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KENAF - A PROMISING WAY INTO SUSTAINABLE TEXTILES ENVIRONMENT DEVELOPMENT OF KENAF-COTTON BLENDED YARN AND FABRICS FOR SUSTAINABLE TEXTILES

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Abstract - *Hibiscus cannabinus also known as Kenaf is a 4000 year annual crop that belongs to Malvaceae family with its origin in Africa. Kenaf produces fibre quickly and can adapt to variety of growing conditions [1]. It requires only a little care during cultivation. Plants cultivated in Andhra Pradesh are in rain fed irrigation and requires 50 cm of water during the important stages like seed germination and vegetative phase of crop growth [2]. This is comparatively a lesser water requirement than its substitute crop Jute thereby a promising future industrial fibre crop. Different yarns are required now days for both technical as well as for aesthetic properties. In the recent years, developing new yarn is the fundamental phenomenon for technical textiles. Kenaf fibre has good antimicrobial, fire resistance and absorbency [3] that can be utilized in various textiles needed for society. The Kenaf cotton blended yarn of 50%-50% was produced through rotor spinning and was spun into 10Ne count. The quality was evaluated for yarn strength, yarn elongation, evenness and hairiness. The quality parameters of Kenaf-Cotton blended yarn were compared to 100% cotton yarn. The results reveal that the Kenaf-Cotton blended yarn were in comparable quality with 100% cotton and can be made into fabrics of different weave structures and can be utilized for various potential business applications like home textiles and medical textiles focusing towards a sustainable environment. Besides a potential fibre crop the tender leaves is well known for its culinary use and the seeds contain 22-24 % oil [4] of high nutritional value and health promoting properties due the presence of relative high amount of mono unsaturated and poly unsaturated fatty acids.*

Key Words: Kenaf, Cotton, Yarn, Quality, Sustainability

1. INTRODUCTION

Hibiscus cannabinus also known as Kenaf is a 4000 year annual crop that belongs to Malvaceae family with its origin in Africa. Kenaf produces fibre quickly and can adapt to variety of growing conditions. It requires only a little care during cultivation. Plants cultivated in Andhra Pradesh are in rain fed irrigation and requires 50 cm of water during the important stages like seed germination and vegetative phase of crop growth. This is comparatively a lesser water requirement than its substitute crop Jute thereby a promising future industrial fibre crop. Kenaf fibre has good antimicrobial, fire resistance and absorbency that can be utilized in various textiles needed for society. Oil extracted from Kenaf seeds has a high medicinal value. It is unaffected by humidity and has excellent sound insulation, fire resistance and thermal insulation properties and hence being used to produce eco – friendly concrete structures. It has good carbon sequestration properties, too.

Fig - 1: Hibiscus cannabinus crop

Fabric - Kenaf plant grown in black cotton soil (Coimbatore) for 120 days, Kenaf fibre (extracted from bast of Kenaf plant), cotton fibre (purchased from local market).

Culinary Use – Kenaf plant grown in black cotton soil, rainfed condition, young tender leaves harvested after 30 days and processed.

2. KENAF BLENDED WITH COTTON:

Kenaf fibres were extracted from the bark and were cut in the length of 1 inch and were blended with cotton in the length of 30mm in the ratio of 50:50 from which kenaf cotton blended yarn and fabric was made. This blended yarn and fabric was also compared to 100% Cotton yarn and fabric. The blended fibers were carded in a miniature carding machine in three stages- breaker card, inter card, and finisher card and blended slivers were produced. These slivers were spun on a miniature rotor spinning machine at rotor speed 3000rpm, open roller speed 1100 rpm and twist 37 TPI. The 50 Kenaf cotton yarn was produced in 12s count.

3. PREPARATION OF THE FABRICS:

The Kenaf cotton yarns were woven in a pit loom of width 24 inches. The blended yarns were used in both the warp and weft direction. They were woven in a plain weave structure using the principle one up one down. The ends were found to be 24 and picks per inch were found to be 26.

Cross sectional view of Hibiscus cannabinus fiber:

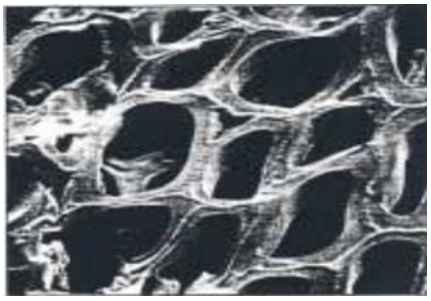


Fig- 2: Cross sectional view of kenaf fiber [12].

4. CHARACTERIZATION OF KENAF AND COTTON FIBRES:

FTIR test was taken for kenaf fiber in order to know the chemical compounds present in the fiber. The results were recorded in the range of 4000 cm^{-1} to 650 cm^{-1}. The graph was plotted against %T and cm^{-1}.

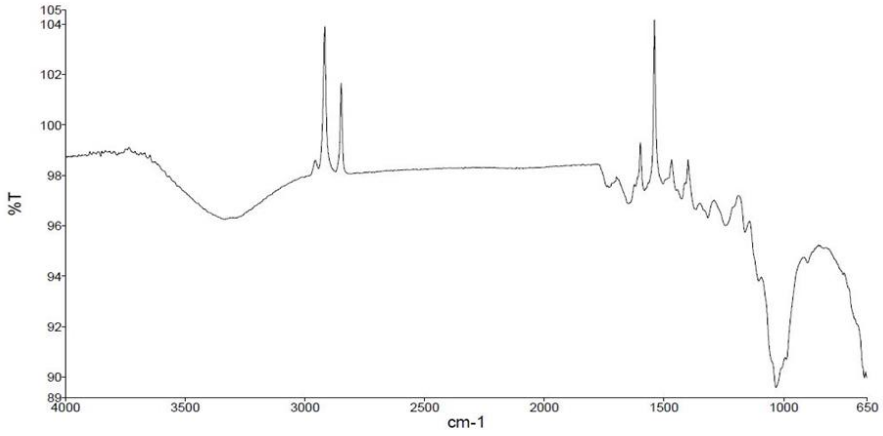


Fig- 3: FTIR graph of Kenaf fibers

5. CHEMICAL COMPOSITION OF FIBERS:

The chemical compositions of Kenaf and cotton fibers are discussed below [13]. Due to the presence of lignin content at a greater level fire resistance of the kenaf fiber is higher than cotton fiber [14].

Table -1: Chemical composition of Kenaf fibers [13]

Fibers	Cellulose (wt%)	Hemi-cellulose (wt%)	Lignin (wt%)	Waxes (wt%)
Kenaf	72	20.3	9	-
Cotton	85-90	5.7	-	0.6

6. PROPERTIES OF KENAF FIBER AND COTTON FIBER:

Through visual inspection, Kenaf fibers were coarser than the cotton fibers. The properties of both the kenaf and cotton fibers are discussed in Table below [13, 15].

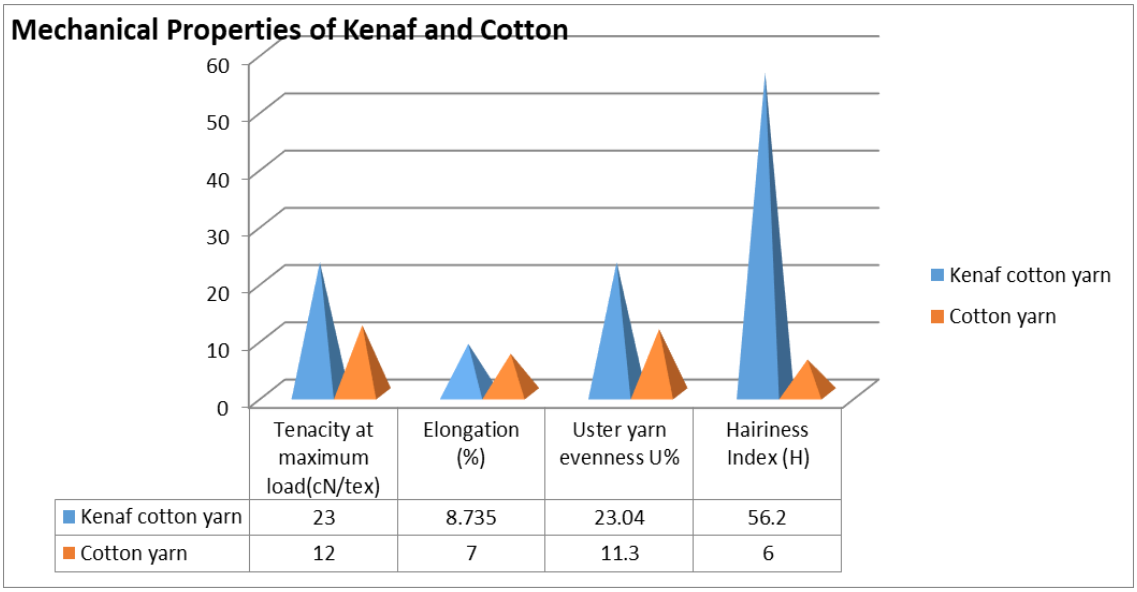
Table- 2: Kenaf and Cotton fiber properties[13,15]

Properties	Kenaf fiber	Cotton fiber
Density (gm/cm^3)	1.45	1.5-1.6
Diameter(µm)	40-90	16-21
Elongation (%)	1.6	7-8
Tensile strength(MPa)	930	400
Modulus(GPa)	53	5.5-12.6

7. DETERMINATION OF YARN QUALITY:

Yarn quality was tested for Yarn Strength, Yarn Elongation, Yarn Evenness and Yarn Hairiness. Yarn strength was tested using a Universal Single column Instron tensile testing machine Model-3345. The values of Extension at maximum load(mm), Tenacity at maximum load(cN/tex) were determined. Yarn evenness test was taken as per ASTM D 1425/D 1425M:2014 to find the U%, Imperfections (For OE) at R.H. 65%+/-2%, Temp.21 Degree C+/-1 Degree C, Nom. twist 0 T/m , v= 400 m/min, t= 0.25 min and were compared to 100% cotton. Yarn hairiness test was taken as per ASTM D-5647:07 2012 in a Zweigle hairiness tester at R.H. 65%+/-2%, Temp.21 Degree C+/-1 Degree C with fineness 10s count pretension 5Cn. 5 tests were taken and the hairiness CV % was found and were compared with 100% rotor spun cotton yarn as per the Sitra norms.

Table -3: Mechanical properties of Kenaf Cotton blended yarn and cotton yarn

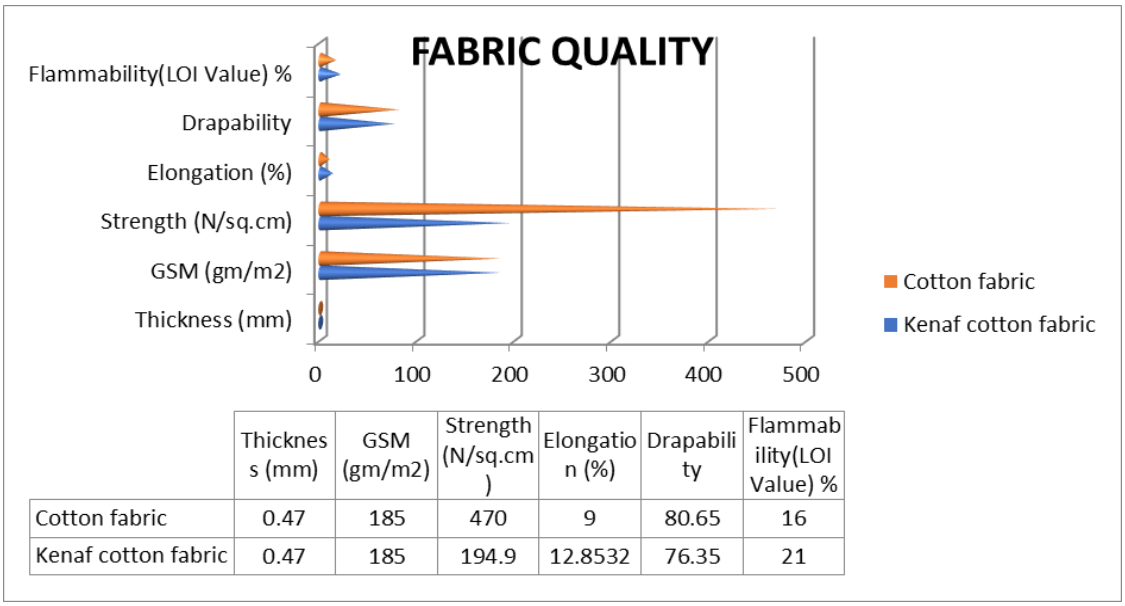


	Tenacity at maximum load(cN/tex)	Elongation (%)	Uster yarn evenness U%	Hairiness Index (H)
Kenaf cotton yarn	23	8.735	23.04	56.2
Cotton yarn	12	7	11.3	6

8. DETERMINATION OF FABRIC QUALITY:

The Kenaf cotton fabric was woven in a pit loom at ends per inch being 24 and the picks per inch or being 26. The fabric was evaluated for the GSM, Thickness, drapability, fabric strength, elongation and flammability. Table 4 represents the fabric GSM, Thickness, Drapability, Fabric Strength, Elongation and Flammability.

Table- 4: Fabric quality parameters of Kenaf cotton blended fabric and cotton fabric



	Thickness (mm)	GSM (gm/m2)	Strength (N/sq.cm)	Elongation (%)	Drapability	Flammability(LOI Value) %
Cotton fabric	0.47	185	470	9	80.65	16
Kenaf cotton fabric	0.47	185	194.9	12.8532	76.35	21

Nutritional Benefits : Besides a potential fibre crop the tender leaves is well known for its culinary use and the seeds contain 22-24 % oil of high nutritional value and health promoting properties due the presence of relative high amount of mono unsaturated and poly unsaturated fatty acids.

Young tender leaves 30 days after sowing were harvested and processed into pickle using vinegar, spices and salt. Kenaf leaves are a great source of dietary fibre besides being a powerhouse of vitamin A, Vitamin B (Thiamin), Vitamin B2 (Riboflavin) and vitamin B9(folic acid) and Vitamin C. Tea made out of Kenaf flowers in boiling water is a great source of anti-oxidants.

Fig- 4: Processed kenaf leaves

Industrial Use of Kenaf Seed Oil : The seeds from Hibiscus cannabinus are economically important and serve as a source of oil. Kenaf seed has 17.22 % fatty oil. The seeds can be separated either by drying or by thrashing. This oil is used by soap making industries in many parts of the world. The oil can be used in preparation of lubricants, linoleum, paints and varnishes. The presence of cyclopropene in seed oil makes it non – edible. However hydrogenation and refining makes it consumable for cooking purpose. Hinsigi and Krisna (1998) had estimated that 50000 tonnes of oil is produced every year from Kenaf.

Fig- 5: Seed separation

Environmental Benefits: Hibiscus cannabinus flowers attract a lot of honey bees and hence can be planted with other crops to increase the cross pollination activities. Kenaf has high Carbon sequestration properties, higher than the other C3 plants. Kenaf has the potential to yield more biomass. Indonesian Center for Estate Crops Research and Development, Indonesia (Aug 2016) reports that Kenaf can absorb 21-89 tonnes of CO2 / ha/ year. So, development of kenaf plants on sideways and industrial areas could be an effort to reduce the greenhouse gas emissions and can be harvested later for fibre or oil.

9. RESULTS AND DISCUSSION:

Kenaf cotton yarns were produced and were compared to the rotor spun yarns as per the Sitra norms. The kenaf cotton blended yarns has nominal strength and elongation of the yarn was good. The U% of the yarn was 23% which is suitable to be spun into fabrics of various weave structures. Generally, the rotor spun yarns have less number of hairs than the ring spun yarns16 but the hairiness in blended yarns are more than 100 cotton yarn. The blended fabric strength and drapability of the fabric was inferior to cotton fabric but the elongation and the flammability of the fabric was good. These were analyzed using ANOVA analysis and significant differences were observed between the samples.

Particulars	SS	Df	MS	F	P-value	F crit	Significance
Yarn strength	119.7067	1	119.7067	945.0526	6.67E-06	7.708647	Significant
Yarn Elongation	4.5414	1	4.5414	69.4935	0.001132	7.708647	Significant
Yarn Evenness	206.7414	1	206.7414	5898.471	1.72E-07	7.708647	Significant
Yarn Hairiness	3780.06	1	3780.06	106932.4	5.25E-10	7.708647	Significant

Fabric strength	113520	1	113520	15777.63	2.41E-08	7.708647	Significant
Elongation	22.815	1	22.815	20.93119	0.010222	7.708647	Significant
Flammability	37.5	1	37.5	9.375	0.03759	7.708647	Significant
Drapability	27.735	1	27.735	26.44199	0.006781	7.708647	Significant

Apart from giving a potential fibre-blend, Kenaf cultivation increased the honey bee activities in the field. Its nutritional value is well known and is one of the common recipes in South India. Eco friendly automobile parts were successfully implemented by Ford and BMW in 2013.

10. CONCLUSION

Thus Kenaf was successfully cultivated under irrigated conditions in black cotton soil and bast fibre was extracted. The kenaf-cotton blended yarns and fabrics were successfully produced. Though not superior to 100% cotton yarns, Kenaf cotton blended yarns have various other attributes like color, lustre, texture, appearance etc. The fabrics produced from Kenaf cotton blended yarns were inferior in strength and drapability but were superior in elongation and flammability of the fabric. Further research on softening of the kenaf fibers may contribute to the improvement in quality of this Kenaf Cotton yarn for textile applications. These fabrics because of its good fire resistance and nominal drapability are best suited for home textiles such as aprons, kitchen wear, curtains, sofa covers, automobile parts, etc. There is an increasing application of these fibers into textiles, automobiles and civil industry which will increase the cultivation of Kenaf plant. Increased cultivation of Hibiscus cannabinus will pave way towards sustainable environment.

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REFERENCES

[1] Wilson, F. D., & Menzel, M. Y. (1964). Kenaf (Hibiscus cannabinus), roselle (Hibiscus sabdariffa). Economic Botany, 18(1), 80-91

[2] Angelini, L. G., Macchia, M., Ceccarini, L., & Bonari, E. (1998). Screening of kenaf (Hibiscus cannabinus L.) genotypes for low temperature requirements during germination and evaluation of feasibility of seed production in Italy. Field Crops Research, 59(1), 73-79.

[3] Zaveri, M. D. (2004). Absorbency characteristics of kenaf core particles.

[4] Dhar, P., Kar, C. S., Ojha, D., Pandey, S. K., & Mitra, J. (2015). Chemistry, phytotechnology, pharmacology and nutraceutical functions of kenaf (Hibiscus cannabinus L.) and roselle (Hibiscus sabdariffa L.) seed oil: An overview. Industrial Crops and Products, 77, 323-332.

[5] Kyung Hun Song et al…Chemical and biological retting of kenaf fibers, Textile Research Journal Volume 76(10): 751–756 DOI: 10.1177/0040517506070520, 2006

[6] Department of agriculture madras(1970) notebook of agricultural facts and figures-7th edition

[7] Mohanty AK, Misra M and Drzal LT. Natural fibers, biopolymers, and biocomposites. Boca Raton, FL: CRC Press, Taylor & Francis Group, 2005.

[8] Ramaswamy, G. N., Body, C.R., Bel-Burger, P., and Kimmel,L., Kenaf / Cotton Blends for Textiles, Family Consumer Sci.Res. J. 24(2), 180–190 (1996).

[9] Ramaswamy, G. N., and Easter, E. P., Durability and Aesthetic, Properties of Kenaf/Cotton Blend Fabrics, Textile Res. J. 67(11), 803–808 (1997).

[10] Lee, H.-J., Ahn, C.-S., Kim, G.-H., Yoo, H.-J., Han, Y.-S., and Song, K.-H., Characteristics of Kenaf/ Rayon Fabrics, J.Korean Soc. Clothing Textiles 28(9/10), 1282–1291 (2004).

[11] Parikh, D. V., Calamari, T. A., Sawhney, A. P. S., Blanchard, E. J., Screen, F. J., Myatt, J. C., Muller, D. H and Stryjewski, D. D., Thermoformable Automotive Composites Containing Kenaf and Other Cellulosic Fibers, Textile Res. J. 72(8), 668– 672 (2002)

[12] A Study on Sulphonated Jute-cotton Blended Yarn and Fabrics and their Characteristics M. A. Salam, F. I. Farouqui and Md. I. H. Mondal Department of Applied Chemistry and Chemical Technology, Rajshahi University Rajshahi 6205, Bangladesh.

[13] Moreau, J. P., Bel-Berger, P., Tao, W. 1995. Mechanical Processing of Kenaf for Nonwovens. Tappi Journal, 78 (2), 96-105.

[14] Recent developments in chemical modification and characterization of natural fiber-reinforced composites, Maya Jacob John et al…Polymer Composites • February 2008

[15] A review on potential development of flame retardant kenaf fibers reinforced polymer composites, N Saba et al…, Polym. Adv. Technol. 2017, 28 424–434.

[16] Tensile and compressive properties of hybrid carbon fiber/ kenaf polymer composite, Napisah Sapiai, Aidah Jumahat, and R.N. Hakim, Advances in Environmental Biology

[17] Improvement of kenaf yarn for apparel applications byting zhang b.s., beijing university of chemical technology, 2000, august 2003.

Web Resources

1. Ecosalon.com
2. Kenaf-fibre.com
3. http://www.fibre2fashion.com/industry-article/6856/ecology-economy-and equity?page=1
4. http://www.fibre2fashion.com/industry-article/6856/ecology-economy-and-equity?page=2
5. http://www.termoisolanti.com/en/products/green-building/more-details-on-green-building/kenaf-fibre.php?lang=EN
6. http://perkebunan.litbang.pertanian.go.id/en/manfaat-kenaf-hibiscus-cannabinus-l-dalam-penyerapan-karbondioksida-co2/