International Journal of Research in Engineering Technology – Volume 4 Issue 1, Nov -Dec 2018

RESEARCH ARTICLE OPEN ACCESS

Comparing Comfort Properties of Single Jersey Conventional and Organic Cotton

Mrs. Mitali Nautiyal* and Dr. N. Vasugi**
*M.Phil. Scholar, Department of Textiles and Clothing
** Dean, School of Home Science and Professor, Textiles and Clothing
Avinashilingam Institute for Home Science and Higher Education for Women
Coimbatore – 641 043, Tamil Nadu, India.

Abstract:

Comfort properties of single jersey knitted T-shirts made using conventional and organic cotton yarns were compared. Air permeability tests and moisture management test were carried out on the two samples. Conventional cotton and organic cotton fabrics were developed in a constant machine and room settings. The fabrics were then stitched to a T-shirt, tested and statistically analysed. Air permeability test for the knitted fabrics was carried out using to ASTM standard: ASTM D 737-04 (2016). For testing Moisture Management, AATCC 195:2012 Moisture Management Test was performed on both samples. The moisture management test included: wetting time, absorption rate, maximum wetted radius, spreading speed, one-way transport index and overall moisture management capability. Even though both the T-shirts were made using 100% cotton yarns, 150 GSM, 30's count and same knitting construction, the statistical analysis revealed that there was a remarkable difference in their comfort properties. Organic cotton showed better air permeability and moisture management capability than conventional cotton T-shirts.

Keywords — **Air Permeability, Moisture Management, Comfort Properties, Organic Cotton T-shirt, Single Jersey.**

INTRODUCTION

Textiles have become an integral part of our everyday life. Knitting is the second most popular technique of fabric or garment formation by inter-looping one or more set of yarns. The production of fabric in the knitting machine is about four times faster than the weaving looms [1]. Knitting can be classified as weft knitting and warp knitting according to the direction of movement of yarn during loop formation. Out of the two types of knitting, weft knitting is the most widely used technique [2]. There has been an increase in demand for knitted products all over the world. This is due to its simple production technique, low cost in manufacture, high level of clothing comfort and wide product range. The knitting industry meets the rapidly-changing demands of the fashion industry and usage [3].

Cotton is the most popular natural fiber used in the knitting industry. It can be used in any kind of machine and can be used for all kinds of knitted goods [4]. Cotton is known for its qualities like good strength, heat conductivity, high resistance to degradation by heat, and is characterized by excellent properties like absorbency, comfort, drape, high wet strength, softness and water retaining capacity and non-allergic properties [5]. The world's production of textile fibres by mass shows that cotton is one of the main fibres in the world with an estimate share of 35% in the textile industry. Due to the high demand of fibre, typical cotton production requires large scale agricultural practices. Cotton cultivation covers a large area of land and also consumes a large amount of agrochemicals and water [6].

Conventional cotton is the cotton grown using conventional agricultural methods utilizing agrochemicals and water. Approximately 25 million tons of conventional cotton is produced every year which takes 29,000 litres of water per kg. Conventionally grown cotton uses 25% of the world's insecticides and more than 10% of all pesticides while the cultivation of cotton accounts for only 2.4% of agriculturally used areas. The chemicals used in the processing of cotton pollute air, surface water and people. The consumer of the garment also suffers since this cotton irritates skin and can cause neurodermatitis [7]. **Organic cotton** is the cotton grown without the use of any synthetic chemicals i.e., pesticides, plant growth regulators, defoliants and fertilizers. Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil's biological activity. It is based on minimal use of off-farm inputs and on management practices that restores, maintains and enhances ecological harmony [8].

Comfort can be defined as "something that can make one feel relaxed and do not cause any pain or discomfort". Clothing comfort can be classified into four categories, namely physiological, thermo-physiological, sensorial (tactile) and garment fit comfort [9]. Psychological comfort relates to the sensory perceptions and fashion trends, thermo-physiological comfort is governed by movement of air, moisture, and heat through fabric, sensorial (tactile) comfort depends upon fabric surface and mechanical properties and garment fit comfort depends on the fit (loose/normal/tight)of the garment on the body [10].

The primary objective of the present study was to compare the comfort properties of single jersey knit fabrics made using conventional and organic cotton yarns. Organic cotton yarns were weft knitted to produce single jersey fabric, and later stitched into a T-shirt. The comfort properties of this T-shirt are then investigated with that of T-shirts made from conventional cotton yarns. Both the T-shirts were made of same size, colour, weight, count and construction.

OBJECTIVES

The following are the objectives of the study:

- Selection and optimization of conventional cotton and organic cotton yarn, knitting technique and T-shirt production.
- To evaluate and compare the comfort properties of conventional and organic cotton T-shirts.
- Consolidation and statistical analysis.

METHODOLOGY

Fabric was knitted using conventional and organic cotton yarn. A plain knit structure, also called single jersey, was produced using 30^S combed yarns of both the cotton varieties on a circular weft knitting machine (Model- Mayer and Cie). The following machine settings were selected for formation of fabric from yarn: gauge- 24, cylinder diameter-30", speed- 30 rpm, feeders- 90, number of needles- 2256 and needle size- 7 mm. Both the fabrics were produced having a medium loop length of- 2.8mm. Constant machine and room settings with relative humidity of the knitting room at 65 $\pm$ 2% and temperature 30 $\pm$ 2^oC was kept. After the fabric was produced, simple round neck T-shirts were cut and stitched, size- large (chest 40"). The T-shirts were then judged for their comfort properties which included air permeability tests and moisture management tests. The results of the various laboratory tests performed on conventional and organic cotton T-shirt samples were statistically analyzed by using T-test method wherever necessary.

EVALUATION OF COMFORT PROPERTIES

The comfort property test included tests for air permeability and moisture management.

I. Air Permeability

Air permeability of a textile fabric is the degree to which the material is permeable by air. Air flow through the fabric occurs when the air pressure is different on the two sides of the fabric. In the present study, air permeability test of the knitted fabric was carried out using ASTM standard: ASTM D 737-04 (2016). It is the standard test method of air permeability for textile fabrics which applies to most fabrics including knitted fabrics. The rate of airflow passing perpendicularly through a known area of the fabric is adjusted to obtain a prescribed air pressure differential between the two fabric surfaces. From this rate of air flow, the air permeability of the fabric is determined. Test specimens from conventional and organic cotton T-shirts of 38 cm^2 were cut and tested at a pressure of 125 Pa. Air permeability was measured on a FX 3300 air permeability tester by Textest AG, Switzerland, at the standard condition of RH 65% $\pm$ 2 % and temperature 21^oC $\pm$ 1^o C. A minimum of 5 readings were taken and the data was recorded by calculating the mean.

II. Moisture management

For testing Moisture Management, AATCC 195:2012 Moisture Management Test was performed on both the samples. It included tests for: wetting time, absorption rate, maximum wetted radius, spreading speed, one-way transport index and overall moisture management capability. The fabric samples were evaluated by placing a fabric specimen between two horizontal (upper and lower) electrical sensors each with seven concentric pins. A moisture management tester was used for the conducting the test which was connected to a computer. A test solution was prepared by dissolving 9 g sodium chloride (USP Grade) in 1 L of distilled water and its electrical conductivity was adjusted to 16 $\pm$ 0.2 milli Siemens (mS) at 25^{o}C by adding sodium chloride or distilled water as necessary. The instrument was started according to the manufacturer's instructions, and test solution was added according to the instructions. The computer software was set up to collect the data.

The upper sensors were raised to its locked position and a paper towel was placed on the lower sensor. The Pump button was pressed until 0.22 cc of test solution was drawn from the container and dripped into the paper towel and there was no air bubbles present inside the tubing. The paper towel was then removed. Similarly, the test specimen was placed on the lower sensor with the specimen's top surface up. The upper sensor was released freely until it rests on the test specimen and the door of the tester was shut. Pump was put on until the predetermined amount of 0.22 cc of test solution was dispensed on the specimen. Measuring time was set for 120 seconds at the start of the test and the computer software automatically stopped the test after 120 seconds and calculated all the indices. The samples were tested at R.H 65% $\pm$ 2 % and temperature 21^{o}C $\pm$ 1^{o} C. A minimum of 5 readings were taken and the data was recorded by calculating the mean.

The grades for the overall moisture management capability test are given in Table 1:

Table-1
Grades for Moisture Management Capability

GRADES FOR MOISTURE MANAGEMENT CAPABILITY		
FROM	**TO**	**RESULT**
0	*0.2*	*Very Poor*
0.2	*0.4*	*Poor*
0.4	*0.6*	*Good*
0.6	*0.8*	*Very Good*
> 0.8		*Excellence*

NOMENCLATURE

The following Table 2 shows the nomenclature used for the study while testing the comfort properties.

Table-2
Nomenclature

Sr. No.	Nomenclature	T-shirt material
1.	CC	Conventional cotton T-shirt
2.	OC	Organic cotton T-shirt
3.	CC(TL)	Conventional cotton T-shirt Top Layer
4.	CC(BL)	Conventional cotton T-shirt Bottom Layer
5.	OC(TL)	Organic cotton T-shirt Top Layer
6.	OC(BL)	Organic cotton T-shirt Bottom Layer

RESULTS AND DISCUSSIONS

The results and discussions for evaluating the comfort properties of Single Jersey Conventional and Organic Cotton T-shirts are given below.

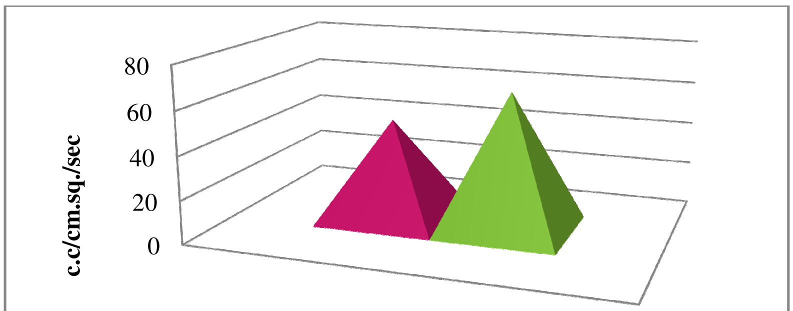
I. Air permeability: The following Table 3 and Figure A indicate air permeability of the T-shirt samples.

Table 3
Air Permeability

Variable	CC	OC	T value
Air Permeability	46.6±1.09	63.7±0.14	22.099**

Values are mean ± SD of five samples in each group
** - Significant at 1% level

Figure A: Air Permeability (cc/cm.sq./sec.)



	Air Permeability in c.c/cm. sq./sec.
CC	46.6
OC	63.7

Table 3 and Figure A showed the air permeability for CC and OC samples. The air permeability for CC was less than that of OC samples. CC recorded the air permeability of 46.6 c.c/cm.sq/sec. whereas OC samples recorded air permeability of 63.7 c.c/cm.sq/sec. According to the T-value of the two samples compared, there was a significant difference in the air permeability of CC and OC samples.

II. Moisture management: The moisture management tests were carried out under the headings wetting time, absorption rate, maximum wetted radius, spreading speed, one way transport index and overall moisture management capability.

1) Wetting time: The following Table 4 and Figure B indicate wetting time of the T-shirt samples.

Table 4
Wetting Time

Variable	CC	OC	T value
Top Layer	2.99±0.11	3.14±0.10	1.6681 [ns]
Bottom Layer	2.99±0.25	3.27±0.08	1.518 [ns]

Values are mean ± SD of five samples in each group
ns – Not Significant

Figure B: Wetting Time in Seconds

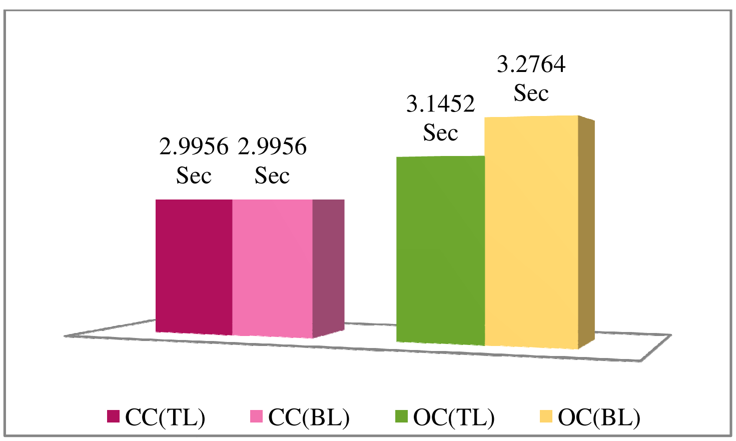


Table 4 and Figure B showed the wetting time in seconds for both CC and OC samples. The wetting time for CC was less for both top and bottom layers than OC. The wetting time recorded for CC(TL) was 2.9956 seconds and the same was observed for CC(BL). Whereas, the wetting time of OC(TL) was 3.1452 seconds and 3.2764 seconds OC(BL). According to the T-value of the two samples compared, there was no significant difference in the wetting time of CC and OC samples on both top and bottom layers.

2) Absorption rate: The following Table 5 and Figure C indicate the absorption rate of the T-shirt samples.

Table 5
Absorption Rate

Variable	CC	OC	T value
Top Layer	33.03±0.14	28.56±0.37	16.14**
Bottom Layer	57.62±0.30	61.83±0.37	12.458**

Values are mean ± SD of five samples in each group
** - Significant at 1% level

Figure C: Absorption Rate in Percentage per Second

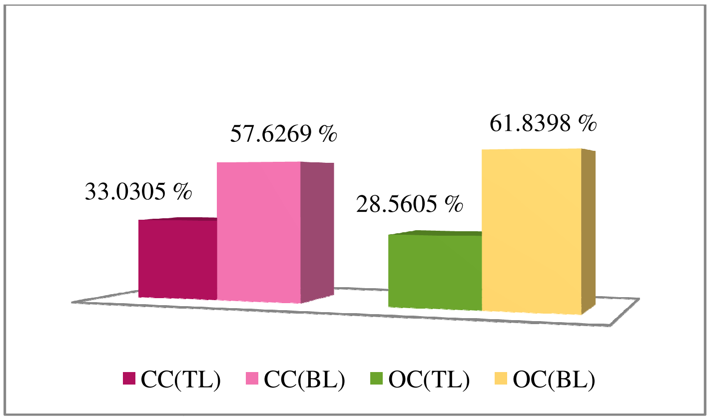


Table 5 and Figure C showed the liquid absorption rate percentage for CC and OC samples. It was observed that the percentage absorption of liquid per second for CC(TL) was higher than that for OC(TL). CC(TL) recorded absorption at 33.0305% per sec whereas OC(TL) recorded 28.5605% per sec. CC(BL) observed absorption at 57.6269% per sec whereas OC(BL) recorded at 61.8394% per sec. According to the T-value of the two samples compared, there was a significant difference in absorption rate of CC and OC samples on both top and bottom layers.

3) Maximum wetted radius: The following Table 6 and Figure D indicate the maximum wetted radius of the T-shirt samples.

Table 6
Maximum Wetted Radius

Variable	CC	OC	T value
Top Layer	23±0.19	20±0.25	13.44**
Bottom Layer	25±0.37	20±0.11	18.41**

Values are mean ± SD of five samples in each group
** - Significant at 1% level

Figure D: Maximum Wetted Radius (mm)

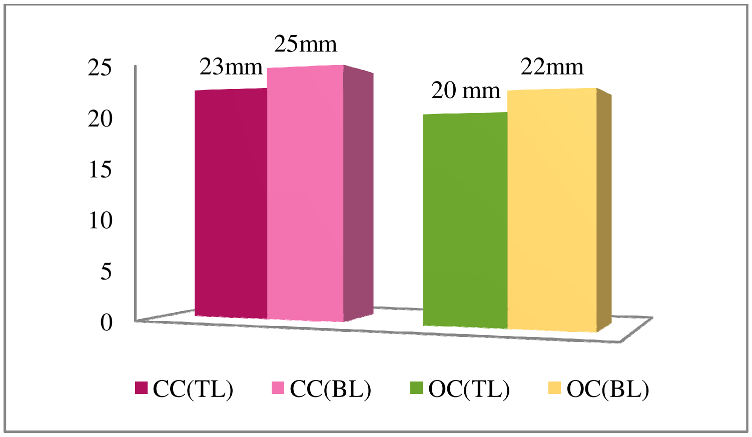


Table 6 and Figure D showed the maximum wetted radius of CC and OC samples. The maximum wetted radius for CC was observed to be more in both top and bottom layers than for OC. The maximum wetted radius for CC(TL) was 23mm and for OC(TL) was 20mm. The maximum wetted radius for CC(BL) was 25mm and that for OC(BL) was 22mm. The T-values show a significant difference in the maximum wetted radius of CC and OC samples on both top and bottom layers.

4) **Spreading speed:** The following Table 7 and Figure E indicate the spreading speed of the T-shirt samples.

Table 7
Spreading Speed

Variable	CC	OC	T value
Top Layer	4.35±0.04	3.98±0.07	7.715**
Bottom Layer	4.45±0.08	3.94±0.06	7.229**

Values are mean ± SD of five samples in each group
** - Significant at 1% level

Figure E: Spreading Speed (mm/sec)

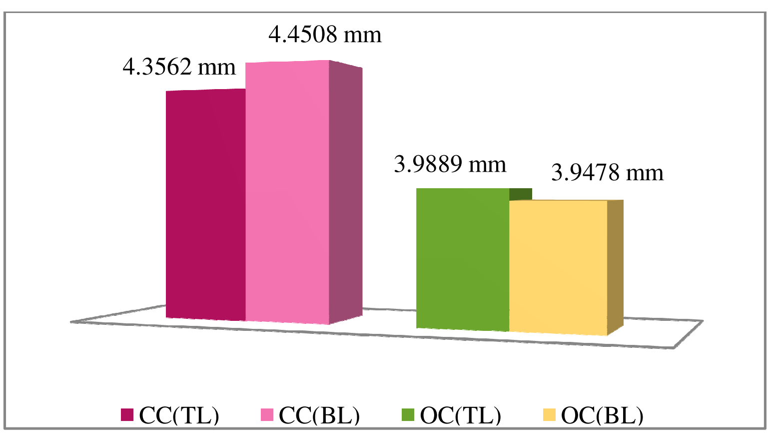


Table 7 and Figure E showed the spreading speed in mm/sec for CC and OC samples. The spreading speed was faster for CC samples than for OC on both top and bottom layers. The spreading speed for CC(TL) was 4.3562 mm/sec whereas for OC(TL) it was 3.9889 mm/sec. The spreading speed for CC(BL) was 4.4508 mm/sec and that for OC(BL) was 3.9478 mm/sec. The T-values show a significant difference in the spreading speed of CC and OC samples on both top and bottom layers.

5) **One-way transport index:** The following Table 8 and Figure F indicate the one-way transport index of the T-shirt samples.

Table 8
One-Way Transport Index

Variable	CC	OC	T value
Top Layer	260.89±4.95	427.26±4.70	34.506**
Bottom Layer	260.89±4.95	427.26±4.70	34.506**

Values are mean ± SD of five samples in each group
** - Significant at 1% level

Figure F: One-way Transport Index Percentage

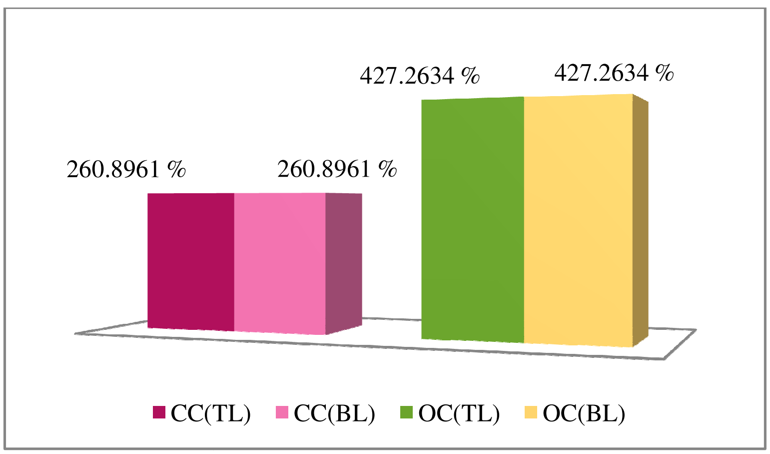


Table 8 and Figure F showed the one-way transport index percentage for CC and OC samples. The percentage of one-way transport index for CC was observed less than that for OC in both top and bottom layers. The One-way transport index percentage for CC(TL) was 260.8961% whereas for OC(TL) it was 427.2634%. The one-way transport index for CC(BL) and OC(BL) was same as that for top layer as 260.8961% and 427.2634% respectively. According to the T-value there was a significant difference in the one-way transport index percentage of CC and OC samples on both top and bottom layers.

6) **Overall moisture management capability:** The following Table 9 and Figure G indicate the one-way transport index of the T-shirt samples.

Table 9

Moisture Management Capability

Variable	CC	OC	T value
Top Layer	0.72±0.04	0.87±0.05	3.8765**
Bottom Layer	0.72±0.04	0.87±0.05	3.8765**

Values are mean ± SD of five samples in each group
** - Significant at 1% level

Figure G: Moisture Management Capability

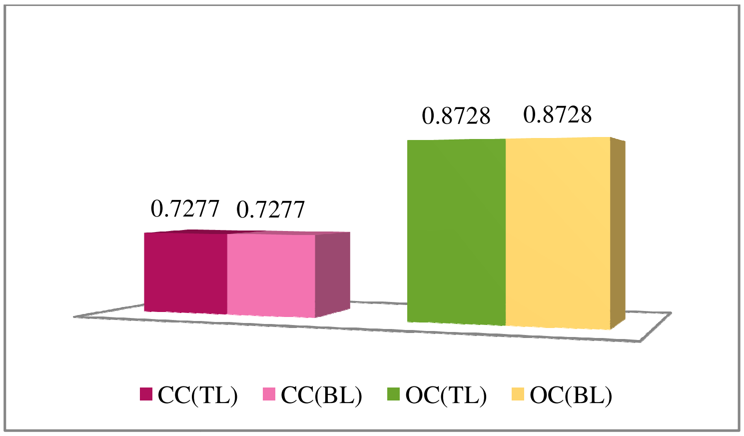


Table 9 and Figure G showed the overall moisture management capability of CC and OC samples. The results of CC show lower overall moisture management capability than OC samples. CC(TL) recorded 0.7277 and OC(TL) recorded 0.8728 overall moisture management capability. The same figures were recorded for the bottom layers. The overall moisture management capability for CC(BL) was 0.7277 and for OC(BL) was 0.8728. According to the T-value of the two samples compared, there was a significant difference in the overall moisture management capability of CC and OC samples on both top and bottom layers.

CONCLUSION

The comfort properties of a garment are of great importance to the wearer. Air permeability and moisture management are some of the important textile attributes to judge the comfort properties of a garment. The study compared conventional and organic cotton, knitted T-shirts with exactly same attributes like size, colour, weight, count and construction. Even though both the T-shirts were made using 100% cotton yarns, 150 GSM, 30's count and same knitting construction, the statistical analysis revealed that there was a remarkable difference in their comfort properties. Organic cotton showed better air permeability and moisture management capability than conventional cotton T-shirts.

REFERENCES

1. Kadolph, Sara, J. (2014) Textile fabrics and their properties; Knitting and Knit Fabrics, *Textiles,* Pp. 25-67 and Pp. 311-335.

2. Power, J. (2008) Developments in Apparel Knitting Technology, *Advances in Apparel Production*, Woodhead Publishing Limited, 9, 178-196.

3. Ucar, N. and Yilmaz, T. (2004) Thermal properties of 1 x 1, 2x 2, 3 x 3 rib knit fabrics, *Fibres and Textile in Eastern Europe*, 12, Pp. 34-38.

4. Mielicka, E. (2011) Types and suitability of yarns for knitting, *Advances in knitting Technology,* Woodhead Publishing Limited*,* 1, Pp. 3-36.

5. Nimkar, U.M. (2006) Quality challenges for the garment export industry, *Journal of the Textile Association*, Vol. 96, No. 4, Pp. 169.

6. Connell, Kim Y. Hiller (2015) Environmental impacts on apparel production, distribution and consumption: An overview, *Handbook of Sustainable Apparel Production,* CRC Press, 8, Pp. 167-180.

7. Sangeetha, K., Abirami, T., Keerthana Sri, A. (2017) Eco-friendly technology options available for textile industry, *Sustainability in fashion and apparels, challenges and solutions,* 24, Pp. 199-209.

8. Ramasamy, Karthikeyan M. and Sahu Omprakash (2013) *Organic Cotton Vs Regular Cotton: A Comparative Study of Characteristics of Organic Cotton with Regular Cotton*, LAP LAMBERT Academic Publishing.

9. Kothari, V.K. (2006) Indian Journal of Fiber Textile Research, 31 (2006) 177.

10. Vadicherla, Thilak and Saravanan, D. (2015) Eco-Design/ Sustainable design of Textile Products, *Handbook of Sustainable Apparel Production,* 22, Pp. 475-499.