer Behaviour, 15(2), 149–162. doi: 10.1002/cb.1559

Nayak, R., Singh, A., Panwar, T., & Padhye, R. (2019). A Review of Recent Trends in Sustainable Fashion and Textile Production. Current Trends in Fashion Technology & Textile Engineering, 4(5). doi: 10.19080/ctftte.2019.04.555648

Warnock, M., Davis, K., Wolf, D., & Gbur, E. (2009). Biodegradation of Three Cellulosic Fabrics in Soil. Retrieved from https://www.researchgate.net/profile/Duane_Wolf/publication/266047454_Biodegradation_of_Three_Cellulosic_Fabrics_in_Soil/links/54ccf6150cf29ca810f7352a.pdf

Non-Peer Reviewed

Bhajekar, R. (2016). General Description - Global Standard gGmbH. Retrieved from https://www.global-standard.org/the-standard/general-description.html

Kuwonuk, F. (2017, December). Protectionist ban on imported used clothing | Africa Renewal. Retrieved February 5, 2020, from https://www.un.org/africarenewal/magazine/december-2017-march-2018/protectionist-ban-imported-used-clothing

Tan, E. (2020). Fiber & Materials. Retrieved from https://textileexchange.org/materials/

EPA. Textiles: Material-Specific Data. (2019, October 30). Retrieved from https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/textiles-material-specific-data

Appendix

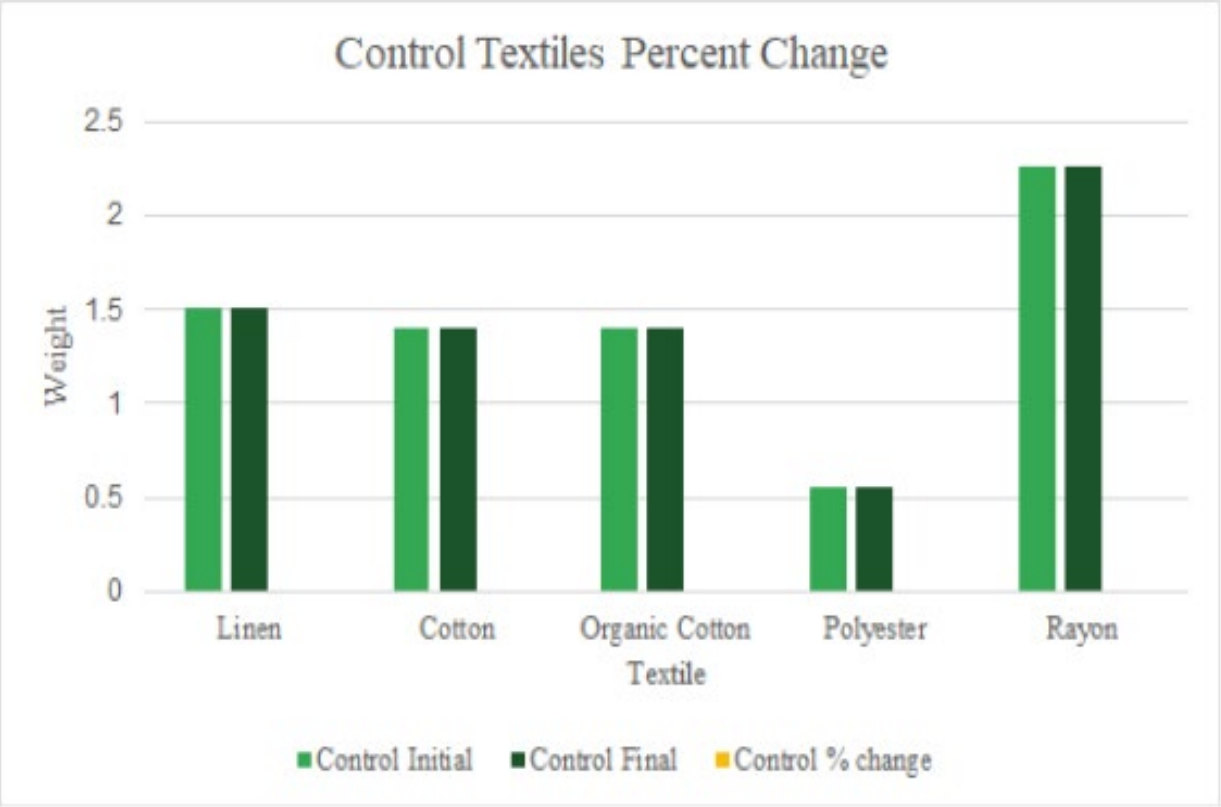

Figure 5: The x-axis is the type of textile with the y-axis representing the final and initial weight. There was no percent change on any of the textiles.

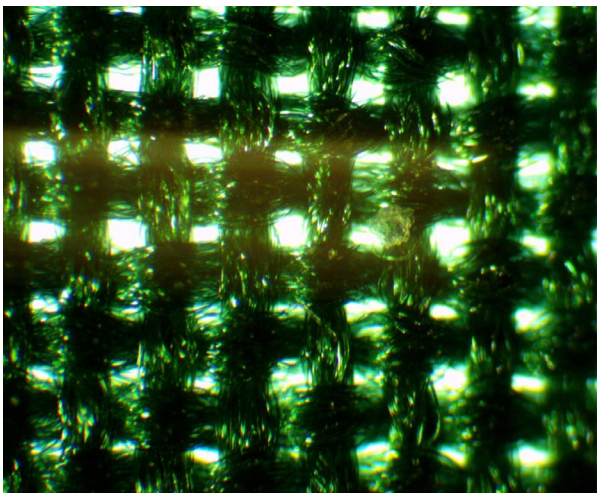

Figure 6. Polyester control.

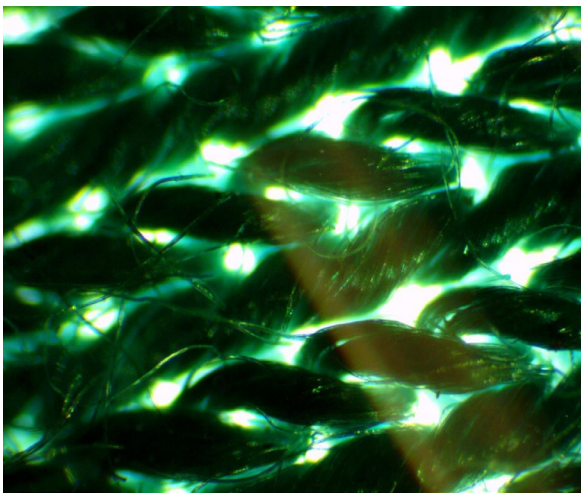

Figure 7. Rayon control fabric.

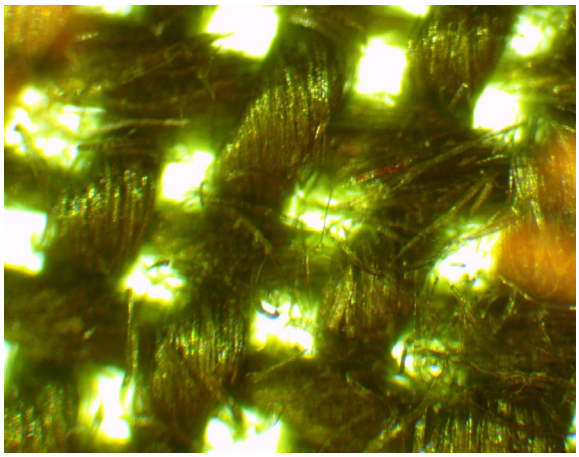

Figure 8. Linen control fabric.

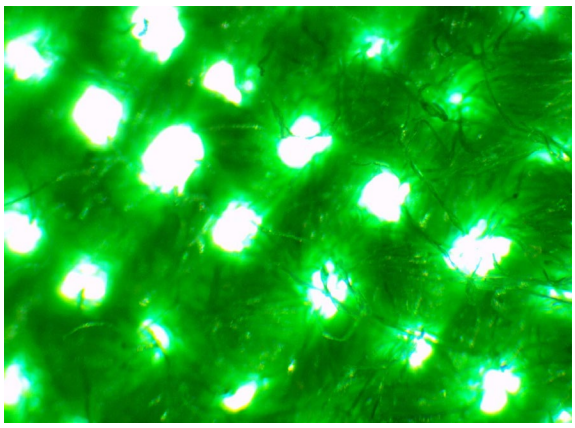

Figure 9. Organic cotton control.

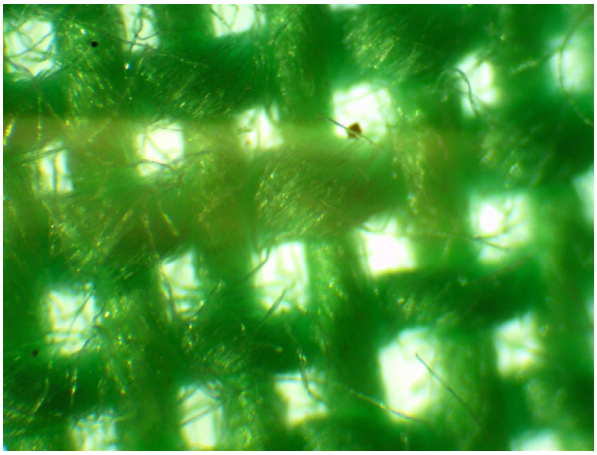

Figure 10. Cotton control.