THE EFFECT OF VARIETIES ON COTTON WAX AS IT RELATES TO COTTON QUALITY PARAMETERS

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Abstract

Cotton wax is one of the non-cellulosic components found on the surfaces of cotton. It is important in dyeing and processing quality. This investigation was carried out to study the yield of wax on the surface of cottons by performing two methods: Soxhlet extractions and accelerated solvent extractions (ASE). These methods were carried out to separate the waxes from the sugars and other water-soluble compounds also found on cotton surfaces. The influence of variety and metal ion content were investigated. Cotton fiber properties were also studied to probe the correlation of cotton wax with the High Volume Instrument (HVI) as well as metal ion content.

Introduction

Cotton wax has previously been shown to affect dyeing and processing methods on cotton (Church et al., 2006). It is largely made up of waxy alkanes, fatty acids, fatty alcohols, plant steroids, and mono, di, and triglycerides (Fargher and Higgingbotham, 1924). Cotton wax has also been reported to be a non-fibrous material which is largely impacted by area of growth, variety, fiber maturity, weathering effects, and harvesting practices (Brushwood, 2003). It is the goal of this study to investigate differences in extraction techniques.

Methods

Fifteen cotton samples grown in Lubbock, TX were analyzed. Although the variety names are unknown, the number of varieties was 2; they were either stripper or picker harvested, and roller or saw ginned. The cotton samples were also collected in crop years 2010, 2011, and 2012. The Soxhlet method by Conrad was used as a reference method (Conrad, 1944). A new Accelerated Solvent Extraction (ASE) method was also employed to extract the waxes and was performed and compared to the Soxhlet method. Conditions in the ASE method were optimized to yield a wax percentage close to the Soxhlet method. Briefly, as reported in Conrad's Soxhlet method, 10 grams of clean cotton were placed in a cotton extraction thimble. Ethanol was added and extracted for 6 hours. Next, separation of the chloroform-water-ethanol layers took place in a separatory funnel. For the ASE method, 4 grams of cotton fiber were placed in the extraction thimble. The thimble was then placed in the sample holder. Wax was extracted at 140°C, 150 psi, and a cycle time of 4 on the instrument. This extraction was completed after 1 hour. Finally, the Conrad Soxhlet method to separate the chloroform-water-ethanol mixture was performed as stated before.

Results

To adequately compare the Soxhlet and ASE methods, optimization of the ASE method was necessary. First, the cycle time was optimized on the ASE. The cycle time referred to the exposure time of the sample to 140°C and 150 psi. Cycle times of 1-5 were available but cycle times of 3, 4, and 5 were investigated for this study. The goal of this study was to select the cycle time, which had an extraction efficiency close to the Soxhlet method. While observing Figure 1, cycle time of 4 gave the best results so this condition was maintained throughout further experiments.

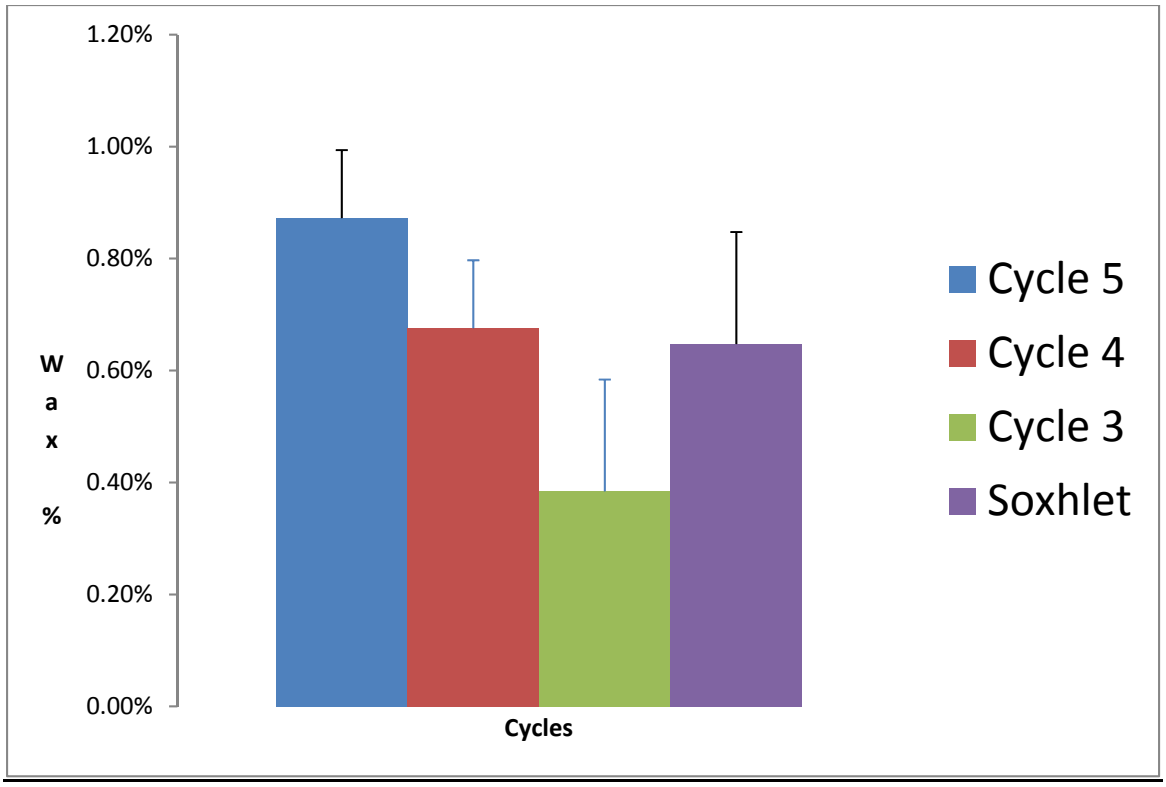

Figure 1. ASE cycle times versus the Soxhlet wax percentage.

Next, the effect of temperature on wax percentage was optimized using cycle 4 is shown in Figure 2. Two temperatures were investigated, 125°C and 140°C. At 140°C, the higher extraction efficiency was observed, so this temperature was maintained throughout subsequent experiments. Once the parameters on the ASE were optimized, 15 cotton samples were selected to be analyzed on the ASE. Table 1 shows the samples along with their corresponding calculated wax percentages. The minimum wax percentage value found was 0.49% and the maximum wax percentage value was 0.81% which is largely consistent with literature values of 0.6-1% (Church et al., 2006).

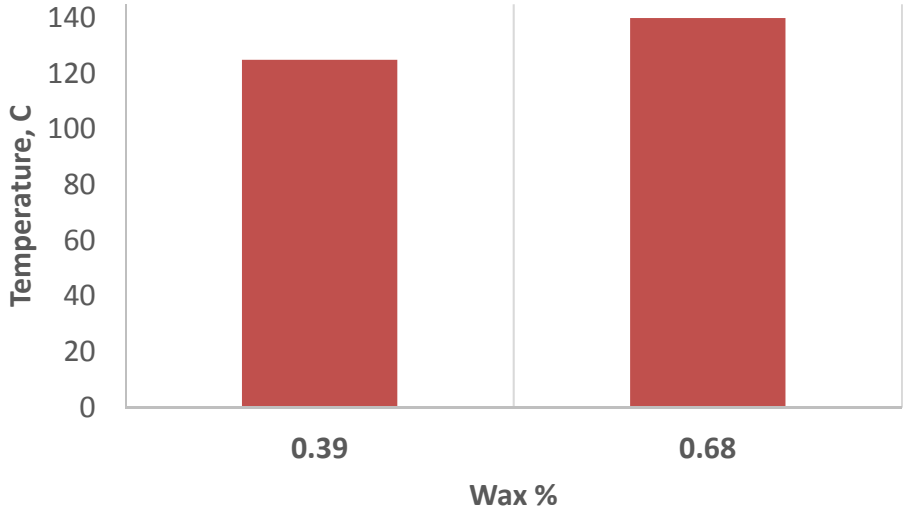

Figure 2. Effect of temperature for the ASE method on calculated wax extraction efficiency.

Table 1. Wax percentage values calculated for 15 cotton samples.

Lubbock, TX Sample Name	Average Wax Percent	SD
13AU1001	0.65	0.09
13AU1005	0.49	0.06
13AU1006	0.77	0.08
13AU1017	0.74	0.06
13AU1018	0.52	0.20
13AZ8001	0.53	0.08
13AZ8002	0.77	0.07
13AZ8005	0.52	0.29
13AZ8017	0.52	0.24
13AZ8018	0.60	0.08
13AZ8021	0.71	0.21
13AZ8022	0.61	0.04
13AZ8033	0.81	0.30
13AZ8034	0.59	0.09
13AZ8042	0.67	0.12

Initially, wax percentage values were compared to HVI values. However, no direct correlation was found. Thus, since metal ion content can affect dyeing similar to cotton wax, the wax and metal concentrations were investigated for a correlation. Data for sample 13AU1005 are depicted in Figures 3a and 3b for the metal ion content of 10 metals including potassium, calcium, magnesium, phosphorus, sodium, iron, aluminum, zinc, manganese and copper at a wax content of 0.49%. As expected from the literature, potassium had the highest abundance of all the metals (Brushwood et al., 1994). The other metals in Figure 3a are quite lower yet are still higher than the metals in Figure 3b. To tell the whole story, the same cotton sample metals were evaluated at higher wax content. When comparing Figures 3a to 4a, phosphorus was at a higher concentration than sodium in Figure 3a but these metals were nearly equally abundant in Figure 4a. Also, for aluminum and zinc, they were present at a higher concentration in Figure 3b than in Figure 4b. The reasons for these findings were not immediately apparent but further studies are needed to explain these results.

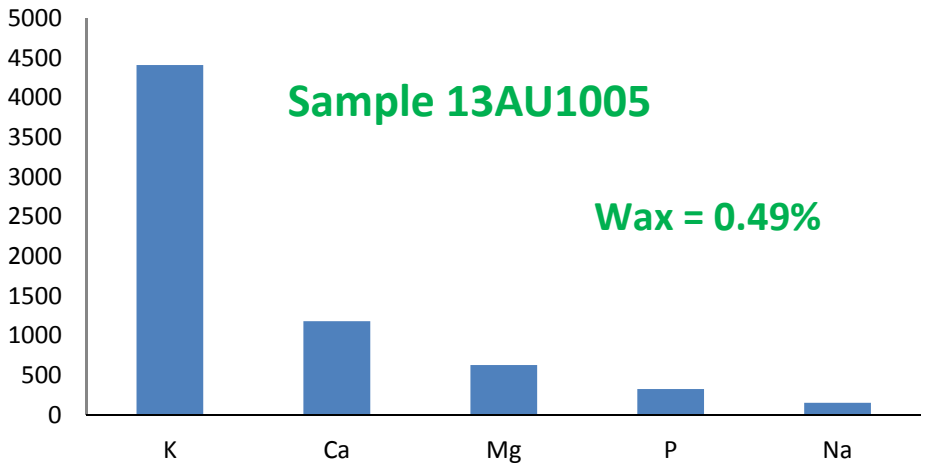

Figure 3a. Effect of low wax percentage for higher abundant metals on cotton fiber.

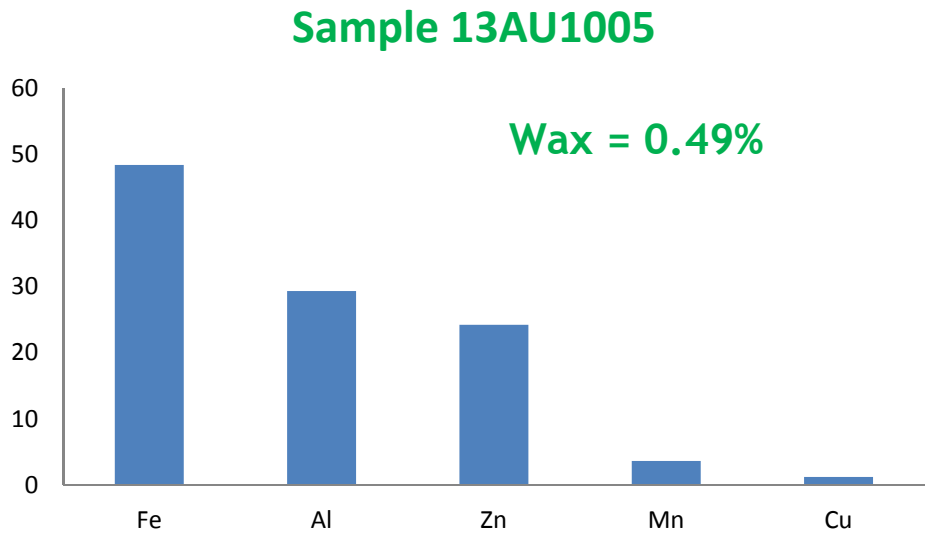

Figure 3b. Effect of high wax percentage for lower abundant metals on cotton fiber.

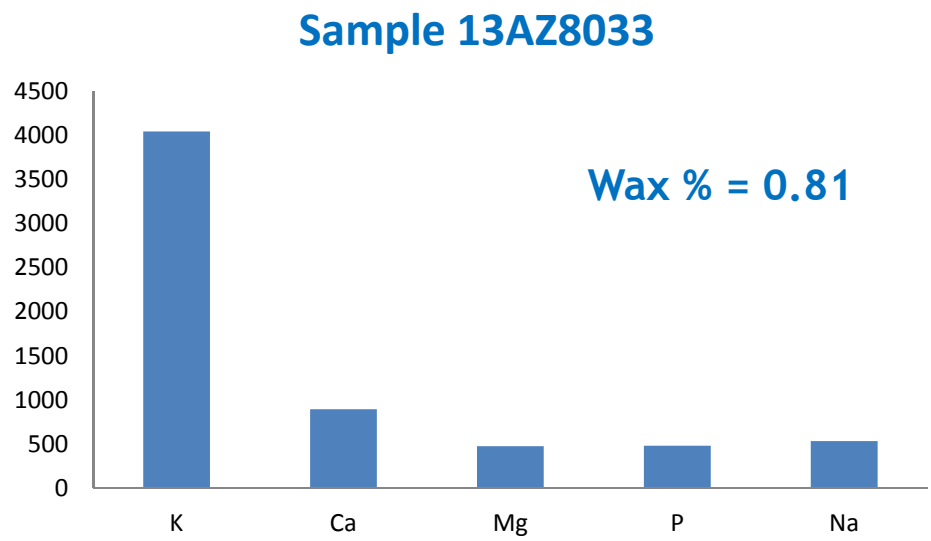

Figure 4a. Effect of high wax percentage for higher abundant metals on cotton fiber.

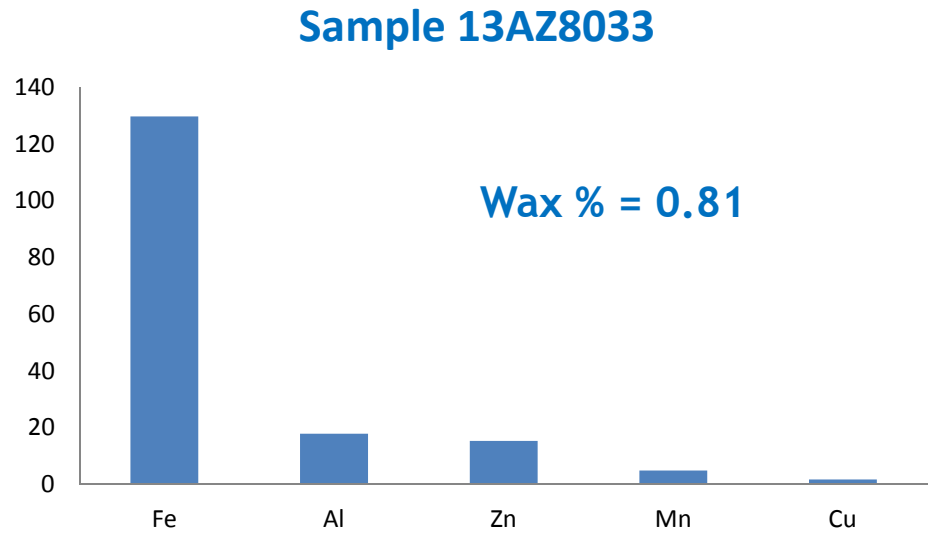

Figure 4b. Effect of high wax percentage for lower abundant metals on cotton fiber.

Summary

In this study, it was found that the ASE method reduces the extraction time from 6 to 1 hour. However, the following separation work up still requires up to 1-2 days. Thus, continued optimization and method development is necessary for the ASE method. There was no correlation between the wax content and HVI parameters. However, based on the preliminary results, there may be a correlation between wax content and metal ion content. Further studies will be carried out to test these results.

References

Brushwood, D. E. 2003. Noncellulosic Constituents on Raw Cotton and Their Relationship to Fiber Physical Properties. Textile Research Journal, pp. 912-916.

Church, J.S. and Woodhead, A.L. 2006. Spectroscopic Assessment of Australian Cotton Waxes. Applied Spectroscopy, pp.1334-1340.

Conrad, C.M., 1944. Determination of Wax in Cotton Fiber, Industrial and Engineering Chemical. 16, pp.745-748.

Fargher, R.G. and L. Higgingbotham, 1924. The Constituents of Wax of Egyptian Sakellaridis Cotton. Journal of Textile Institute Transactions 15, pp.T419-433.