MedCrave
Step into the World of Research

Journal of Textile Engineering & Fashion Technology

Review Article

Open Access

CrossMark

Extraction and mix compatibility study of beohmeria fiber with cotton

Abstract

The study focuses on the mix compatibility of cotton and bohemeria fiber for the production of yarn. The Bohemeria fiber used for the study was by chemical degumming. By the chemical degumming from 1,500gm decorticated boehmeria 1,370gm of bohemeria fiber extracted which 91.3% fiber yield. The color of the extracted fiber is reddish yellow due to the presence of lignin, pectin, wax and other unwanted materials. To make the color of the extracted fiber compatible to cotton, bleaching using H_2O_2 was carried out and the converted bleached fiber into staple length by chopping. To facilitate the mixing of the bohemeria and cotton fiber; first Manual opening carried out and Further opening using waste feeder continued to open gently and to form homogeneous mix. In the mix Component ratio of 35% Bohemeria and 63% cotton was used. The mixed fibers were opened to individual fibers on carding. Finally 33Nm yarn is produced on rotor spinning machine. The Yarn has Tenacity of 10.822g/tex, elongation of 5.026% and breaking load 298.9gm.

Keywords: fiber extraction, mix compatibility, yarn characterization

Volume 6 Issue 1 - 2020

Lami Amanuel
Department of Textile Engineering, Kombolcha Institute of Technology, Wollo University, Ethiopia

Correspondence: Lami Amanuel, Department of Textile Engineering, Kombolcha Institute of Technology, Wollo University, Ethiopia, Tel +251910621749, Email lamiamanue@gmail.com

Received: April 20, 2019 | **Published:** February 17, 2020

Introduction

In recent decades manufacturing industries; including Textile manufacturing units are reverting back to natural polymers and fibers due to the promulgation of more restrictive regulations concerning environmental protection. Natural cellulosic plant fibers are characterized by their high production, biodegradability, low cost, and high thermo stability.[1,2] Boehmeria nivea is a perennial plant with at least three harvests per year. The principal end product of Boehmeria nivea is textile grade fiber, famous for its fine characteristics in textile industries. Boehmeria fiber is harvested three times a year and is used for textile and rope production.[2]

There is abundant cellulose with some impurities called gum such as hemicellulose, pectin, and wax in Boehmeria. It has been used as a fabric for centuries because of its excellent fiber.[3]The fibers obtained from the outer part of the stem are one of the strongest and longest fine fabric fibers.[4] Other positive attributes of this fiber are resistance to bacteria, insect attack, and mildew, and its strength increases slightly when wet.[5] It is also used as a feedstock and mulch, and in the manufacture of bio-ethanol, and medicines.

It is grown on the slopes of hilly areas to reduce soil erosion and water loss.[6] The disadvantages associated to Boehmeria are its brittleness, stiffness, low elasticity, and easy wrinkling.[7,8]

Boehmeria stems are the main source of fiber, any increase in fiber yield would be attributed to an increase in stem weight. A positive correlation has been reported between the content of the stem and fiber yield.[9] In studies and trials conducted at the Institute of Innovation in Biotechnology and Industry of the Dominican Republic,[10] the fiber is processed to elaborate tablecloths, hammocks, cloths, dolls and others.

Chemical degumming has been used by researchers to extract Beohmeria fiber from the stems, Chemical degumming of natural fiber in plants removal Gummy substances and increase the content of cellulose. Mostly this extraction technique is employed in the textile and other industries. The characteristics the Degummed fiber can be enhanced further by appropriate surface treatments.[11]

The objectives of the current study were to extract fiber from stem of beohmeria plant indigenous to Ethiopia, mix the extracted fiber with cotton and study the mix compatibility of Boehmeria and cotton fibers by forming into yarn to characterize the mechanical properties of the formed yarns.

Materials and methods

Materials

In order to extract bohemeria fiber and blend with cotton the following materials were used: Gloves are used to prevent stinging from the plant), cut palm tree stem sickle was used, vat for degumming and to immerse decorticated fiber, Mesdanl Lab Strength Tester for testing yarn strength, waste feeder for opening the fibers, carding machine to individualize the fibers, thermometer, Digital weighing balance pipette and chemicals (NaOH, H_2O_2 AND wetting agent) for chemical degumming and bleaching the fibers.

Methods

Harvesting

Bohemeria was harvested by cutting the canes sufficiently close to the ground with the help of sickle and the plants are stripped off the leaves carefully with the help sickle, without causing any damage to the cane.

Decorticating and drying

The cortex or bark is removed from Bohemeria stem either by hand or machine and the cortex is decorticated to remove the outer bark, the parenchyma in the baste layer and some of the gum and

pectin. The residual pectin and gummy materials left attached to the bark after decortications washed off to prevent any fiber stickiness and then dried under the sun for two to three days by hanging them on bamboo frame work (Figure 1).

Figure 1 Decorticated dry beohmeria stem bark.

Chemical degumming

To remove the gums contained in the decorticated boehmeria bark, chemical degumming using caustic soda was carried out. 1500gm of raw decorticated boehmeria bark immersed in water over night and dried under sun light hanging on wooden material. Using 1:20MLR; 7% sodium hydroxide on the weight of fiber is prepared and taken into a metal beaker. Chemical degumming of the decorticated Beohmeria stem bark was carried out using Sodium hydroxide, sequestering agent and wetting agent. The fiber is immersed in the mixture of the chemicals and incubated at boiling temperature for 1hour. The degumming removes the gummy substances from the decorticated bark of beohmeria stem.

After extraction the fiber were washed with distilled water and neutralized with acetic acid, washed again to rid off any acid stain and finally dried. The color of fiber extracted by chemical degumming was reddish yellow.

Bleaching

To remove the reddish yellow color and reveal the creamy white color of beohmeria fiber Oxidative bleaching using H_2O_2 was carried out. On the weight of fiber; 4% hydrogen peroxide, 2% caustic soda, 2% wetting agent and 2% sequestering agent taken into a beaker with 1:20MLR. The degummed fiber immersed into the mixture and incubated at boiling temperature for 1 hour. The fibers were washed with distilled, neutralized with acetic acid and washed for the 2nd time to remove any acid stain from the fiber finally dried.

Softening

To soften the bleached boehmeria fiber; on the weight of fiber 4% Polydimethylsiloxane (silicone emulsion) softening agent, 0.5% wetting agent and 1% sequestering agent taken into a beaker using 1:20MLR. The fiber immersed into the beaker and the mixture incubated at 80˚C for 1 hour. After softening the fibers were washed with distilled water; neutralized with acetic acid washed for the second time to remove any acid stain from the fiber, then dried.

Fiber compatibility in mixing

While mixing, care has taken to ensure that Beohmeria and cotton fibers used for the study are compatible with regard to processing. The two were considered as factors that influence the compatibility of mix are the fiber length and its distribution, and fiber fineness. In fact, fibers having length less than 12-15mm do not contribute to the yarn strength.

Very short fibers (4-5mm) are lost during processing as waste and fly. When components varying widely in fiber length are mixed, the mixing will suffer from a serious drawback having a high level of fiber length variability. This fiber length variability (or increase in short fiber content) will cause problems at every stage of processing. To control such problems the length of beohmeria fiber is chopped into staple length to adapt it to the length of cotton fiber in the mix. The fibers were prepared in such a way that the components in the mix vary in fiber length only up to 5mm. As the Fiber fineness affects the strength, irregularity of yarn and the twist for maximum strength; improper blending leads to greater variation and non-homogeneity of blending in the yarn. In commercial practice, it would be safe to blend cottons differing in micronaire values not greater than 1.2. The same case is taken as a bench mark for this specific study and the cotton fiber which will not vary greater than 1.2 from the micronaire value of the Beohmeria fiber was selected and used in the mix.

Apart from the above; Commercial Experience shows that cottons having bundle strength of 15g/tex and lower are generally sources of trouble. Since both the selected cotton and the extracted Beohmeria fiber have strength in the range compatible for mix; such trouble did not occur in this study. Also the average level of trash in the mixing influence compatibility. The average level of trash in the mixing for producing a card sliver of good quality is given below Table 1.

Table 1 Recommended average level of trash in the mixing for carded sliver

Card Sliver (Ne):	20	30	40	60	80	100
Average Trash (%) in mixing	5	4	3.5	3	2.5	2

The intention of the study was to produce a 33Ne yarn count. The compatible range of cotton trash content for the study was identified as the range between 3.5%-4% and from available cotton fiber; the one with minimum trash content (3.8%) was selected and used in the mix.

The other fiber parameter which affects mix compatibility is color. In this study the color of Beohmeria fiber was revealed white by bleaching to make it compatible to the white color of cotton fiber and the fibers are compatible so far.

The General Compatible characteristics considered in this study to disclose the compatibility of the fibers are illustrated in Table 2.

Citation: Amanuel L. Extraction and mix compatibility study of beohmeria fiber with cotton. *J Textile Eng Fashion Technol.* 2020;6(1):16–20.
DOI: 10.15406/jteft.2020.06.00221

Table 2 Properties of Cotton and beohmeria fibers used for the study

Characteristics	Cotton fiber	Bleached and softening boehmeria
Fiber fineness	4.84	6.04
Fiber strength	38.5	41.25
Fiber length	32.5mm	34.5mm
Fiber trash content	3.92	0
Fiber color	White	White

Mixing

A typical mix of 35/65 Beohmeria cotton mix was studied in this particular Investigation. To get a homogeneous fiber mix the Fibers were first opened and mixed manually by hand on the in late lattice of Blending feeder. Further Opening and mixing continued in Blending feeder opener machine to get homogeneous mix of the fibers.

Individualization and sliver formation

The Opened fibers were taken to carding section and fade into tex tima carding machine where the fibers were individualized and formed into sliver. The specifications of the selected Textime carding machine were as follows in Table 3 (Figure 2).

Table 3 Specific settings of the selected carding machine

Machine type	Tex tima
Machine No	7
RPM motor	120
Count	0.18Ne

Figure 2 Fiber individualization and sliver formation.

Drawing and yarn spinning

The slivers where drawn on drawing machine to improve the slivers evenness through doubling. Two different types of yarn spinning i.e yarn spinning from cotton only and yarn from Beohmeria cotton mix; was carried out on rotor spinning machine. The purpose of manufacturing the two different yarns was to conduct comparative study of the physical properties of the fibers.

Characterization of Yarn physical properties

Yarn physical test was carried out using Mesdanl Lab Strength Tester and uster for yarns spun from cotton only and Beohmeria cotton Mix and summarized in Tables 4–6 below:

a. Material Type: Cotton only

b. Yarn Count: 33Nm,

c. Sample number: 5

d. Sample length: 500mm

e. Clamp speed: 1000mm/min

Table 4 Yarn characteristics by Mesdanl lab strength tester from

S. N	Breaking load (gm)	Elongation (%)	Time (s)	Tenacity (RKM)
1	277.3	3.06	0.9	9.29
2	329	4.38	1.3	11.022
3	340.8	5.04	1.5	11.417
4	264.5	2.82	0.8	8.861
5	368.7	4.02	1.2	12.351
Maximum	368.7	5.04		12.351
Minimum	264.5	2.82		8.861
Average	316.06	3.864	1.2	10.588
Range	32.968	57.453		32.968
CV%	13.892	23.895		13.968
Standard deviation	43.907	0.923		1.471
IC95%	38.485	0.809		1.289
IC99% cotton	50.578	1.064		1.694

Citation: Amanuel L. Extraction and mix compatibility study of beohmeria fiber with cotton. *J Textile Eng Fashion Technol.* 2020;6(1):16–20. DOI: 10.15406/jteft.2020.06.00221

Table 5 Yarn characteristics by Mesdanl Lab Strength Tester from cotton and beohmeria blend

S.N	Breaking load(g)	Elongation (%)	Time (in seconds)	Tenacity (RKM)
1	305.1	4.8	1.4	10.221
2	312.8	5.04	1.5	10.479
3	341.2	5.1	1.5	11.43
4	357.2	5.76	1.7	11.966
5	298.9	4.38	1.3	10.013
Maximum	357.2	5.76	1.7	11.966
Minimum	298.9	4.38	1.3	10.013
Average	298.9	5.016	1.5	10.822
Range	18.047(%)	27.512(%)	0.4	18.047(%)
CV	7.748(%)	10.029(%)		7.748(%)
Standard deviation	25.031	0.0503		0.839
IC95%	21.94	0.441		0.735
IC99%	28.834	0.58		0.966

Table 6 Yarn characteristics by Uster Tester from cotton yarn and beohmeria cotton blend yarn

S.N	Yarn type	U%	CVM	Thick place	Thin place	Nep	Hairiness	count
1	Cotton	10.5	14.9	54.9	32.6	30.94	8.9	33Nm
2	Boehmeria cotton blend	10.94	13.94	61.6	6	15.6	4.79	33Nm

Discussion and conclusion

By chemical degumming of Beohmeria stem bark 91.3% fiber was extracted. The extracted Fiber is Reddish yellow in color. To make mix of the beohmeria fiber compatible to cotton the color of the component fibers for the mix has to be similar. Cotton fiber is creamy white in color. To remove the reddish yellow color of the extracted Beohmeria fiber; oxidative bleaching using H_2O_2 was carried out with MLR of 1:20. And the creamy white color of the fiber is revealed.

In literatures; Cohesiveness and flexibility properties of fiber influence spinablity. Cohesiveness and flexibility properties of fiber are directly related to spinabilty. In another hand flexibility affect cohesive property of fibers highly. Beohmeria fiber flexibility less than that of cotton even after bleaching. To improve the softness and flexiblity of Beohmeria fiber; softening was carried out using Polydimethylsiloxane (silicone emulsion) softening agent. After softening to improve flexibility, cohesiveness and elongation at break of the fiber.

The bleached Beohmeria fiber has longer length compared to cotton fiber. Mixing the fiber as it is with cotton increase length variability and cause problems at every stage of processing. To minimize the variability of the fiber lengths Beohmeria fiber is chopped and adapted to cotton fiber length. The other major fiber Properties that affect fiber compatibility in mix are fineness and strength. In commercial practices it's not recommended to mix fibers varying in fineness more than 1.2micronaire. The actual micronaire values of cotton and beohmeria fiber used in this study are 4.84 and 6.04 respectively. The micronaire difference is 1.2 and it's in the recommended range. Practical trend in industries shows that fibers with strength less than 15gm/tex are not compatible for mixing. The strength of the beohmeria and cotton fiber used have 41.25gm/tex and 38.5gm/tex respectively. The strength of both fibers under study was compatible for mix as no fiber has strength less than 15gm/tex. The above scientific literature surveys revealed the compatibility of the fibers for mix.

Mixing of fibers is highly influenced by opening. Repeatedly opening gives homogeneous fiber. In this study to improve the homogeneity of the mix the fibers were first mixed manually on feed lattice of blending feeder followed by opening by blending feeder opening machine. The fiber is then opened to individual level on carding machine. Card sliver is partially oriented. There are three different fiber hooks i,e leading, threading and double hooks, in card sliver. To achieve an optimal strength of yarn, fibers must be arranged parallel to each other and along the axis of the yarn. In this study Drawing was carried out on 4/4 drafting arrangement Draw frame to parallelize the fibers by stretching between pairs of rollers. Finally two different Yarns spun from cotton only and Beohmeria cotton mix drawn sliver on rotor spinning machine.

The results from Mesdanl Lab Strength Tester and Uster evenness tester revealed that yarn spun from Beohmeria cotton mix has more quality in terms of Tenacity, elongation and uniformity. The improvement in quality is due to the attributes of the beohmeria fiber. Beohmeria fiber is strong, longer fiber and is more uniform.

The results from Mesdanl Lab Strength Tester; yarn tenacity and elongation at break; revealed yarn spun Beohmeria and cotton mix has more tenacity and elongation at break (Figure 3).

Mass variation (CVm%) and evenness (U%) of the two yarns characterized by uster tester. There is slight difference between the yarns manufactured from cotton and beohmeria cotton blend. Beohmeria cotton blend yarn is more uniform than cotton yarn (Figure 4).

Citation: Amanuel L. Extraction and mix compatibility study of beohmeria fiber with cotton. *J Textile Eng Fashion Technol.* 2020;6(1):16–20.
DOI: 10.15406/jteft.2020.06.00221

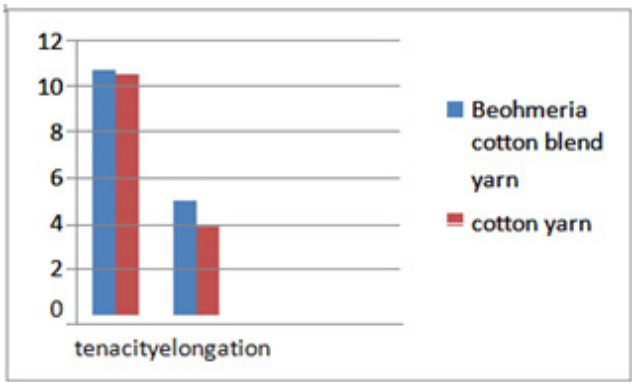

Figure 3 Plot of tenacity and elongation at break of Beohmeria cotton blend yarn and cotton yarn from Mesdanl Lab Strength Tester.

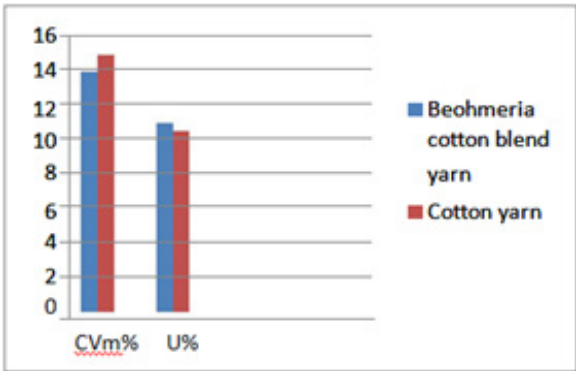

Figure 4 Plot of yarn imperfection percentage and evenness of Beohmeria cotton blend yarn and cotton yarn from Uster Tester.

The goal of the research to study mixing compatibility of cotton with beohmeria fiber was accomplished resulting in good quality of yarn, decreased cost of fiber and with intention of generating income to the farmers. Both yarns; Cotton yarn and Beohmeria Cotton blend yarn; manufactured in this study good have mechanical and physical characteristics such as strength, fineness, elongation at break and uniformity.

Acknowledgments

None.

Funding

None.

Conflicts of interest

The authors declare that they have no competing interests.

References

1. Monteiro SN, Lopes FPD, Ferreira AS, et al. Natural fiber polymer matrix composites: cheaper, tougher, and environmentally friendly. *JOM*. 2009;61(1):17–22.
2. Nam S, Netravali AN. Green composites. I. Physical properties of ramie fibers for environment-friendly green composites. *Fibers Polym*. 2006;7:372–379.
3. Kirby RH. Vegetable fibres: World crops books. London: Leonard Hill; 1963. 464 p.
4. Jarman CG, Canning AJ, Mykoluk S. Cultivation, extraction and processing of ramie fibre: a review. *Trop Sci*. 1978;20:91–116.
5. Lu Y, Weng L, Cao X. Morphological, thermal and mechanical properties of ramie crystallites-reinforced plasticized starch biocomposites. *Carbohyd Polym*. 2006;63:198–204.
6. Rong L, Xiao Ning T. Taking ramie resources development as a breakthrough to speed up soil and water losses control in slope farmland of South China. *Glob Seabuckthorn Res Dev*. 2010;1:68–76.
7. Blackburn RS. Biodegradable and sustainable fibers. Cambridge, UK: CRP Press; 2005:70–77.
8. Goda K, Sreekala MS, Gomes A, et al. Improvement of plant based natural fibers for toughening green composites-effect of load application during mercerization of ramie fibers. *Compos Part A Appl Sci Manuf*. 2006;37:2213–2220.
9. Liu F, Liang X, Zhang S. Accumulation and utilization efficiency of potassium in ramie varieties. *J Plant Nutr*. 2000;23:785–792.
10. Pérez A, Hilda B Wencomo, Nayda Armengol, et al. Boehmeria nivea (L.) Gaud. *Pastos y Forrajes*. 2013;36(4):404–408.
11. Wulandari AP, Septarini D, Zainuddin A. Study on structure and morphology (Boehmeria nivea) in the irregular and regular parts of the fiber after biodegumming. *IOP Conference Series: Earth and Environmental Science*. 2017;65:012043.