Pyrolysis GC/MS of Plant Derived (Cellulosic)Textiles

Application Note
Textiles

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Plant-based textiles come from a variety of different plants. Most plant-based clothing is made from cotton. However, clothing and textiles are also made from flax (linen), and increasingly popular plant fibers are hemp, and bamboo, which are touted to be ecofriendly. For example, bamboo grows quickly, and requires little or no pesticides.

Cotton fabric is derived from the cotton boll, a growth that forms around the seeds of a cotton plant, and is mostly cellulose. The other mentioned fibers are bast fibers, derived from the stem of the plant, which is lignocellulosic. This means that it contains not just cellulose, but lignin, hemicellulose, pectin, and other compounds essential to plant structure and function. Most textile industries are interested in just the cellulose part of the plant, so compared to cotton boll, more extensive processing is required to remove the extraneous material. In this note, we describe the use of pyrolysis GC/MS to locate differences in plant-based fibers. Lignin is an easily spotted impuritiy, as its phenolic structure is quite different from the other constituents, which are mostly sugar polymers.

Consumer products analyzed were a cotton ball, bamboo t-shirt, a linen napkin, hemp yarn, hemp twine, a knit cap made from hemp, and jute twine. Figure 1 contains pyrograms of a cellulose standard, linen, bamboo, and cotton. Each product appears to be just cellulose. However, by extracting m/z 154, we were able to find 2,6-dimethoxy phenol, a pyrolysis product of lignin, in hemp yarn, hemp twine, and a knit cap made from hemp (Figure 2). Lignin in jute twine was visible without the need to extract ions. Lignin was not found in cotton, bamboo, or linen.

Pyrolysis GC/MS can be used to detect differences in plant-based fabrics. In this note, we found traces of lignin in hemp and jute fibers. A more in-depth analysis may uncover other trends in peak area ratios or markers indicating other impurities such as pectin or hemicellulose, or even fatty acids and proteins.

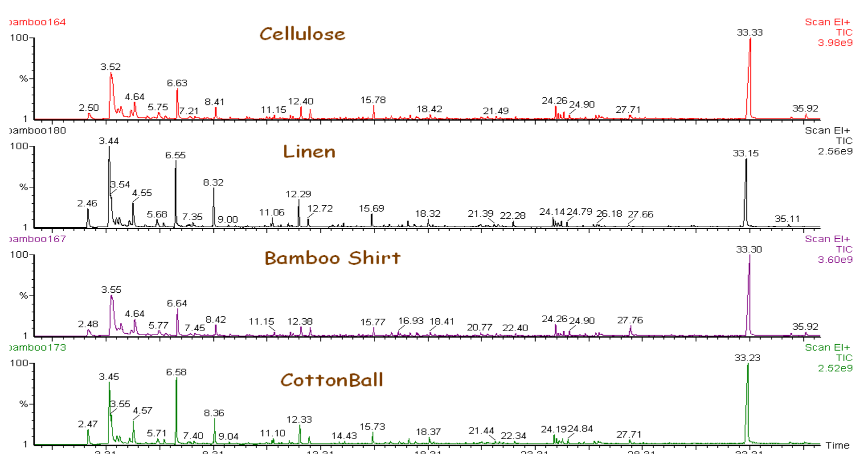

Figure 1: Pyrograms of Cellulose, Linen, Bamboo, and Cotton.

Instrument Conditions
Pyroprobe:

Interface: 300°C for 3 minutes
Pyrolysis: 600°C for 60 seconds
Valve Oven: 350°C
Transfer Line: 310°C

GC/MS

Column: RTX-1701 (60m x .25mm)
Carrier: Helium, 50:1 split
Injector: 280°C
Program: 40°C for 2 min
6°C/min to 280°C
Mass Range: 25-620 amu

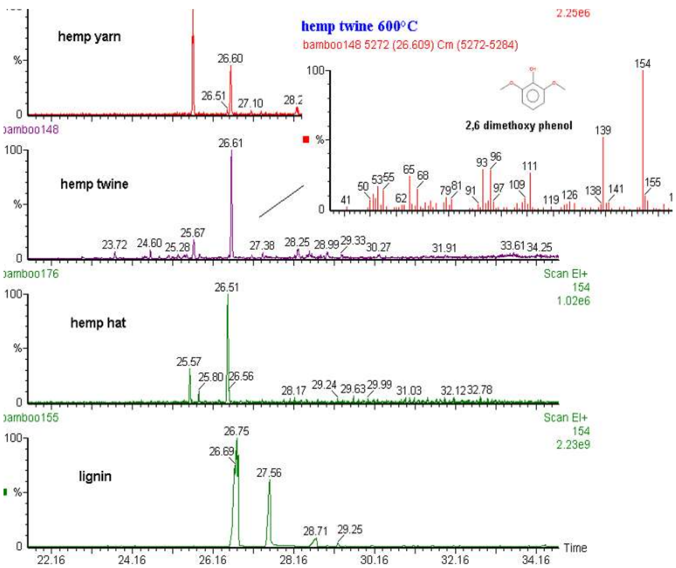

Figure 2: m/z 154 extracted to show 2,6 dimethoxy phenol, in a lignin standard and 3 sources of hemp.

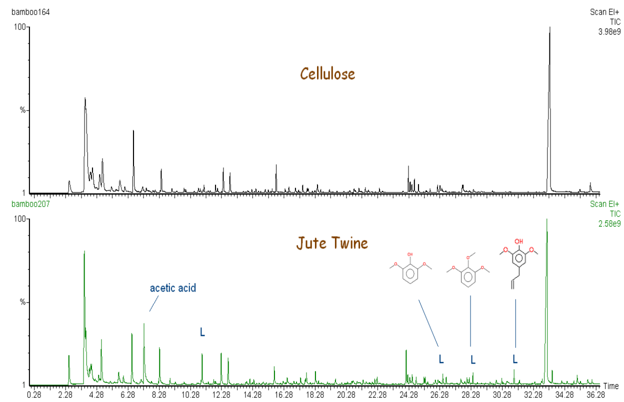

Figure 3: Cellulose and Jute twine. Phenols (labeled L) from Lignin are clearly visible.

FOR MORE INFORMATION
CONCERNING THIS APPLICATION, WE RECOMMEND THE
FOLLOWING READING:

Morrison, W.H. III; Archibald, D.D. Analysis of Graded Flax Fiber and Yarn by Pyrolysis Mass Spectrometry and Pyrolysis Gas Chromatographyl Mass Spectrometry., J. Agric. Food Chem. 1998, 46, 1870-187