Viscose and Lyocell Fibers from Bamboo Dissolving Pulp – A Scientific Review on Claimed Properties

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Abstract

There is quite some confusion at the market about so-called "bamboo fibers". Mostly, viscose and lyocell fibers from bamboo dissolving pulp are misleadingly named "bamboo fibers", in contrast to virgin and natural bamboo fibers. In the EU, USA and Canada, these products consequently have to be labelled as "viscose or rayon"; the appendix "from bamboo" is optional. This review of scientific literature enlightens the origin and properties of viscose and lyocell fibers from bamboo dissolving pulp in more detail. The mechanical fiber properties, UV≈protection and comfort properties are discussed, and the literature shows that they are not unique because they are comparable to those of regenerated cellulosic fibers from any other dissolving pulp. Differences in UV protection could be ascribed to inconsistent measurement methods. Especially, antimicrobial effects have been reported by producers and were attributed to the natural resistance of bamboo plants. No differentiation was made between bacteriocidal and bacteriostatic. Responsible bio-chemicals are mainly stored in the leaves and therefore, removed even before pulping. Several research teams disproved the fact of special antimicrobial fiber properties. They stated that a preservation of antimicrobial properties associated with the raw material is not very likely. In contrast, the literature gives evidence that variations in antimicrobial performance of the regenerated cellulosic fibers are more likely related to residual chemicals from the viscose production process, e.g. sulfur.

Introduction

The wording "bamboo fiber" is not defined nor consistently applied. Three different groups of fibers could be identified in the literature:

The first and dominant group comprises regenerated cellulosic fibers made from bamboo dissolving pulp. They have the biggest market share compared to other "bamboo fibers". They are produced in the viscose process. However, customers are confused and misled, because the wording is easily mixed up with natural and virgin bamboo fibers as described below. In the EU, USA and Canada, these products consequently have to be labelled as "viscose or rayon (from bamboo)" and no longer "bamboo fiber" (*Nayak and Mishra 2016*). These regulations have consistently been pursued e.g. by the Federal Trade Commission, USA or by higher regional courts in the EU. Several companies have so far been sued for using misleading wording. The same is true for lyocell fibers from bamboo dissolving pulp, although, they have a minor market share. Some bamboo-lyocell fibers offered at the market are even blended products and not lyocell fibers made from bamboo pulp.

Virgin and natural bamboo fibers are the second group. In contrast, these original bamboo fibers have only a minor market share. They are processed by a mechanical separation process like flax or hemp. Experts can easily distinguish natural bamboo fibers from viscose fibers because they are hollow, round, much smaller and contain only cellulose I in contrast to solid viscose fibers with their typical cloudy shape and cellulose II (see figure 1 and *Wang and al. (2010)*).

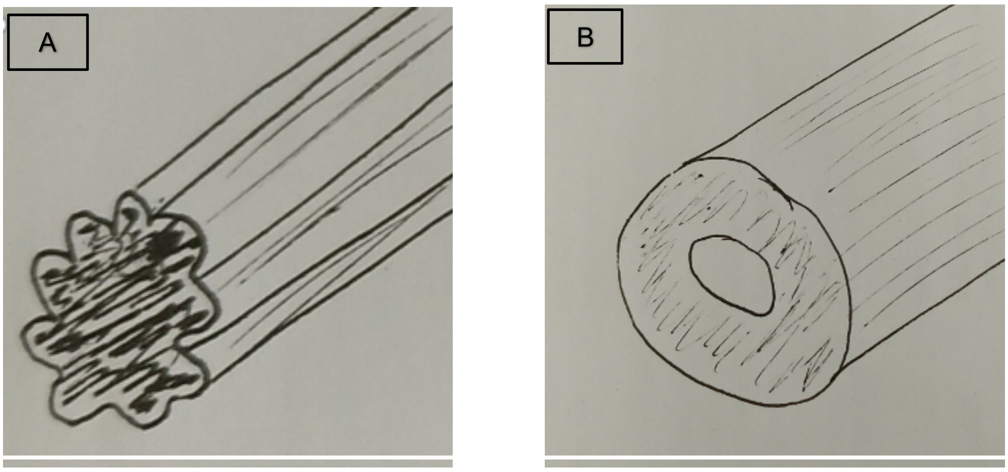

Figure 1: *Schematic drawing of the cross section of regenerated and natural bamboo fibers; A: shape of a viscose fiber from bamboo dissolving pulp; B: shape of a natural virgin bamboo fiber.*

The size of the two fiber types is similar in diameter, but very different in length: A standard viscose fiber with a titer of 1.3 dtex has a diameter of 10.5 μm and a length of 30 to 40 mm while a single isolated bamboo fiber depicts a diameter of 10 to 30 μm and a length of 1 to 4 mm *(Rusch et al. 2019)*. Their mechanical properties are about >50% less compared to the properties of viscose fibers from bamboo pulp.

A third group of so-called "bamboo fibers" are charcoal bamboo fibers. This composite fiber is produced by the addition of charcoal from bamboo to cellulose acetate production (e.g. by *Shanghai Tenbro Bamboo Textiles Co. Ltd,* China) or mixed with polyester (e.g. by Quanzhou Shengxin Fibre Co. Ltd, China). Charcoal is a by-product of the production of bamboo acetic acid. Bamboo carbon layers are often used for three layered fabrics for e.g. wetsuits. Astonishingly, Asian producers state that charcoal from bamboo has the same properties as viscose fibers from bamboo pulp with respect to their antimicrobial behavior. They attribute this to the organic extractives content of the plant. It is hardly convincing that the bamboo ash containing carbon and minerals should have the same properties as the non-burned plant. The burning of the wood surface, charring, is a very old procedure to improve durability especially in the contact zone with the ground for construction wood. Carbon and minerals of the ash contribute to an improvement of antimicrobial properties, more precisely a bacteriostatic effect, but they do not have a bactericidal effect. One may therefore deduce that the charcoal has a bacteriostatic effect that has nothing to do with the properties of the organic molecules of the original plant. The article of *Nayak and Mishra (2016)* provides a detailed description of all types of so-called bamboo fibers and their production processes.

Verification or disproof of claimed properties by scientific literature

What properties are claimed for viscose and lyocell fibers from bamboo?

Producers were identified by an internet search, and their claims on viscose and lyocell fibers made from bamboo dissolving pulp were analyzed. Interestingly, they all claim the same facts in a similar wording on their homepages, and they all attribute these properties to a non-specified sum of extractives of bamboo that are called "kun" or "khun". The properties are:

- Organically grown bamboo, eco-friendly
- UV protection
- Excellent moisture absorption and permeability
- Soft, smooth and good drapability
- Bright color and special luster; good dyeing properties and color fastness
- Thermal control
- Anti-bacterial and bacteriostatic
- Producers of lyocell fibers from bamboo claim the same properties and insist that they are superior to viscose made from bamboo and normal lyocell fibers.

Hereinafter, this list of properties was compared to results from scientific literature.

What is so special about the plant bamboo?

Bamboo is a grass and not a timber, endemic to all continents except Europe *(Nayak and Mishra 2016)*. Its many species depict a broad variety of properties, and its uses have a very long history and are plentiful from flooring to medical. In its natural environment, the plant itself shows many benefits like soil stabilization, water pollution treatment, carbon capturing, improving soil fertility and more. On natural sites, bamboo does not need any fertilizers, watering or replanting. The growth rate outraises wood by far. In tropical forests, the annual growth rate of bamboo is about 4 tons per hectare, in plantations, up to 20 to 36 tons per hectare. For comparison, the annual growth of a beech forest in Denmark is about 11 tons per hectare *(Scholz 2019)*, and it is constantly decreasing in Europe from the 1950s. Nevertheless, severe problems with fertilization and pesticides occur in any kind of plantations.

If there is any bactericidal or bacteriostatic performance of viscose fibers originating from bamboo pulp as claimed by the producers, these substances should be present in the raw material itself. Here we have to differentiate between the culms and the leaves of the bamboo plant. The bamboo wood or culm, which is the raw material for pulping, is classified class 5 natural durability according to DIN-EN 350-2. This is the lowest and less durable class. For instance, oak is categorized class 2 and spruce class 4. The classification describes the natural durability of the material against fungi that means that there is almost no fungistatic activity of natural bamboo *(Schmidt et al. 2015)*.

Extractives from the culm range from 3.4% – in average – to over 16% for the inner layer of the internodes of a certain bamboo species *(Wahab et al. 2013)*. There are plenty of bamboo species with a broad variety of extractives. More than 40 components have been identified in the literature. About half of the extractives are soluble in hot water and an additional portion is soluble in alkali, which means that they will not survive pulping. *Afrin et al. (2012)* investigated the natural bamboo plant and used 20% DMSO to xtract hemicelluloses, and 80% dioxane water for lignin extraction. They found weak antibacterial activity for the first sample characterizing hemicelluloses and high antimicrobial activity against *Escherichia coli* for the isolated lignin sample. The authors attributed this to the aromatic and phenolic functional groups of lignin in bamboo. It is well known that lignin in wood and annual plants has a general antimicrobial effect, and it is widely used as a natural preservative *(Espinoza-Acosta et al. 2016, Gabov et al. 2017, Dong et al. 2011)*. In general, bamboo shows a low lignin content, even lower than eucalypt. Published data range from 10.2% to 22.4% lignin for bamboo and 26.6% for eucalypt from Brazil *(Wang et al. (2010), Ribas Batalha et al. (2012))*, which was confirmed by the data of *Nayak and Mishra (2016)* for bamboo from Indonesia. This implies that the natural antimicrobial property of the bamboo culm must be low because of the low lignin concentration in the raw material, and furthermore, that it will be removed after alkaline pulping with its typical harsh conditions. Regarding the raw material, there is no indication that bamboo pulp, viscose or lyocell fibers should depict special antimicrobial properties that can be ascribed neither to the extractives nor to the lignin of the raw material of natural bamboo culms.

Nevertheless, bamboo is known as an allelopathic plant. This means that the plant produces biochemicals that work like natural herbicides and pesticides to protect the plant actively from diseases. The so-called allelochemicals are produced and stored in the leaves of the plant *(Rawat et al. 2017)*. Especially, younger bamboo plants develop a moderately strong allelopathic activity *(Ogita and Sasamoto 2017)*. This is the reason why no pesticides and herbicides are necessary for natural sites of bamboo. These extractives are used for medical or cosmetic purposes separated from bamboo leaves. All the same, leaves are not used for pulping; only culms are.

Producers argue that the claimed antimicrobial properties of the final product can be attributed to the extractives of the bamboo culm. This is obviously a misleading interpretation of the natural resistance against pests and the suppression of undergrowth because it results from the leaves that are removed during harvesting before pulping.

However, bamboo has a perspective for future uses, especially for non-wood pulping. The enormous growth rate, easy harvesting and the high cellulose content of 50%+ combined with a low lignin content make it a promising raw material, not only for dissolving pulp production. Nevertheless, major drawbacks for dissolving pulp production are the high ash content of up to about 2%, a silica content up to about 1.6% of the raw material and disintegration problems of the nodes. In some areas, harvesting can only be carried out seasonally because of the monsoon. All the same, the benefits make it worth to work on these challenges.

Which are the mechanical properties, UV protection factor and comfort properties of viscose fibers from bamboo pulp?

The U.S. Federal Trade Commission (FTC), an autonomous government organization, measured Fourier Transform Infrared Spectroscopy (FTIR) of conventional viscose fibers and viscose fibers from bamboo pulp. The spectra matched identically showing that there is no chemical difference between viscose fibers from bamboo or wood pulp. They state that the cellulose is the same *(Nayak and Mishra 2016)*.

Mechanical Properties

Mechanical properties of viscose and lyocell fibers from bamboo pulp have been compared to conventional viscose and lyocell several times. Table 1 gives a comparison of different literature data. *Erdumlu and Ozipek (2008), Lipp-Symonowizc et al. (2011)* and *Büyükakinci (2010)* demonstrated that normal viscose and viscose from bamboo pulp showed comparable strength properties. The strength properties are more related to the production process, the molecular weight of the pulp and its distribution. The same was confirmed for lyocell fibers from bamboo compared to lyocell fibers from wood by *Yang et al. (2009)*.

UV Protection

Gambichler et al. (2001) investigated the UV protection of a broad variety of fabrics and found a UV protection factor UPF of more than 70% for wool, polyester, and fabric blends, and only less than 30% for cellulosic fibers like cotton, linen, and viscose fabrics. Naturally, the color of the fabrics showed a great influence: fabrics with black, navy-blue, white, green, or beige colors provided a higher UPF. The authors as well complained about the non-standardized testing procedure, which renders the comparison of results from different research groups very difficult. *Hatua et al. (2013) and Mishra et al. (2012)* from the University of New Delhi, India, measured the UV protection

Type of fiber	Type of pulp	Titer dtex	Tensile strength cN/dtex	Elongation %	Literature
Viscose	Beech pulp	1.3	25	18.3	*Schild and Sixta (2011)*
Viscose	Eucalypt pulp	1.3	26	18.2	*Schild and Sixta (2011)*
Viscose	Wood pulp	1.7	25-31	14-18	*Bambrotex*
Viscose	Bamboo pulp	3.3	21	19.7	*Yang et al. (2009)*
Viscose	Bamboo pulp	3.1	16	16.8	*Erdumlu and Ozipek (2008)*
Viscose	Bamboo pulp	2.5	16	16.2	*Erdumlu and Ozipek (2008)*
Viscose	Bamboo pulp	2.0	15	15.3	*Erdumlu and Ozipek (2008)*
Viscose	Bamboo pulp	1.7	22-25	14-18	*Bambrotex*
Viscose	Bamboo pulp	Density 1.51g/cm^3	16	17.1	*Lipp-Symonowizc et al. (2011)*
Lyocell	Eucalypt pulp	1.3	36	13.5	*Schild et al. (2020)*
Lyocell	Eucalypt pulp	1.8	32	12.9	*Schild et al. (2020)*
Lyocell	Eucalypt pulp	1.4	41	12.8	*Schild and Sixta (2011)*
Lyocell	Wood pulp	2.8	35	8.6	*Yang et al. (2009)*
Lyocell	Bamboo pulp	2.9	36	9.3	*Yang et al. (2009)*

Table 1: *Literature data of mechanical properties of viscose and lyocell fibers from bamboo pulp and wood pulp compared with natural virgin bamboo fibers.*

of viscose fabrics made from bamboo pulp and compared it to a cotton fabric. They found the same UPF if the cover percentage and areal density of the two fabrics was similar. Comparable findings have been reported by *Gericke and Pol (2011)* and *Sarka and Appidi (2009)*. In contrast, an Indian producer of modal fibers and Chinese producers of viscose fibers made from bamboo dissolving pulp claim high UPF values of up to 97.5% plus *(Bambrotex 2003, Aditya Birla Group 2017)*. Scientists explain the apparently higher UPF of bamboo viscose fabrics by a higher cover percentage and areal density instead of bamboo's inherent UV protective property.

Comfort Properties

Gericke and Pol (2010) from the University of Stellenbosch, South Africa, investigated the comfort properties of fabrics made from viscose, cotton and viscose made from bamboo. Thermal resistance, water vapor resistance, water absorbency and moisture permeability showed very similar results (tab. 2). They could not find any evidence that viscose from bamboo was superior to any of the other fabrics tested. *Cimilli et al. (2010)* even favored regular modal and viscose over viscose from bamboo with respect to comfort properties of knitted socks.

Are there any antimicrobial properties?

What does antimicrobial mean? Bacteriostatic vs bactericidal

Per definition, bacteriostatic is something that prevents the growth of bacteria e.g. keeps them in the stationary phase of growth. In contrast, bactericidal means that it actively kills bacteria. Only a reduction of bacteria on a sample of close to 100% is considered as bactericide. Anti-bacterial or antimicrobial is a broader term referring to both, killing microorganisms and/or stopping their growth.

Internationally standardized testing methods exist and are widely accepted and used: Antibiotic Resistance and Sensitivity Testing of Bacteria from the American Type Culture Collection. ATCC was established in 1925 with headquarters in Virginia, USA *(ATCC 2021)*. It is a nonprofit organization, which collects, stores, and distributes standard reference microorganisms, cell lines and other materials for research and development. Taking into account differences in sample preparation and selection of bacteria strains, the standardized method usually allows a comparison of results.

Only very few producers of viscose or lyocell from bamboo pulp mention bactericidal effects. The majority refers to their fibers being anti-bacterial/antimicrobial and bacteriostatic. This may be used misdirecting because retail customers usually will not distinguish between killing and stopping of microorganisms.

What happens to extractives during pulping of bamboo?

The processes used for production of dissolving pulp from bamboo are mostly prehydrolysis kraft or soda/AQ pulping followed by conventional or elemental chlorine free bleaching, sometimes combined with enzyme treatment *(Yuan et al. 2017, Ma et al. 2011, Ribas Batalha et al. 2012)*. *Sugesty et al. (2015)* tested four Indonesian bamboo species for production of dissolving pulp in lab scale. The properties of the final bleached pulps were comparable to market pulps from wood. The ash content in the raw material ranged from 1.7 to 6.1% and dropped to 0.08% in the final pulp. The final ash content of the bleached pulp was very low, which may be due to a high water consumption as usual during lab procedures. The same happened to the extractives content; it decreased from 3.4 - 8.4% in the raw material to 0.06 - 0.09% in the pulp. A significant decrease was visible although different solvents had to be used due to the form of the sample. However, this article gives an important answer with respect to antimicrobial features of regenerated fibers:

Viscose fabric made of	Thermal resistance m^2K/W	Water vapor resistance m^2Pa/W	Water absorbency %	Moisture permeability index, Im
Wood pulp	0.181	21.19	2.16	0.52
Bamboo pulp	0.189	20.74	2.02	0.55

Table 2: *Measurements of comfort properties by Gericke and Pol (2010).*

The components said to be responsible for the antimicrobial properties are claimed to be part of the extractives. The extractive content was significantly lowered by pulping and bleaching to the level of market dissolving pulps. Therefore, extractives said to have an antimicrobial effect have been removed to a very high percentage by pulping and bleaching.

Components of the bamboo plant ensuring its natural durability are extractives and lignin. Their concentrations in the culm, the raw material for pulping, are low compared to wood. Furthermore, they are to a great extend removed during the production of dissolving pulp. In this point of view, there is no advantage of dissolving pulp from bamboo over wood. Additionally, no special component in bamboo pulp could be identified in the literature that would give rise to special fiber properties.

Is there a proof of the antimicrobial claims for viscose and lyocell fibers?

This is probably where the story of antimicrobial viscose from bamboo began: Bambrotex, part of *Hebei Jigao Chemical Fiber,* China, published test results for anti-bacterial effects from their own lab and from the *Japan Textile Inspection Association*. The Japanese tests showed a reduction of >70% of bacteria, while their own tests, which were only conducted with the single bacteria strain *Staphylocccus areus,* showed a reduction of >96.5%. While the Japanese results would stand for a bacteriostatic effect, the Chinese results would imply a bactericidal property *(Bambrotex 2007)*. Different companies argue that the antimicrobial effect originates from a non-specified group of extractives from the plant called “kun” or “khun” which is said to be tightly combined with the cellulose persisting throughout the production process. This may theoretically be true for natural mechanically processed bamboo fibers. In contrast, for regenerated fibers from bamboo pulp, the *U.S. Federal Trade Commission* (FTC) states that “once the cellulose is simply cellulose, the source cannot be differentiated” *(Nayak and Mishra 2016)*.

Some additional Chinese literature reported bacteriostatic or even bactericidal properties for regenerated fibers from bamboo dissolving pulp. Nevertheless, results are not consistent. *Yang et al (2009)* found an antimicrobial activity for viscose and lyocell fibers from bamboo compared to viscose from wood pulp, which showed no activity at all. The samples were washed with ethanol that probably did not remove chemical residues from the production processes, which might have caused the antimicrobial activity of the sample. Controversy, a researcher team from the Colorado State University, USA, tested 100% bamboo viscose knit single jersey with no previous finishing treatment from China. The sample showed only minimal antimicrobial activity towards *S. aureus* and *E. coli (Sarka and Appidi (2009))*. A second group *(Gericke and Pol (2011))* found a similar, also minor antibacterial effect of both viscose fabrics from bamboo and wood pulp; both did not eliminate or prevent bacterial growth. They identified sulfur residues on their fabrics that are known to have an antimicrobial effect. This article is a strong indication that there is only a weak antimicrobial activity of viscose fibers no matter if they are made from bamboo or wood. In contrast, the bacteriostatic effect is obviously induced by residual chemicals from the process and not by the raw material. A bactericidal property was not measured in any of the literature.

Hardin et al (2009) were even more rigorous and accused the producers of market fraud. They investigated the antimicrobial behavior of a wide range of market samples from several fabrics and non-woven products from viscose made from bamboo from different suppliers in comparison to normal viscose from wood. Using the standardized test method from ATCC with three different types of bacteria, they found no antimicrobial activity in any of the samples. *Xi and Qin (2012)* finally gave a proof of the abovementioned assumptions. They demonstrated that natural bamboo fibers did not show any activity against bacteria, but regenerated fibers depicted up to 76% bacteriostatic rate against *Staphylococcus aureus*. They applied three different bacteria with the standard-test described by *Hardin et al (2009)* and used other annual plants as reference like jute and flax and antibacterial cotton. Xi and Qin used solvents typical for the separation of extractives like hot water, benzene and 1% NaOH during sample preparation. These results confirm that extractives from natural bamboo do not provide any antimicrobial impact. They argued: “The antibacterial performance of regenerated bamboo fiber may largely come from the use of a large amount of chemicals in manufacturing process.” The same arguments are valid for the lyocell process. Although, tradeKorea shows a brochure of *Fujian Hongyuan,* China, with documents for antimicrobial effects of lyocell fibers *(tradeKorea 2021)*. Additionally, *Acelon (2013)*, Taiwan, claims the antimicrobial properties of their lyocell fibers in the patent TW201437444A.

What patents have been filed?

It is an interesting approach to study the patent landscape because the data of patent claims have to withstand careful scrutiny. There are plenty of patents covering the application of bamboo viscose in textile blends or covering bamboo charcoal in multiple layered fabrics. Antimicrobial properties are mainly attributed to bamboo charcoal or to fibers with special antimicrobial treatment (addition of e.g. metals). Only six producers were identified holding patents that deal with the production of regenerated cellulose fibers from bamboo pulp (tab. 3). The listed patents represent patent families and not single patents. No patents for the production of viscose fibers from bamboo dissolving pulp are granted. The patents cover modal and lyocell fiber production only. Two of these patent applications have been withdrawn by the applicants (CN101857983A, CN102234849A), and four have been granted by the patent authorities (CN103556281B, CN100503907C, TW201437444A, AT505492B1). Out of these, only Acelon (TW201437444A) claims special properties for their lyocell fibers made from bamboo pulp. Bamboo pulp is mixed with coffee residues, dissolved and spun in NMMO. They list a "natural antimicrobial property of bamboo cellulose fiber with natural antibacterial, deodorizing and negative ion functions" in the description and in the claims. In example 3, the authors describe the antimicrobial property of the fiber as bacteriostatic, not bactericide. They used *Staphylococcus aureus* and *Klebsiella pneumoniae* from ATCC as test strains, but not an internationally standardized testing method nor an internationally standardized data analysis. Additionally, they only discuss the effect of bamboo and not the antimicrobial effect of coffee grounds, especially, because coffee grounds are widely known as home remedies for various pests in the garden and household.

Certificates

The labelling advertised in the internet is often elusive. Producers from China, India and Taiwan claim OCIA, FSC and OEKO-TEX 100 certificates. In their article "No Such Thing as Organic Bamboo Clothing", *The Epoch Times* marks the Chinese certificates for organic bamboo as false and even as global market fraud by referring to the *Organic Crop Improvement Association* (OCIA) *(Vos 2014)*.

The *Forest Stewardship Council* (FSC) issues a certificate for the wood production from socially and environmentally compatible forestry. OEKO-TEX® offers two certifications for textiles: OEKO-TEX® 100 for products and OEKO-TEX® 1000 for production sites and factories. OEKO-TEX® labels ensure that these fibers do not contain allergenic dyestuffs or other banned chemicals that are harmful to human health. Thus, FSC and OEKO-TEX 100 certificates maybe correct.

The *Global Organic Textile Standard* (GOTS) is a measure for textiles made from organic fibers. It includes textile processing, manufacturing, packaging, labeling, exportation, importation and distribution, but not the cultivation of the plant. Any kind of regenerated fiber is not organically grown and can therefore not be certified by GOTS. In a blended fabric with up to 10% regenerated fibers, the certificate may be used if the viscose is made from organically grown bamboo. In general, GOTS certificates are consequently not available for regenerated cellulosic fibers from bamboo or any other pulp source.

Conclusions and Outlook

There is quite some confusion on the market about "bamboo fibers", their origin and properties. This literature and patent review gives a scientific overview on so-called "bamboo fibers" and sums up the following facts:

Most so-called "bamboo fibers" are viscose fibers made from bamboo dissolving pulp like any other viscose fibers made from eucalypt or other wood dissolving pulp. They should not be mixed up with natural virgin bamboo fibers.

Although viscose fibers are simple to distinguish from natural fibers for an expert, customers are easily cheated by false information. Therefore, the product has to be named "viscose/rayon fiber (from bamboo)" in the EU, USA and Canada.

Mechanical properties, UV protection and comfort properties of viscose and lyocell fibers and fabrics from bamboo dissolving pulp are reported in the literature to be similar to viscose and lyocell fibers from any other dissolving pulp. Therefore, there is no unique selling position (USP) for viscose or lyocell fibers from bamboo pulp.

The producers attribute the so-called unique properties of fibers from bamboo pulp especially to the antimicrobial behavior of the raw material itself. Scientific literature shows that the natural resistance of bamboo plants results from biochemicals produced and stored in the leaves, which are removed before pulp production. Only culms are used for pulping. Additionally, the harsh conditions during dissolving pulp production remove extractives and lignin from the raw material. A preservation of antimicrobial properties associated with the raw material was disproved by scientific literature.

The literature gives evidence that variations in antimicrobial performance of the regenerated cellulosic fibers are more likely related to residual chemicals from the production process like e.g. sulfur from the viscose process.

The same facts are valid for lyocell fibers from bamboo pulp. Although some sources report antimicrobial performance of lyocell fibers from bamboo, this seems very unlikely.

Certificates for organic fibers have been identified as frauds in the literature. GOTS certificates are generally not available for regenerated fibers of any kind.

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