



An Assessment of the Validity of Claims for “Bamboo” Fibers

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Introduction

In late 2006 and 2007, a number of online retailers began to market garments made with “bamboo” fibers. This “bamboo” fiber was advertised as very soft, taking dye to deeper shades than cotton, and having natural antimicrobial properties. It was said to have been grown without pesticides and to be far more “environmentally-friendly” than cotton and other fibers.

The frequency of advertising for “bamboo” fibers grew significantly last year, with segments on National Public Radio and articles in popular magazines touting all the above fiber claims. Almost all of the claims for the bamboo fibers were made without justification. The purpose of this paper is to examine several examples of fabrics and garments that were advertised as “bamboo” to assess their nature and the validity of the claims being made for such fibers, fabrics, and garments.

Bamboo Plant

Bamboo plants are giant, fast-growing grasses that have woody stems. They grow in tropical to mild temperate regions of Asia and islands of the Indian and Pacific oceans. There are even a few species of bamboo belonging to the genus *Arundinaria* that are native to the southern United States. These characteristically form dense canebrakes along riverbanks and in marshy areas. It is estimated that there are about 1,000 species of bamboo within about 91 genera.¹⁻³

Woody, hollow, aerial stems (culms) of bamboo grow in branching clusters from a thick underground stem (rhizome). The

culms often form a dense undergrowth that excludes other plants. Bamboo culms can attain heights ranging from 10 to 15 centimeters (about 4 to 6 inches) in the smallest species to more than 40 meters (about 130 feet) in the largest. Mature bamboos sprout horizontal branches that bear sword-shaped leaves on stalked blades; the leaves on young culms arise directly from the stem. The culms of some species grow quickly—as much as one foot (0.3 meter) per day—and when in an undesirable location can be a pest plant, hard to eradicate.⁴

Bamboo plants are used for a great variety of purposes, especially in East and Southeast Asia. The seeds are eaten as grain, and the cooked young shoots of some bamboos are eaten as vegetables, especially in Chinese cuisine. The raw leaves are useful fodder for livestock. The pulped fibers of several bamboo species can be used to make fine-quality paper.

Bamboo Fiber in the Market

In 2006, fabrics and garments began appearing in the marketplace, particularly online, advertised as being “bamboo.” Many claims were made about this fiber’s beneficial properties. Very often, these claims were juxtaposed against statements about the undesirable aspects of cotton production. For example, some “bamboo” fibers web sites claimed that cotton requires a pound of applied chemicals for every pound of cotton grown. However, according to the USDA (as cited on Cotton Incorporated’s website), cotton uses about 1.2 pounds of insecticides and 2.1 pounds of herbicides for each acre of cotton.⁵ Since a typical acre produces

about 800 pounds of cotton, 0.004 pound (0.066 ounce) of pesticides would be used per pound of cotton grown, based on this calculation.

An examination of most of the advertisements for “bamboo” fibers, fabrics, or garments shows that many, if not most, are using information from one company in China that has made the above claims and others, sometimes in a way that confuses the attributes of rayon and bast fibers. The language on most internet sites for bamboo fibers and garments seems to indicate that the fiber being marketed is rayon rather than a bast fiber from the stem of the bamboo plant.

One source of bamboo fiber, clearly from the plant stem, was found after an extensive literature and web search. This was Litrax GmbH, a company based in Switzerland.⁶ Its web site describes its bamboo fiber as “extracted biologically from the bamboo stem.” The process is described as “enzyme retting, steaming, boiling, bleaching.” The fiber cross-section (Fig. 1) from the Litrax web site,⁶ is kidney shaped to oval, with a hollow core characteristic of natural cellulosic fiber. The fibers are described as having a fineness of 7 to 67 microns, with a median of ~ 29 microns.

Of note in Fig. 1 is the irregular shape of the cross-sections, with lumens clearly visible in many of the fibers. In Fig. 2, nodes characteristic of many bast fibers are also clearly evident. The staple length of the Litrax fibers varies from 15 to 159 mm (0.6 to 6.3 in.) with a median staple length of 2.6 in. The fiber tenacity is 14.2 cN/tex. (1.67 g/den.). Litrax also claims that the bamboo fiber (from the stem of the plant) eliminates *Staphylococcus aureus* in an antibacterial test.⁶

Bamboo Fiber in the Scientific Literature

Several investigators have examined bamboo as a source of bast fiber, and as a source of cellulose from pulping the bamboo. Ray, et al.,⁷ studied the microstructure of an Indian bamboo. Just inside the epidermis was the layer of hypodermis, mostly made up of the sclerenchyma cells that are the bamboo fibers. The structure and the location of the fibers were quite similar to what is seen in the flax plant. Rao and Rao⁸ examined natural fibers from vakka

(a palm tree), date palm leaf stalks, and bamboo fibers from the main stalk of that grassy plant. Bamboo fibers were obtained by first removing the node and the thin bark of the main stalk. The culm was then soaked for three days and beaten and scraped to remove the individual fibers. An entirely chemical method of degumming was also used to obtain fibers. The cross-sections of the bamboo fibers were approximately circular.

He, et al.,⁹ prepared and analyzed cellulose pulp from bamboo Cizhu (*Dendrocalamus affinnis*). They obtained 51% cellulose from the bamboo after chemical processing. This was similar to the yield from hardwoods (42%-51%) and more than that from softwoods (39%-43%). The lignin content was similar to hardwoods (~22%), but lower than from softwood (~30%).

In a study that relates directly to validation of some of the bamboo fiber claims, Xu, et al.,¹⁰ reported on the structure and thermal properties of bamboo viscose, lyocell, and conventional viscose (rayon) fibers. The SEM micrographs of the bamboo viscose confirmed that it was identical to conventional rayon in configuration. All three of the fibers showed a typical cellulose II pattern by wide angle X-ray diffraction (WAXR). The WAXR pattern for conventional rayon and the bamboo cellulose rayon were very similar, with a crystallinity of 53% and 45%, respectively. Lyocell crystallinity was higher at 69%. Thermal analysis of the three fibers showed behavior typical of cellulose II fibers, with small differences that would be expected from the differing crystallinity indexes.

Hypotheses

Based on claims made in marketing the “bamboo” fibers, and the properties of other bast fibers, it was hypothesized that:

1. The “bamboo” fibers, yarns, fabrics, and garments being offered, primarily on the internet, were actually rayon made from cellulose derived from bamboo plants after pulping, similar to pulping done to trees.
2. The “bamboo” fibers, yarns, fabrics, and garments advertised as having antibacterial properties would not, in fact, exhibit these qualities when tested by standard procedures.

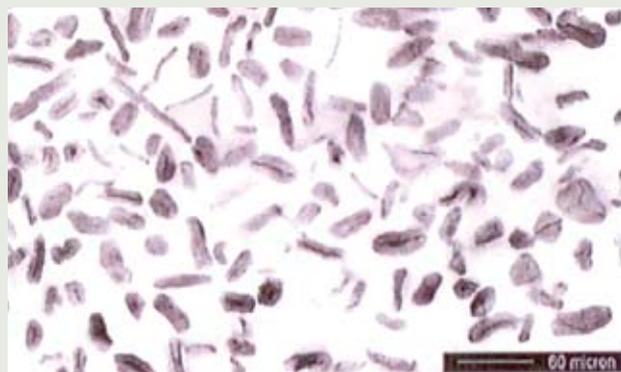


Fig. 1. Cross-sections of bamboo bast fiber.⁴

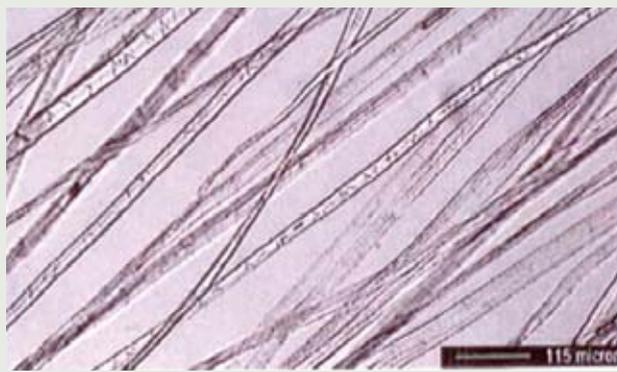


Fig. 2. Longitudinal view of bamboo bast fiber.⁴

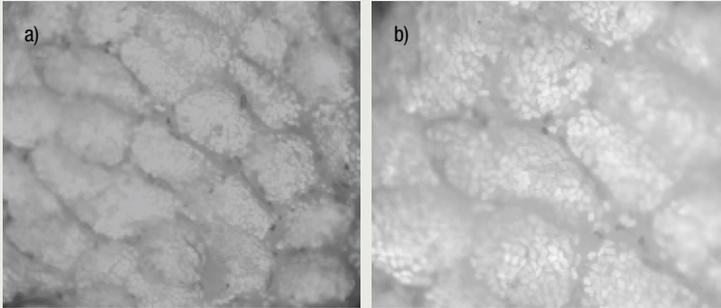


Fig. 3. Micrograph of cross-section of a) spun viscose and b) "bamboo" woven fabric.

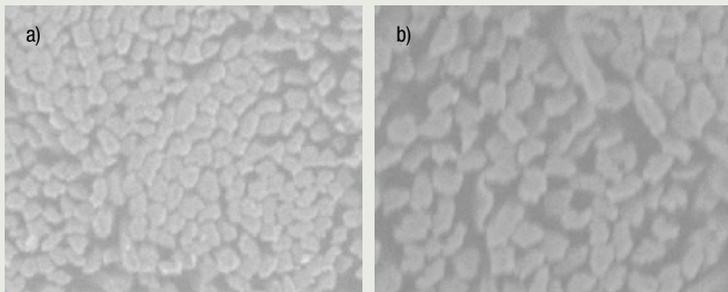


Fig. 4. SEM photograph of a) spun viscose and b) "bamboo" woven fabric.

Materials and Procedures

Fabrics Tested

Bamboo fabric samples (7) were purchased over the internet from a variety of sources. Each of the sources made claims for the bamboo fiber contained within its products. These included claims of antimicrobial properties, the ability to evaporate sweat quickly, never sticking to the skin in hot weather, ultraviolet radiation protection, and production in a green process without any pollution. Typically, "bamboo" advertisements insisted it was the most environmentally friendly fiber available. Specimens from these sites were picked to give a variety of fabrics and garment products. The samples examined are listed in Table I, along with other fabrics that were used for comparisons.

Microscopy

Fibers from each of the seven samples were extracted and cross-sections prepared. These were examined by optical microscopy and by scanning electron microscopy (SEM). These cross-sections were compared to those in the literature from rayon and bast fibers.

Antimicrobial Testing

Specimens were tested for antimicrobial activity using AATCC Test Method 147. A Gram-positive bacterium, *Staphylococcus aureus*, and a Gram-negative one, *Escherichia coli*, were used in the testing. *S. aureus* is the most common cause of various staph infections, and is one of the four most common causes of nosocomial (hospital-acquired) infections. These are most often associated with post-surgical wound infections. *E. coli* is commonly found in

the lower intestine. Some strains can cause very serious food poisoning, though most are harmless.

Results

Fiber Identification

Microscopy results are shown in Figs. 3 and 4. When these photographs were compared to standards for conventional rayon fibers, there was little difference to note. Comparisons to bast fibers, and to the microphotographs from Listrax, showed conclusively that the samples tested were not bast fibers. Fig. 5 shows a comparison of the viscose rayon sample and that of a typical "bamboo" fiber taken from the fabric samples.

Antimicrobial Testing

Typical results from antimicrobial testing are shown in Fig. 6. These tests showed that none of the "bamboo" samples tested had any antimicrobial properties. Bacterial colonies grew straight across the agar plate where streaking had been done. A remarkable contrast was the antimicrobially-treated nonwoven fabric that was several years old. This specimen showed the contrast between effectiveness and no effectiveness at all.

Summary and Conclusions

Fabric samples (7) advertised as bamboo fibers were obtained and tested by optical microscopy and SEM, and compared to known samples of rayon and bast fibers. These same samples were tested for antimicrobial properties against *S. aureus* and *E. coli*. The results showed that the fibers in question are almost certainly rayon, perhaps made from purified cellulose isolated from bamboo pulp.

The hypotheses were confirmed. The fibers in questions are not bast fibers from bamboo, but are rayon from bamboo-derived cellulose. Further, these fabrics have no antimicrobial properties, in great contrast to claims being widely circulated by marketers. A further conclusion might be offered. Rayon production is an inherently chemical-intensive and potentially polluting process. With this rayon coming from China, where environmental controls

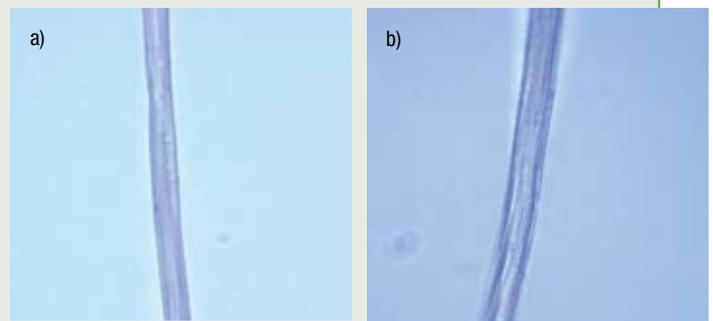


Fig. 5. Longitudinal view of fibers taken from a) rayon fabric and b) "bamboo" woven fabric.

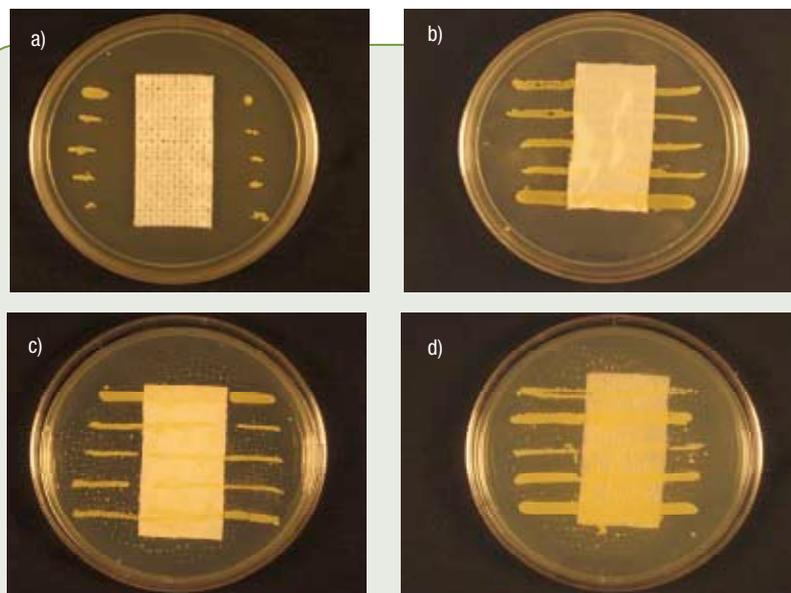


Fig. 6. Assessment of antibacterial properties using AATCC Test Method 147 and *S. aureus* on a) nonwoven fabric treated with an antimicrobial finish (triclosan), b) "bamboo" woven, c) spun viscose fabric, and d) bamboo nonwoven towelette.

are rare, these fibers and the fabrics and garments made with them may be the *least* environmentally-friendly choice a consumer could make.

Governmental Actions

The US Federal Trade Commission (FTC) held hearings about the "bamboo" issue in August 2008, with several representatives from academia and business testifying as to the validity of bamboo as a unique fiber. No immediate action was taken, but on August 11, 2009, the FTC put out a press release entitled "FTC Charges Companies with 'Bamboo-zling' Consumers with False Product Claims."¹¹ The FTC charged four sellers with "deceptive labeling and advertising ... items as made from bamboo fiber, when they

are made of rayon." The FTC also charged the companies with "false and unsubstantiated 'green' claims that their ... products are manufactured using an environmentally friendly process, that they retain the natural antimicrobial properties of the bamboo plant, and that they are biodegradable." Three of the complaints have been settled, with one continuing as of August 2009.

Canada was even more aggressive in its actions. On March 11, 2009, the Competition Bureau of the

Canadian government issued an announcement regarding accurate labeling of textile articles "derived from bamboo."¹² It was their judgment that most of the "bamboo" textiles in the market are "rayon fibre from bamboo pulp," a violation of Competition Bureau rules. Dealers were permitted to sell existing stocks with the inaccurate labels until August 31, 2009. Since then, the Canadian Competition Bureau may conduct market surveillance to insure compliance with their Textile Labeling Act. The Canadian rule is that man-made rayon fibers derived from bamboo must first be labeled "rayon," and *can* (author's emphasis) be followed by "from bamboo."

US Market

The current situation in the US market seems to be mixed. Over the past year, there has been considerable evidence of retailers making inaccurate and completely unsubstantiated claims for

"bamboo" fibers. As was the case two years ago, the claims all seem to be a repetition of those from the Chinese company. On the other hand, even before Canadian and US regulatory actions, there have been more references to "bamboo-based rayon" appearing in advertising, although this is sometimes still mixed with claims regarding antimicrobial properties and UV resistance.

Given the present and future importance of consumer interest in eco-textiles, evidence-based claims and substantiation for the environmental impact of fibers and textiles are of paramount importance to the maintenance of manufacturer and retailer credibility.

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TABLE I.
"Bamboo" Fabrics/Garments
and Sources

Fabric or Garment	Source
Bamboo Jersey Slip	Bamboosa
Bamboo Compressed Towelette	Shirts of Bamboo
Bamboo Satin	Bamboofabric Store
Bamboo Woven	Bamboo Fabric Store (Australia)
Bamboo Towel	Ecofabric
Bamboo Shawl	Ecofabric
Bamboo ecoKashmere	Jonano
Hemp Fabric	-
Viscose Challis	Test Fabric
Cotton	-
Antimicrobial-treated Nonwoven	-