Quality Control of Wicking Characteristics for Sodium-Selective Wearable Fabric Sensors

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What is SweatID?

SweatID, formerly Roosense, is a start-up company founded in Akron, Ohio specializing in a wearable fabric sensors (WFS) designed to be electrolyte selective to sodium ions in sweat. The SweatID system utilizes the fabric sensor in combination with an electronics device to measure resistance across the sensor after exposure to sweat generated during exercise. From that resistance, concentration of the sodium present is then calculated. During field trials, the WFS is used to determine a "plateau" steady state reading of sodium within the sweat of the participant. It is vital that those readings are accurate post when compared to lab analysis of the sweat collected and the design specifications of the sensor components are very important.

ABSTRACT

The SweatID system includes a sodium-selective fabric-based sensor that consists of a functionalized electrospun nylon sensor attached to a piece of fabric using technical embroidery with conductive thread. The WFS attaches to a wearable electronics device to continuously monitor sweat sodium concentration during exercise. The sodium concentration is calculated by measuring the change in resistance across the WFS. Many factors can affect this resistance reading; one of the most important being the wicking characteristics of the fabric material used to assemble the WFS. Therefore, a standard wicking experiment was needed to compare the standard WFS fabric to potential replacement fabrics. A vertical wicking experiment was designed to determine the wicking speed and water absorbance capacity (WAC) of the standard and four alternative fabrics. The wicking of the WFS must be fast enough to keep the sweat moving through the sensor but also have a low enough absorbance capacity that there is no sodium accumulation in the fabric. From the data collected, changes can be made to the WFS to ensure that the most accurate and desirable readings are measured during field trials when the WFS is worn for 90 minutes of exercise. The collected wicking data, individual sensor calibrations, and sensor response while worn during indoor cycling trials were used to determine the optimal fabric to be used in the WFS.

OBJECTIVES

- **Measure wicking speed of the five different fabrics**
- **Measure absorbance of the fabrics**
- **Comparison to current standard sensor during field trials**

METHOD : VERTICAL WICKING TEST

The method of choice here for determining the wicking speed and water absorbance capacity of each type of fabric would be the Vertical Wicking Test.

- Fabric was cut to approximately 2 cm x 12 cm, and a line was drawn at 8 cm from one of the ends of the strip.
- Each strip was weighed prior to the wicking test to measure the dry weight.
- Fabric was suspended in the air inside of a beaker, as shown in Figure 3.
- Water was then added to the bottom of the beaker until it just started to touch the bottom of the fabric strip.
- The recording time was started from when the edge of the fabric strip gets wet to when the water line reaches the 8 cm line on the strip. From the known distance divided by the time recorded, the wicking speed of the fabric can be calculated.
- Once the wicking speed was determined for the strip of fabric, the fabric was then submerged in water until saturated. It was then drained and then reweighed to determine the water absorbance of each strip.

5 Strips are to be taken from each set of fabric, for a total of 25 fabric strips to be tested.

LAB DATA

Sample	Composition	Avg. Weight (g)	Avg. Wicking Speed (cm/s)	Avg. Absorbance (g)	Avg. WAC %
Standard Fabric (White 1)	86% Polyester 14% Spandex	0.659	0.002	1.265	192%
Black	93% Polyester 7% Spandex	0.729	0.001	0.869	119%
Grey	88% Nylon 12% Spandex	0.965	0.042	1.412	146%
Blue	77% Polyester 20% Rayon 3% Spandex	0.695	0.057	1.252	180%
White (2)	97% Cotton 3% Spandex	0.944	0.015	1.224	130%

Table 1: Comparison Table of 5 Sample Fabric

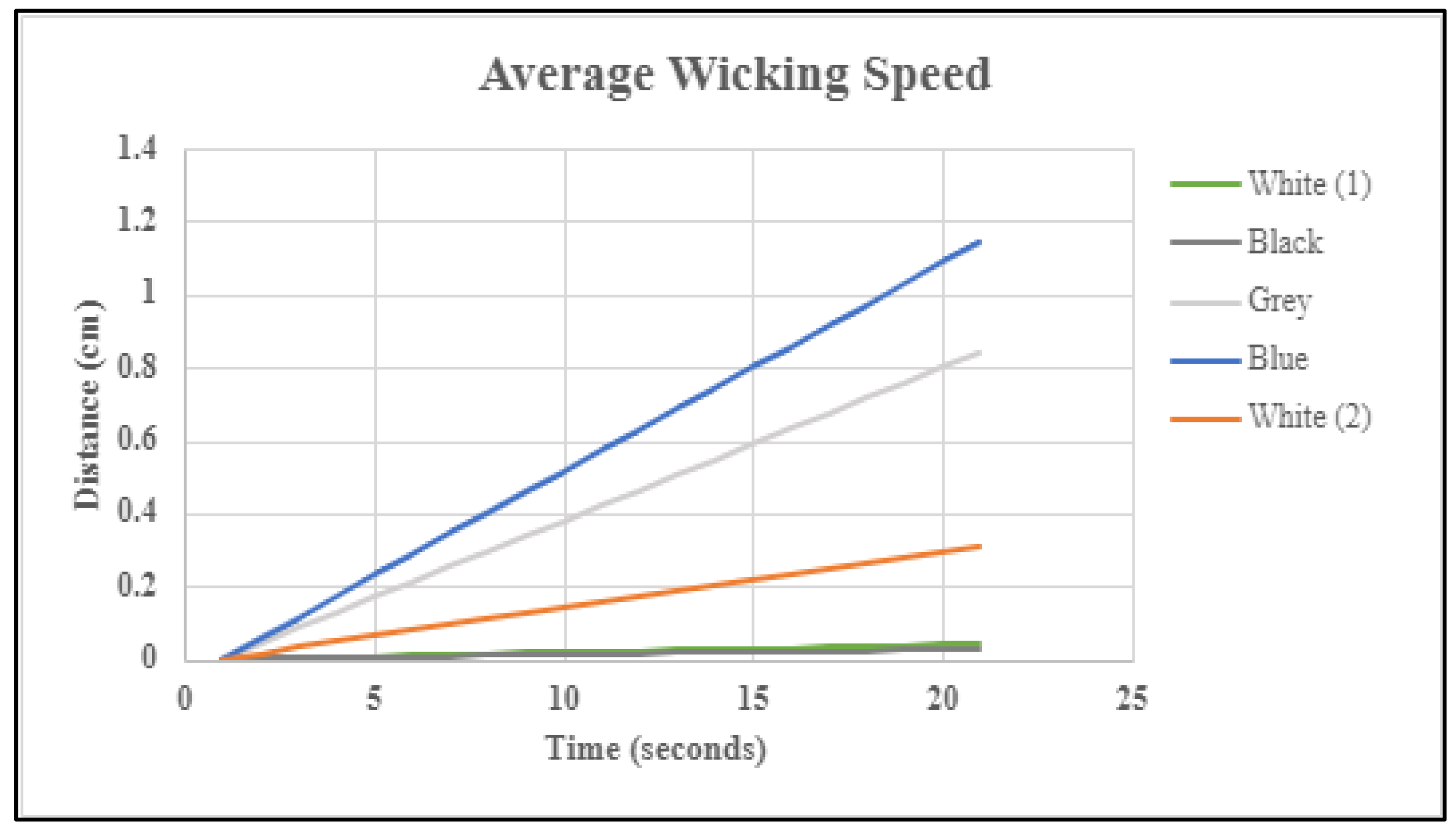

Figure 1: Visual Representation of the Average Wicking Speed of Each Fabric From Table 1

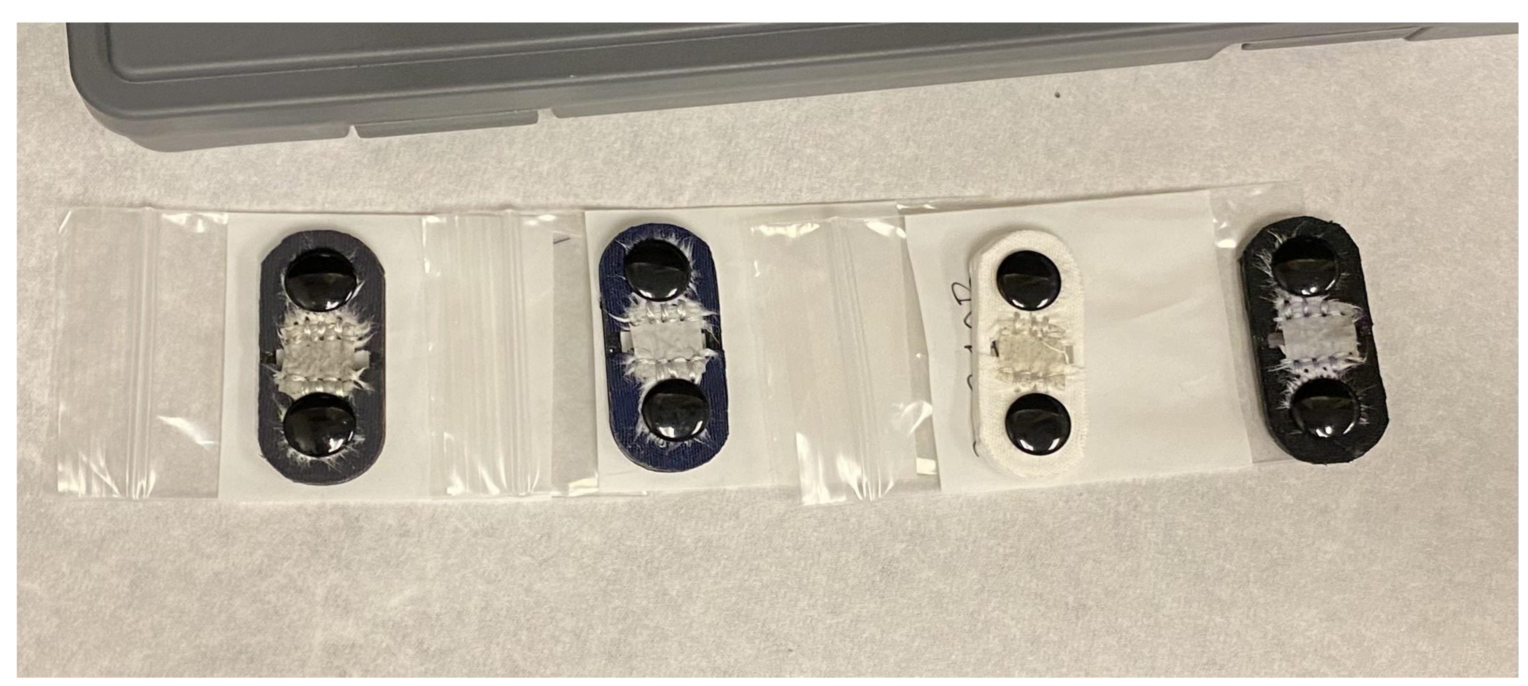

Figure 2: Assembled Sensors with alternative fabrics in order: Grey, Blue, White 1, Black

Figure 3: Vertical Wicking Test Set Up

FIELD TRIAL COMPARISON

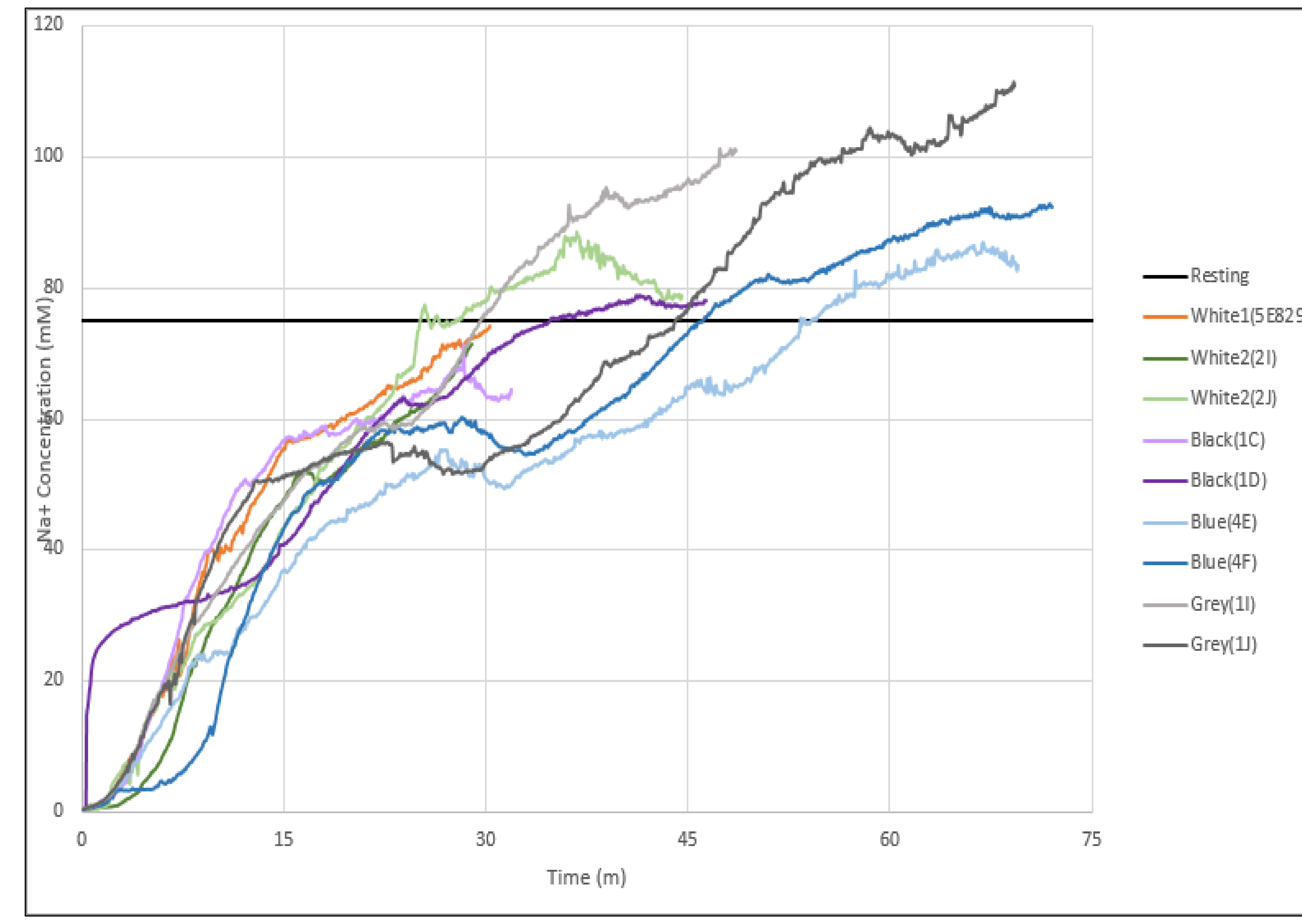

Figure 4: On-Body Field Trials Comparing Results for Fabric Assembly

CONCLUSIONS

Based on the wicking characteristics found within the lab settings, field trial comparison, and sensor readings, the best fabric alternative to our standard white fabric would be the black fabric. Similar in composition, the black fabric and the standard fabric both are made with a majority polyester and smaller percentage of spandex. From the field trials, the other fabric alternatives had shown to take a longer amount of time to plateau, i.e., read the steady-state sodium concentration. The faster wicking speeds seemed to be wicking the sweat away faster than the sensor was able to read them. This causes the sensor to take a longer time to reach the plateau. The plateau reading is a vital part of determining the accuracy of the electrospun nylon sensor. Every factor that can contribute into making a sensor that produces the most accurate readings should be tested, analyzed and explored.

FUTURE WORKS

More trials need to be done involving the black fabric now that it is seen as an alternative toward our standard fabric selection. From these current trials, more variations within the ratio of the polyester-spandex blend will be explored to determine what is the threshold of variation that is allowable before the accuracy of the data readings become skewed.

DISCLAIMER

ACKNOWLEDGMENTS

I would like to acknowledge Dr. Chelsea Monty-Bromer, Shelby Daniels, Mike Fulmer, Victoria Stege, and others in the SweatID Lab for their collaboration with this project and all the help they have provided. It was an honor working with them and I look forward to continuing this project in the future.

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