

Production of Ecofriendly Natural Bamboo Bast Fiber and Assessment of Antibacterial Activity

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Background

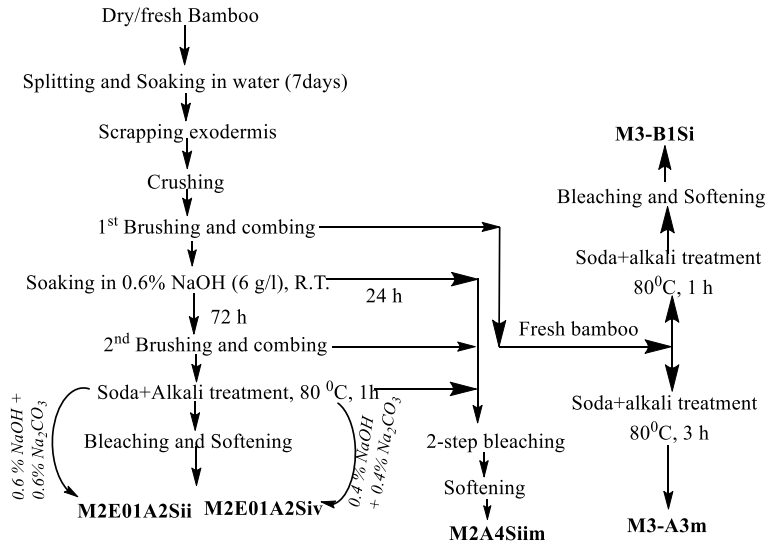
Awareness of the environmental impact of textiles and apparel has continued to be a growing trend. With the increasing amount of eco-advertising ambiguous information may not give consumers full or correct information. One such product is viscose textiles made from bamboo that has been misunderstood as eco-friendly. Unfortunately, manufacturers and retailers are claiming many unique “natural” properties of bamboo without showing evidence that their viscose textiles have those properties. In several studies, researchers have shown that bamboo fibers produced by mechanical means have numerous excellent properties, such as moisture wicking, anti-static, anti-UV, anti-itching, anti-odorous, breathability, a comfortable feel, antimicrobial, high strength to weight ratio, and thermal regulation. These properties are only possible when fibers are produced in their natural form, not in regenerated cellulose like viscose. A preliminary examination for this work reviewed over 70 producers and retailers of bamboo fabrics/apparel worldwide and found that all of them used viscose rayon processes. Thus, no producer has been currently identified as producing bamboo bast fibers for commercial consumption. However, viscose bamboo textiles have been very popular and assumed as ecofriendly among consumers.

As mentioned, the viscose process is an extremely harsh and eco-hazardous process that uses high concentrations of alkali (15-30%), H_2SO_4 , Na_2SO_4 , $ZnSO_4$ and CS_2 . Application of such a solution dissolves cellulosic biomass (bamboo or any plant comprised of cellulose) which form a viscous solution. It is then ripened, hardened, and collected as pure cellulose followed by spinning. Since no other natural components are retained besides cellulose in the viscose process, claims about the unique properties of bamboo being retained in viscose is invalid. This research focuses on producing eco-friendly bamboo fibers and assessing antibacterial properties attributed to bamboo.

Methodology

Production of bast fiber from bamboo is very challenging due to the high weight to strength ratio of the plant and the way the fibers are bundled in the culms. A combination of several techniques was created to find the best process for fiber extraction. *Phyllostachys rubromarginata* (red margin) was the bamboo of choice as it is one of the most used species in product production and grows readily in the southeastern United States. Both dry and fresh bamboo samples of *Phyllostachys rubromarginata* were used to evaluate how this would affect fiber extraction. Bamboo internodes of the culms of 8-10 inches were split and pretreated as outlined in Flowchart 1. Strips were soaked in either water or 0.6% NaOH solution for 3-7 days and crushed followed by repeated brushing. Then, specimens were exposed to different delignification processes using enzymes and/or chemicals, such as NaOH, Na_2CO_3 and H_2O_2 .

Delignification was carried out in solutions of NaOH (4-6 g/l), Na₂CO₃ (4-10 g/l) or H₂O₂ (4-6 g/l). For enzymatic delignification, combined pectolyase and laccase were used in an AATCC Launderometer. After washing in cold water, samples were dried at room temperature. Mild peroxide bleaching, softening and hand-carding posttreatments were applied to improve the produced fibers.



Flowchart 1: Process steps of natural bamboo fiber production
Tests and Results

Each specimen was assessed by visual evaluation as compared with other natural fibers. Luster, color, length, diameter, stiffness and pliability were evaluated to see if it would be a good candidate for spinning. Most of the fibers produced in this research were considered suitable for spinning. However, some processes produced very coarse and stiff fiber that needed further modification.

For antibacterial tests, Parallel Streak Method AATCC TM-147-2011 and Spread Plate Method of Isolation as described in TAPPI test T205 were used. Except for two samples, all other samples as well as two commercial bamboo viscose (for comparison) showed antibacterial activity against *Staphylococcus aureus* microbes. Surprisingly, raw bamboo (*Phyllostachys rubromarginata*) exhibited very slight or no antimicrobial activity in both tests. Probably, bamboo has both microbe attracting and repulsing compounds. It is proposed that the mechanical processes removed bacteria attracting soluble compounds, and thereby improved antibacterial activity in the bast bamboo fibers. However, viscose processes are thought to remove both kind of compounds but fiber still may show the antibacterial activity due to the presence of residual sulfur and other viscose process compounds, not from bamboo’s inherent antibacterial properties. (Xi, Qin, An, & Wang, 2013).

Selected Reference

Xi, L., Qin, D., An, X., & Wang, G. (2013). Resistance of natural bamboo fiber to micro-organisms, and factors that may affect such resistance. *BioResources*, 8(4), 6501–6509.