



Soybean straw



Introduction

Soybean (*Glycine max*) straw is an abundant and renewable form of biomass with enormous potential as a low-cost, sustainable source of energy and chemicals. Soybean is a species of annual legume herb native to East Asia that is widely grown for its edible bean, which has numerous uses. It has hard pods, stout stems, and trifoliate leaves that are covered with fine brown or gray hairs. Before the soybean seeds are mature, all the leaves wilt and fall. Soybean straw is mainly used for animal feedstock, burned for rural energy, or disposed in the field.

Fiber extraction

Literature found reporting about fiber extraction from soybean straw for textile application is limited. Soybean straw has relatively high resistance to alkali in terms of extracting the technical fibers compared to extracting fibers from other agricultural byproducts such as cornhusks, cornstalks and rice straw.



In the SUSTEX project, the fibers were extracted from dry and non-retted soybean straw after boiling in an 8% NaOH for 1 hour. Afterwards, the stems were thoroughly washed in warm water of 60°C and neutralized in dilute acetic acid solution of 1% to remove any remaining alkali. After the rinsing process the fibers were manually extracted from the wet stems and air dried.

Fiber composition and properties

The composition (%) of soybean technical fibers obtained from soybean straw is comparable to cotton and linen. The higher amount of cellulose content in the technical fibers from soybean straw is mainly due to the rigorous treatment of the straw in alkali solution during fiber extraction. The rigorous treatment removes most of the hemicellulose and other non-cellulosic substances resulting in cellulose rich technical fibers.



	Soybean straw technical fibers	Soybean straw	Cotton	Linen
Cellulose (%)	85 ± 3.1	44–83	85-90	72-82
Lignin (%)	11.8 ± 0.7	5–14	0.7-1.6	2-3
Ash (%)	1.0 ± 0.3	2-5	0.8-2.0	-

Reddy et al. 2009

The presence of higher amounts of lignin and the unique cellular structures on the surface of the soybean straw make it difficult for the chemicals to penetrate the straw and remove the non-cellulosic components.

Single fibers in soybean straw are shorter than those in the common cellulose fibers such as cotton and linen. The width of the single cells in soybean straw fibers is similar to that of cotton and also to fibers obtained from other lignocellulosic sources.

	Single fiber dimensions		
	Soybean straw fibers	Cotton	Linen
Length, mm	1.5 ± 0.5	15–56	4–77
Width, µm	15.6 ± 3.6	12–25	5–76

Reddy et al. 2009

The quality of the fibers obtained during the SUSTEX project by chemical method seems lower than what was reported in literature. The fibres are finer, but shorter and weaker and have comparable elongation. This may be due to all sorts of causes like e.g. difference in treatment, difference in growth of the plants and also the limited number of soya fibres available.

	Mean ± STDEV	Reddy et al. 2009
Fineness (tex)	14.5 ± 6.5	67.2 ± 32.6 den (7.4 ± 3.6 tex)
Length (mm)	62.8 ± 17.2	80
Tenacity (cN/tex)	15.5 ± 7.4	2.7 ± 1.4 g/den (23.7 ± 12.3 cN/tex)
Elongation (%)	3.0 ± 1.3	3.9 ± 1.4 %

Conclusion and outlook

- Limited amount of material tested, reproducibility has to be confirmed
- Optimization of the extraction procedure is needed to envisage fibers suitable for textile applications and preferably to reduce the amount of alkali % used.