Water Retention Capacities of Different Fabrics

Vyom Buch and Josh Leary
Summer Ventures in Science and Math 2012
Visual and Image Processing
Mentors: Dr. Rahman Tashakkori, Ahmad Ghadiri, Sina Tashakkori
Appalachian State University

Abstract: *The goal of this experiment was to determine the water retention capacities of five different fabrics. All fabrics were tested in a controlled environment. They were weighed, submerged in water, dried for 30 minutes, and weighed again. The relationship between the dry weight, wet weight, evaporated water percentage, leftover water percentage, and knots per square inch were found. The results show that some fabrics are more efficient at absorbing water while others are more efficient at expelling it.*

1.0 Introduction

Clothing is a necessity in today's world. There are a wide variety of clothing options to choose from; from specialized clothing to casual apparel, clothes nowadays satisfy all occasions. This plethora of options arises from the different materials the clothes are made from, the different weaves, and, in some cases, the blend of multiple fabrics. One of the main objectives of clothing is comfort. Clothing provides three main types of comfort: psychological, tactile, and thermal. Psychological comfort relates to fashion and acceptance into society; tactile comfort refers to the fabric material and its feel, and thermal comfort applies to the clothing's ability to retain body heat [1]. The general consensus is that the transfer of air, water vapor, and heat are the main factors when purchasing clothes [2]. Moisture plays a key role in comfort. The human body functions optimally at 37° Celsius, which is 98.6° Fahrenheit [3]. In order to maintain this temperature, the body perspires. Sweat then evaporates using the excess body heat; this cools down the body. Clothing, by covering the body, obstructs this natural phenomenon and prevents sweat from evaporating. Therefore, it is necessary to wear clothing that aids, or doesn't block, perspiration.

Clothing varies depending upon the occasion. Therefore, certain fabrics can be extremely useful in some cases, or totally inappropriate in others. In this paper, we test the moisture retaining, or moisture releasing, capacity of various types of fabrics in a controlled environment. The weight of the fabric before and after immersing in water and after drying for 30 minutes show that some fabrics are very good at retaining moisture while others are very good at expelling moisture.

2.0 Method

The aim of this experiment was to test the water retention capacities of different types of fabrics. The fabrics used were 100% Cotton (Navy-Blue with stripes), 100% Polyester (Red), 100% Rayon (Black), 50% Polyester and 50% Nylon (Polka Dots), and 65% Polyester and 35% Cotton (Pink).

This experiment consisted of two major parts. The first part uses a ProScope HR, 5 different types of 10X10 cloths, and a computer to observe the characteristics of the fibers. The second

part tests the water holding and drying rates of the different types of fabrics using a drying rack made of string, the five types of fabrics, plastic cups, a balance scale, a clock, water, and a large saucer.

2.1 Calculating the KPSI

Use a ProScope HR to capture the images of each of the 10X10 fabric squares under 100x and 400x magnifications. Use ImageJ to calculate the knots per square inch for each piece of cloth. The knots per square inch along with the weave patterns can help us determine the water retention capacity of the fabrics. Figure 1 shows the ProScope HR image of the 65% Polyester and 35% Cotton fabric.

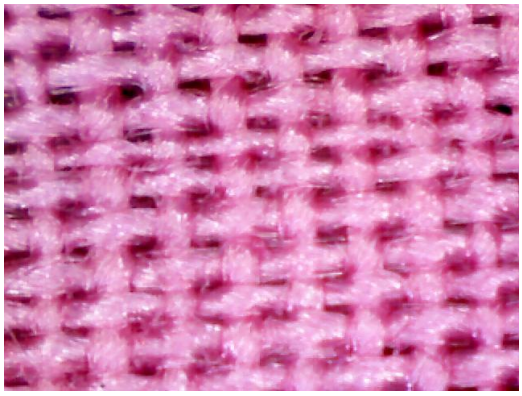

Figure 1- ProScope HR Image of Fabric

2.2 Moisture Testing

This part of the experiment is conducted in a controlled environment. The step-by-step directions of the testing are (in order) listed below.

1. Weigh the piece of cloth.
2. Submerge the cloth full in the saucer containing water for 1 minute.
3. Pull out the cloth and hold it from two adjacent corners above the saucer for 30 seconds so that the surface water drains out.
4. Weigh the piece of cloth again. Use cups on both sides of the scale with the cloth in one cup.
5. Let the water sit in its cup for 30 minutes. Illustrated in Figure 3.
6. Hang the cloth on the string as shown in Figure 4.
7. Weigh the amount of water left in the cup.
8. Remove the cloth from the string after 30 minutes.
9. Weigh the cloth.

Each of these steps is to be repeated for each cloth. Once the first round of testing is over, repeat the experiment again with the same sizes once more.

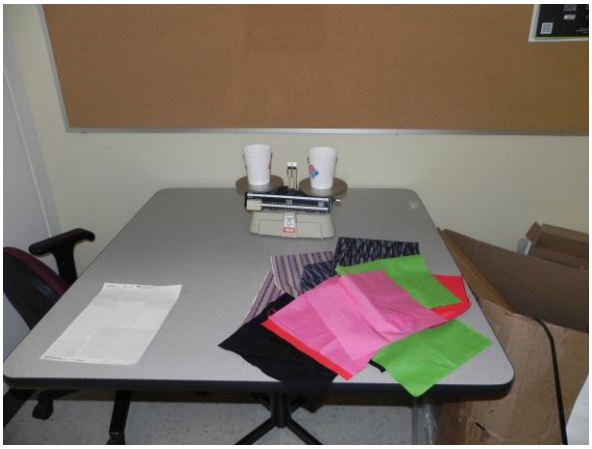

Figure 2- The Apparatus

Figure 3- First Stage of Drying

Figure 4- Final Stage of Drying the Cloths

3.0 Results

Microsoft Excel 2010 was used to calculate the relationship between the following factors: dry fabric weight, wet fabric weight, after drying weight, and knots per square inch. Table 1 shows the annotations for each fabric for easier reference.

Table 1- Fabric Annotations

Cloth	Annotation
100% Cotton- Bule w/ stripes	1
100% Rayon- Black	2
50% Polyester 50% Nylon- Polka Dots	3
100% Polyester- Red	4
65% Polyester 35% Cotton- Pink	5

3.1 Weight of Water Absorbed by the Cloths

The comparison of the weight of the dry piece of cloth and the water it holds is very important as it shows the absorption of water by different fabrics with respect to their weight.

The pure fabrics (100% Cotton, 100% Polyester, and 100% Rayon) absorbed more water than their own weight; they absorbed approximately 125% their own weight in water. The blends, on the other hand, absorbed less water than their own weight; they absorbed about 85% their own weight in water.

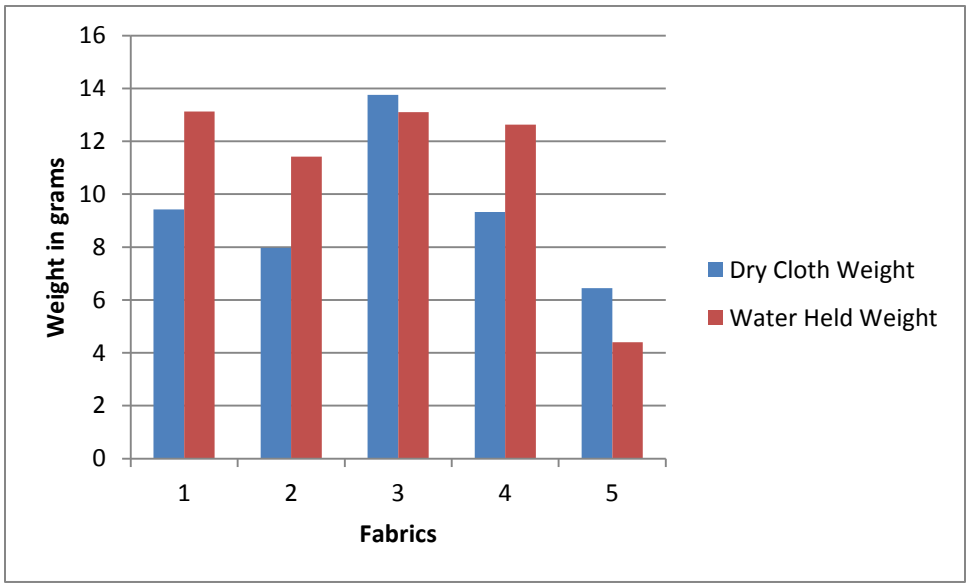

Figure 5- Water Held by Cloths

3.2 Water Left After Drying, the Evaporation Percentage, and the Leftover Percentage

The water left in the cloth after 30 minutes of drying shows the rate of drying and the water retention capacity.

Figure 6 shows the amount of water left in each piece of cloth after drying them for 30 minutes. This shows that some fabrics dry faster than the others.

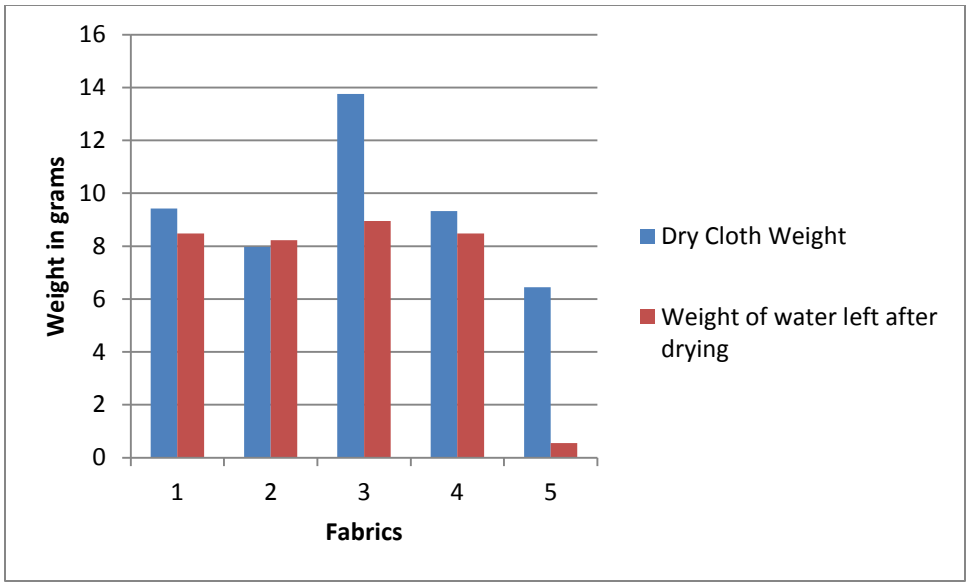

Figure 6- Weight of Water Left after Drying

The percentage of water left presents a more accurate value of the water retention capacities of the different types of fabrics.

Table 2 shows that the percent of water left is lowest for the 65% polyester-35% cotton blend, then 100% cotton, followed by 100% polyester, 50% polyester-50% rayon, and then by 100% rayon. Table 2 aids in determining which fabrics lose water by showing the amount of water lost to evaporation.

Table 2- Distribution of Water

Annotation	% of Water Left	% of Water Evaporated
1	64.57142857	35.42857143
2	71.99124726	28.00875274
3	68.32061069	31.67938931
4	67.12871287	32.87128713
5	12.5	87.5

The evaporated percentage of water is follows the inverted trend as it shows the amount of water expelled by the fabrics.

3.3 Correlation between Knots per Square Inch and Water Retention

Table 3 shows that there is no direct relation between the knots per square inch of a cloth and the amount of water it can hold.

Table 3- Correlation of KPSI and Water Left

	KPSI	% of Water Left	
1	5150	12.5	**3**
2	5515	64	**1**
5	6222	67	**4**
4	8530	68	**5**
3	13090	71	**2**

4.0 Conclusion

Table 4 ranks the 5 fabrics by their water absorption and expulsion efficiencies. A score of 1 translates to very efficient whereas a score of 5 translates to least efficient.

Table 4- Cloth Ranks

Cloth	Absorption	Expulsion
100% Cotton- Bule w/ stripes	1	2
100% Rayon- Black	4	5
50% Polyester 50% Nylon- Polka Dots	2	4
100% Polyester- Red	3	3
65% Polyester 35% Cotton- Pink	5	1

100% Cotton- Cotton ranked very high in both absorption and expulsion of water. This means that cotton would easily absorb water and would quickly get rid of it, making it an ideal cloth for exercise.

100% Rayon- Rayon ranked very low in both absorption and expulsion. This means that it doesn't absorb water easily, but when it does absorb water, it holds on to it for a longer time than other fabrics.

50% Polyester and 50% Nylon- This blend of fabrics is very effective at absorbing water, but very ineffective at expelling it. Therefore, it holds on to its liquid contents for a long time.

100% Polyester- This fabric ranked in the middle for both absorption and expulsion of water. This means that it's neither good nor bad at retaining water. It would be a good fit for casual wear.

65% Polyester and 35% Cotton- This fabric absorbed the least amount of water out of all the specimen tested and ranked the lowest. However, it was the most efficient fabric in terms of expelling water. This makes it an ideal cloth for anti-water activities as it doesn't absorb a lot of water and gets rid of the absorbed very quickly.

This research has many practical uses. Industry, sports, fashion, etc. can benefit from the results gathered by this research. Companies can optimize their offerings to better suit their target niche and improve the quality of their products. This research is, however, far from perfection. In the future, we plan on incorporating more types of fabrics, different types of weaves, a wider variety of blends, and an amalgam of all of these factors to provide more comprehensive results. We also plan to better the method, material, and location of testing in order to have more accurate results. This research topic is very promising and has a high potential of usefulness.

References

[1] Pamuk, Otkay, "Clothing Comfort Properties in Textile Industry", *New World Science Academy,* University of Ege, 2008

[2] Das, A. and Ishtiaque, S.M., "Comfort Characteristics of Fabrics Containing Twist-less and Hollow Fibrous Assemblies in Weft", *Journal of Textile and Apparel Technology and Management, Volume:3, Number:4*. 2004.

[3] Campbell, Neil A. *Biology*. 3rd ed. California: Benjamin Cummings, 1987: 790.