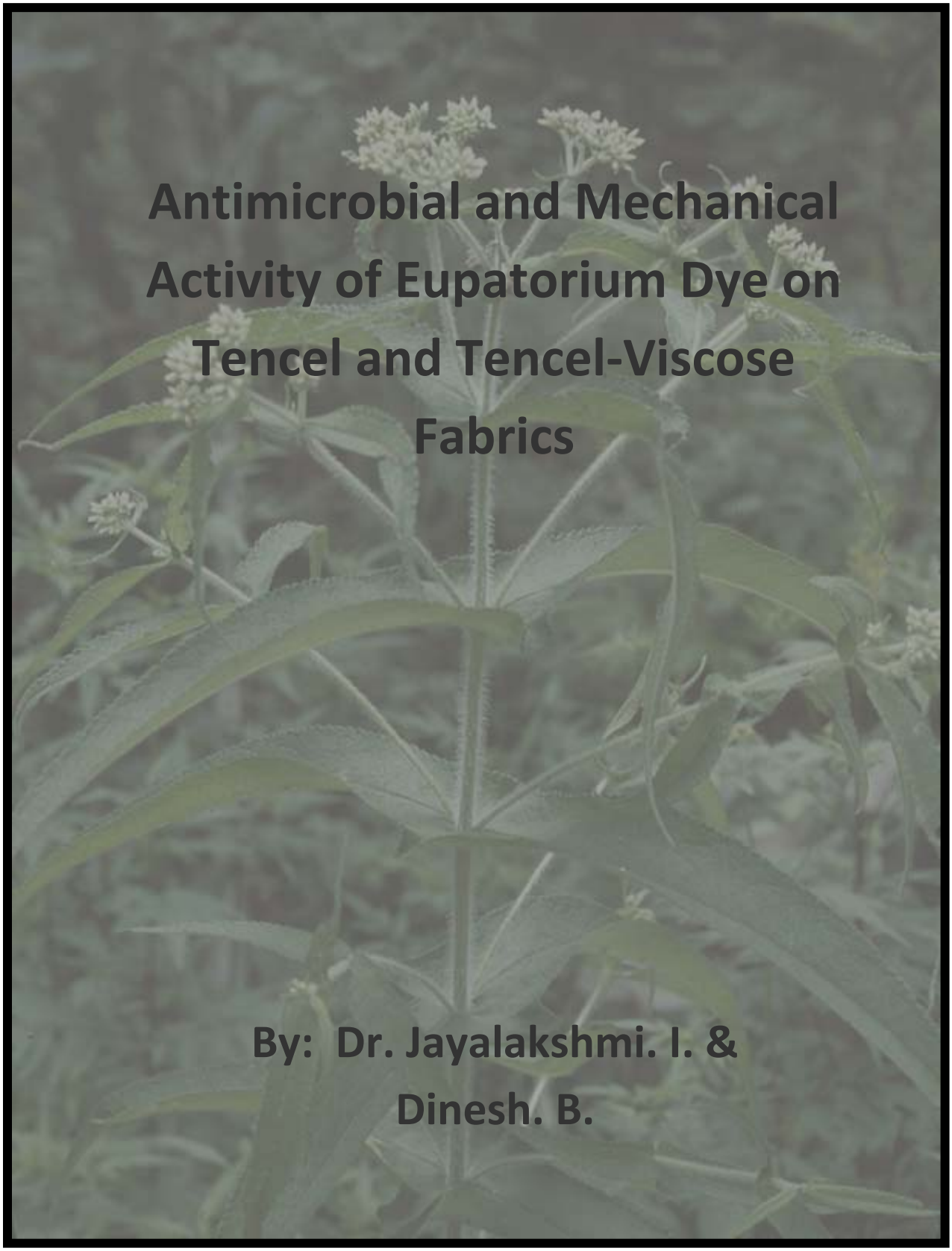

Antimicrobial and Mechanical Activity of Eupatorium Dye on Tencel and Tencel-Viscose Fabrics

By: Dr. Jayalakshmi. I. &
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Abstract

The Tencel and Tencel-Viscose fabrics was dyed with the selected Eupatorium natural dye with different types of mordants and analysed for its mechanical property and antimicrobial activity present which exhibited good results. The antimicrobial activity in the eupatorium dyed Tencel and Tencel-Viscose fabrics are found to control micro-organisms and deterioration in textile material. Effective levels such as this technology have sustained textile for future.

Environmental issues are becoming more crucial all over the world. Natural dyes, due to their ecofriendly nature serve a superior value to textile material and apparel, because of their bio-degradable nature which are safe to flora, fauna, ecology and to our skin. The application of natural dyes on the cellulosic fibers of tencel and viscose are technical activities to bring researches more sensory and provokable. Eupatorium known as Nilgiri Kohzla which belong to the Family - *Asteraceae* , the stems are about 50cm tall, pubescent, herbaceous, typically single, forming colonies with creeping rhizomes, green to red. The flowering of the plant is between July - October. The habitat of the plant is moist ground, low woods, stream banks, ditches, base of bluffs. The main origin of the plant is U.S. This little species can be found mainly in the southern half of Missouri but it also occurs in a few countries such as India, China, Sri Lanka etc. The plant greatly resembles another commonly cultivated genus *Ageratum* plant. Thus a diverse transaction from the basic usage of cotton to the new developed fibers/yarns play a considerable challenge from initial processing such as scouring to the wet processing stages in textiles. The sensory perception on the skin plays an important role for the overall feel factors. This plays a special significance for persons with sensitive skin. The diverse requirements are thus solved by the up growth of cellulosic fabrics such as Viscose and Tencel. The cellulosic fibers such as the Tencel consist of a nano fibril cellulosic structure which makes it a superior cellulose since its origin.

Finishing is the treatment of fabrics that produces finished textile goods. Finishing is one necessary aspect that gains good appearance and feel of the garment. Functional finishes are non toxic and free in nature. The Antimicrobial finish controls the growth of odour causing bacteria arising in everyday use of apparel and home textiles. Antimicrobial treatments is necessary for textile materials in order to control microorganism ,to reduce odour from perspiration, to reduce the risk of cross infection being carried by feet, to control spread of diseases and deterioration of textile fabrics. Effective levels of this technology do not leach or diminish over time. When applied, the technology actually

polymerizes with the substrate making the surface free from anti microbes. These types of antimicrobial technology used in textiles that are likely to have human contact or where durability is of value suggest *D.Gopalakrishnan (2006).*

Methodology

Selection of Fabrics

Tencel and Tencel-Viscose of 40's count yarn was selected to knit the single jersey structure. In the Tencel-Viscose knitted fabric, Viscose was used for the wales and Tencel for the course thus forming single jersey structure

Eupatorium plant

Selection of Natural Dye

Eupatorium natural dye was selected to dye Tencel and Tencel-Viscose knit fabrics for the study.

Selection of Mordent

The investigator selected Myrobalon – 5% , Alum – 20%, Copper Sulphate- 5% ,Ferrous Sulphate- 4% as mordants for the study.

Pre-treatment of Knit Fabric

The selected Tencel and Tencel-Viscose Knit fabrics were scoured before dyeing following the receipe as shown in Table A . The 20 liters of water was taken in a large vessel in which 100 gms of soda ash, 50 gms of non detergent washing soap,20 gms of caustic soda were added and stirred well, until all the contents were dissolved. This mixture was boiled for 10 minutes under 70-80◦C. The Tencel or Tencel-Viscose fabric samples were steeped into the mixture and continuous stirring was given for 2 hrs, and then prepared for the dyeing process.

Table A: Recipe for Scouring

Parameters	Proportions
Knitted Fabric (Tencel or Tencel-Viscose)	1 kg
Soda ash	100 gms
Washing Soap (Non detergent soap)	50 gms
Caustic soda(optional)	20 gms
Water	20 lts
M:L	1:20

Pre-treatment before Dyeing

The scoured fabrics were given a pre-treatment either with alum or myrobalon before dyeing. 200 gms of alum was mixed with 20 liters of water in a M:L ratio of 1:20 . 1kg of the knitted fabric was steeped into this solution for 1hr. Later the fabric was taken out and kept ready for the mordanting process.

Dyeing

The dyeing for the knit Tencel and Tencel-Viscose fabrics was carried using the parameters of dyeing shown in Table B.

Table B: Parameters of Dyeing

Parameters	Proportions
Knitted material (Tencel or Tencel-Viscose)	1kg
Mordanting	
Alum Water Time Temperature M:L	20per cent, 200gms 20 liters 1hr 80-90◦C 1:20
Copper sulphate Water Time Temperature M:L	5per cent, 50gms 20 liters 1 hr 90-80◦C 1:20
Ferrous sulphate Water Time Temperature M:L	4per cent, 40gms 20 liters 1 hr 90-100◦C 1:20
Myrobalon Water Time Temperature M:L	5per cent, 50gms 20 liters 1hr 80-90◦C 1:20

Dye Preparation	
Eupatorium Plant Turmeric Washing Soda Water Time Temperature M:L	2 kg 50gms 10gms 20 liters 1hr 100◦C 1:20
Dyeing	
Knitted Fabric (Tencel or Tencel-Viscose) Dye solution Time Temperature M:L	1 kg 15 liters 1/2 hr 60-70◦C 1:20
After Treatment	
Soap solution Water Time Temperature M:L	50gms 20 liters 15min normal 1:20

Preparation of Natural dye

The 2 kgs of Eupatorium plant was taken in a vessel with 20 liters of water, to which 10 gms of washing soda, 50 gms of Turmeric was added and boiled at 100◦c for 1 hour until a fine visky semi liquid substance was formed. The solution was stirred occasionally and then kept for dyeing.

Mordanting

The recommended individual percent of mordant was taken when required and added with the dye and mixed well with 20 liters of water. This mixture was heated at 80-90◦c for 1-11/2 hrs. The 1kg of pre-treated Tencel or Tencel-Viscose knit fabric was taken and was steeped into the prepared mordant solution, thus mordanting the fabric.

Dyeing process

The mordanted knit samples were taken and into the dye bath prepared and boiled for half an hour maintaining a temperature of 60-70◦c. this mixture was stirred continuously so that fixation of dye was evenly obtained. After the desired time the fabric was taken out, rinsed thoroughly in plain water and dried in shade.

After Treatment

After twenty four hrs of drying, the dyed knit fabrics were washed with 50 gms of soap solution, rinsed and dried in the shade.

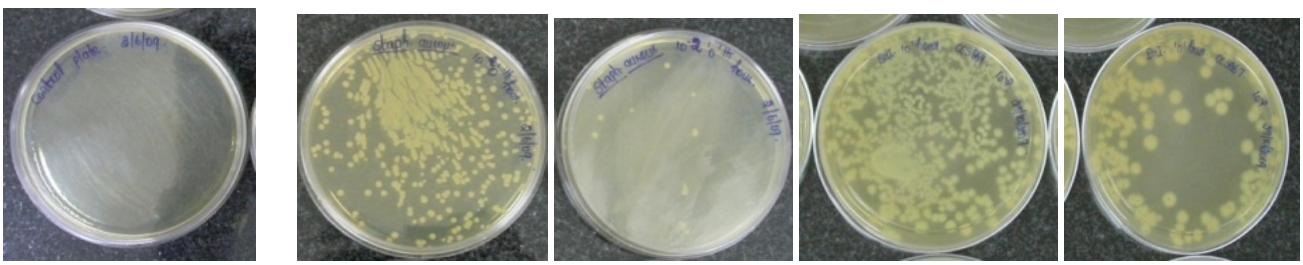
After Dyeing four samples from Tencel (TO) such as Eupatorium+ Myrobalon - TEM, Eupatorium+ Alum- TEA, Eupatorium+ Ferrous sulphate- TEF, Eupatorium+ Copper sulphate- TEC and four samples from Tencel-Viscose TVO such as Eupatorium+ Myrobalon- TVEM, sEupatorium+ Alum- TVEA, Eupatorium+ Ferrous sulphate- TVEF,Eupatorium+ Copper sulphate- TVEC ,a total of eight samples were obtained. These natural dyed samples were cut into small pieces and stuck on a paper and kept for visual evaluation. The evaluation was carried out amongst fifty adolescent boys and girls for good colour and general appearance.

Mechanical Tests

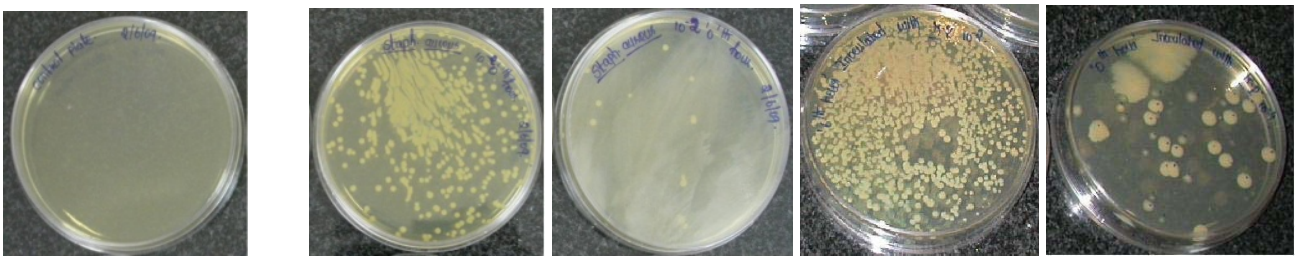
The Mechanical tests such as Course per inch, Wales per inch, Lengthwise and Widthwise shrinkage percent, Fabric GSM, Loop Length, Spirality Percent, Bursting Strength and Drape Co-efficient for the ten consecutive samples from TO, TEM, TEA, TEF, TEC, TVO, TVEM, TVEA, TVEF and TVEC were taken, tested and results analysed statistically.

Percent of Bacterial Reduction Test - Quantitative Assessment Method

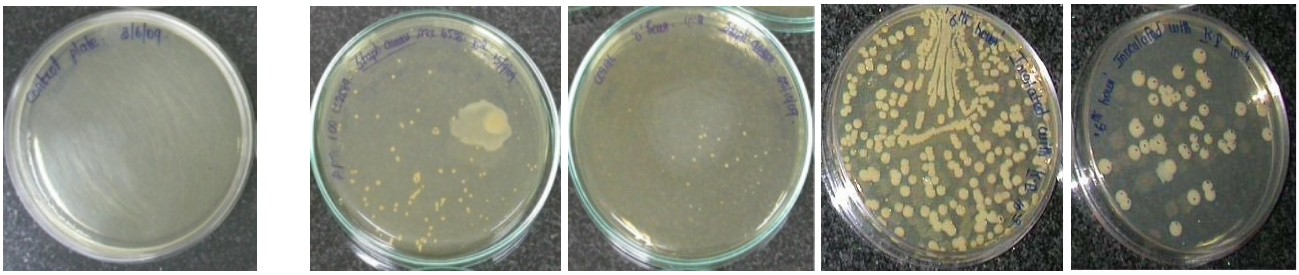
This test method provides a quantitative procedure for the evaluation of the degree of antibacterial activity on textile materials, following AATCC TM100-2004.The inoculation of the fabric was done using the Staphylococcus aureus bacteria and Klebsiella Pneumoniae bacteria. The bacteria is shaken well and kept still for 15-20 mins before the inoculation Fabric swatches are placed in sterile petri dishes and inoculated using micraliter pipette so that the inoculums are distributed evenly. After inoculation, 100 ml of neutralizing solution is added and shook well for one minute after which it is diluted with water. The swatches are incubated for 16 hours and then analyzed with the untreated swatches to find the counts per sample in bacterial reduction. The percent reduction proves the antimicrobial activity rate and results. The consecutive eight dyed samples from TEM (Plate 6), TEA, TEF, TEC (Plate 7), TVEM (Plate 8), TVEA, TVEF and TVEC (Plate 9) were taken, tested for antimicrobial activity and results recorded. The subjected Tencel and Tencel-Viscose knit fabrics were tested with the Staphylococcus aureus (ATCC 6538) for gram positive bacteria and Klebsiella Pneumoniae (ATCC 4352) for gram negative bacteria.



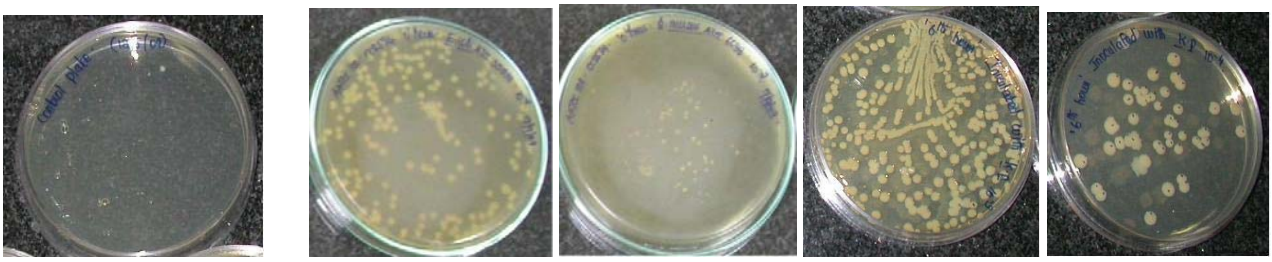
TEM (Plate 6) Before After Before After



TEC (Plate 7) Before After Before After



TVEM (Plate 8) Before After Before After



TVEC (Plate 9) Before After Before After

Control plate	Staphylococcus aureus	Klebsiella Pneumonia
	Gram '+' ev bacteria	Gram '-' ev bacteria

Per cent of Bacterial Reduction Test

Wear Study

TEM and TVEM ,which were selected as best amongst the eight dyed Tencel and Tencel-Viscose samples were constructed into a T-Shirt and given to a girl of age group 9-10 years to wear for a period of 30 days and was subjected to washing. The opinion regarding comfort, irritation to the skin, colour changes, brilliancy in colour was collected and recorded.

Results and Discussion

The results of Mechanical tests such as Course per inch, Wales per inch, Lengthwise and Widthwise shrinkage percent, Fabric GSM, Loop Length, Spirality Percent, Bursting Strength and Drape Co-efficient were tested and are shown below with their respective Tables.

From Table I a, the course per inch for all the samples show an increase in their mean when compared with their respective original means. T_{EF} sample had a maximum gain of 12.04 percent where as T_{EM} had the minimum gain of 3.65 percent respectively when compared between tencel dyed samples. Similar, TV_{EM} had a maximum gain if 19.26 percent where as TV_{EM} had the minimum gain of 13.70 percent when compared between Tencel-Viscose dyed sample. The statistical 't' test analysis for course per inch proved that most of the knit Tencel and Tencel-Viscose samples were significant at one percent level. When two way anova was compared in Table I b between dyed Tencel and Tencel-Viscose samples, TEA had the highest course per inch, and TVEM had the least course per.

From Table II a, the Wales per Inch (WPI) mechanical test showed that,all the dyed knit sample of Tencel and Tencel-Viscose showed an decreased in their mean when compared with their respective original means. T_{EM} sample had a maximum gain of 0.21 percent respectively when compared between Tencel dyed samples, TV_{EM} had a maximum loss of 8.19 percent and TV_{EF} had the minimum loss of 4.20per cent when compared between Viscose- Tencel dyed samples. The statistical 't' analysis for wales per inch was proved that most of the knit Tencel and Tencel-Viscose sample in the course per inch test were significant at one percent level. When two way anova was compared in Table II b between dyed Tencel and Tencel-Viscose samples, TEM had the highest wales per inch followed by TEF ,whereas TVEM had the least wales per inch.

From Table lll a, the Lengthwise Shrinkage percent showed that, all the dyed knit sample of Tencel showed a decrease in their mean when compared with their respective original means where as the dyed knit samples of Tencel-Viscose showed an increase in their mean when compared with its respective. T_{EA} sample had a maximum loss of 14.93 percent where as T_{EM} had the minimum loss of 7.71 percent respectively. TV_{EM} had a maximum gain of 5.46per cent where as TV_{EC} had the minimum gain of 2.20per cent when compared between Viscose- Tencel dyed samples. The statistical 't' analysis for Lengthwise Shrinkage Percent clearly indicated that most of the knit Tencel and Tencel-Viscose samples were significant at one percent level. When two way anova was compared in Table III b between dyed Tencel and Tencel-Viscose samples, TEA had the highest lengthwise shrinkage followed by TVEF and the least shrinkage in lengthwise was seen in TEF.

From the above Table lV a, the Widthwise Shrinkage percent shows that, all the dyed knit sample of Tencel and most of the Tencel-Viscose knit samples decreased in their mean when compared with their respective original means, whereas TVEM increased in its mean when compared. T_{EM} sample had a maximum loss of 15.67 percent and T_{EA} had a minimum loss of 9.74 percent respectively when compared between Tencel dyed samples, whereas, TV_{EM} had a maximum gain of 0.33per cent. The statistical 't' analysis for

Widthwise Shrinkage Percent was proved that most of the knit Tencel and Tencel-Viscose sample were significant at one percent level. When two way anova was compared in Table VI b between dyed Tencel and Tencel-Viscose samples, TEA had the highest widthwise shrinkage percent and TVEM had the least widthwise shrinkage percent .

From Table V a, the fabric GSM denoted that, all the dyed knit sample of Tencel and Tencel-Viscose showed an increase in their mean when compared with their respective original means.T_{EM} sample had a maximum gain of 11.28 percent followed by T_{EF} of 11.05 percent respectively when compared between Tencel dyed samples, Similarly, TV_{EM} had a maximum gain of 83.67 percent followed by TV_{EM} which had 87.19 percent when compared between Viscose- Tencel dyed samples. The statistical 't' analysis for fabric GSM proved that most of the knit Tencel and Tencel-Viscose samples were significant at one percent level. When two way anova was compared in Table V b between dyed Tencel and Tencel-Viscose samples, TVEA had the highest GSM followed by TVEF and the lowest GSM was noted in TEM.

From Table Vl a, the fabric Loop length was found that, all the dyed knit sample of Tencel and Tencel-Viscose showed an decrease in their mean when compared with their respective original means. T_{EM} sample had a maximum loss of 25.80 percent followed by 24.57 percent T_{EA} sample when compared between Tencel dyed samples. Similarly, TV_{EM} had a maximum loss of 22.50 percent followed by TV_{EC} of 21.58 percent when compared between Viscose- Tencel dyed samples. The statistical 't' analysis for loop length proved that most of the knit Tencel and Tencel-Viscose samples were significant at one percent level. When two way anova was compared in Table VI b between dyed Tencel and Tencel-Viscose samples, TVEA had the highest loop length followed by TVEF and the least loop length was seen in TEM.

From Table Vll a, the Spirality percent of all the dyed knit sample of Tencel and Tencel-Viscose showed a decrease in their mean when compared with their respective original means.T_{EC} sample had a maximum loss of 7.54 percent followed by T_{EF} of 5.05 percent when compared between Tencel dyed samples. Similarly, TV_{EF} had a maximum loss of 6.19 percent followed by TV_{EA} of 4.50 percent when compared between Viscose- Tencel dyed samples. The statistical 't' analysis for Spirality percent proved that most of the knit Tencel and Tencel-Viscose samples were significant at one percent level. When two way anova was compared in VII b between dyed Tencel and Tencel-Viscose samples, TEM sample had the highest spirality percent followed by TEA, whereas TVEC sample had the least spirality percent.

From Table Vlll a, the bursting strength all the dyed knit sample of Tencel and Tencel-Viscose showed a decrease in their mean when compared with their respective original means. T_{EF} sample had a maximum loss of 30.90per cent where as TV_{EA} had the minimum loss of 23.94 percent when compared between Tencel and Viscose- Tencel dyed samples. The statistical 't' analysis for bursting strength proved that most of the knit Tencel and Tencel-Viscose samples were significant at one percent level. When two way anova was compared in Table VIII b between dyed Tencel and Tencel-Viscose samples,

TEF had the highest bursting strength followed by TEC, whereas TVEC had the least bursting strength.

From Table lX a , the Drapability of all the dyed knit sample of Tencel and Tencel-Viscose showed an increase in their mean when compared with their respective original means.T_{EF} sample had a maximum gain of 6.11 percent and TV_{EC} had the maximum gain of 1.72 percent respectively when compared between Tencel dyed samples when compared between Tencel and Tencel-Viscose dyed samples.The statistical 't' analysis for drape co-efficient proved that most of the knit Tencel and Tencel-Viscose samples were significant at one percent level. When two way anova was compared in Table IX b between dyed Tencel and Tencel-Viscose samples,TEM had the highest drapability. whereas TVEF had the least drapability.

Table I A: Course Per Inch (CPI)

Samples	Mean	% Loss or gain over original	't' value	
			General	Paired
T_0	27.4			
T_{EF}	30.7	12.04	10.738**	11.000**
T_{EC}	28.7	4.74	2.3958*	2.3265*
T_{EA}	30.2	10.22	8.4000**	7.7992**
T_{BM}	28.4	3.65	1.3580 ^{NS}	1.2048 ^{NS}
TV_0	27			
TV_{EF}	31.3	15.93	12.8360**	10.8638**
TV_{EC}	32.2	19.26	8.5105**	6.7382**
TV_{EA}	31.8	17.78	10.2857**	12.3479
TV_{BM}	30.7	13.7	5.6867**	5.6867**

Table II A: Wales Per Inch (WPI)

Samples	Mean	% Loss or gain over original	't' value	
			General	Paired
T_0	47.6			
T_{EF}	46.3	-2.73	4.8374**	4.9934**
T_{EC}	45.6	-4.2	7.2761**	9.4868**
T_{EA}	47.4	-0.42	0.8660 ^{NS}	0.68 ^{NS}
T_{BM}	47.7	0.21	0.37 ^{NS}	0.55 ^{NS}
TV_0	45.2			
TV_{EF}	43.3	-4.2	5.2697**	5.4596**
TV_{EC}	41.9	-7.3	8.8548**	9.8509**
TV_{EA}	41.7	-7.74	8.9708**	8.7198**
TV_{BM}	41.5	-8.19	6.1954**	5.2857**

Table IIIA: Shrinkage Percent-Lengthwise

Samples	Mean	% Loss or gain over original	't' value	
			General	Paired
T_0	24.11			
T_{EF}	20.82	-13.65	10.4592**	11.2413**
T_{EC}	21.56	-10.58	8.6770**	7.7336**
T_{EA}	20.51	-14.93	10.7368**	10.9208**
T_{BM}	22.25	-7.71	5.7943**	5.6470**
TV_0	22.7			
TV_{EF}	23.7	4.41	3.0460**	3.4549**
TV_{EC}	23.2	2.2	1.3449 ^{NS}	1.4569 ^{NS}
TV_{EA}	23.5	3.52	2.4293*	2.2419 ^{NS}
TV_{BM}	23.94	5.46	4.2382**	3.916**

Table IVA: Shrinkage Percent-Widthwise

Samples	Mean	% Loss or gain over original	't' value	
			General	Paired
T_0	19.91			
T_{EF}	17.04	-14.41	5.359**	5.3458**
T_{EC}	17.74	-10.9	4.0535**	4.0234**
T_{EA}	17.97	-9.74	3.4837**	4.0804**
T_{BM}	16.79	-15.67	5.8028**	5.3811**
TV_0	21.28			
TV_{EF}	19.75	-7.19	4.4877**	4.2763**
TV_{EC}	20.87	-1.93	1.1432NS	0.9253NS
TV_{EA}	20.89	-1.83	1.1163NS	1.1041NS
TV_{BM}	21.35	0.33	0.1919NS	0.1755NS

Table V A: Fabric GSM

Samples	Mean	% Loss or gain over original	't' value	
			General	Paired
T_0	0.86			
T_{EF}	0.955	11.05	9.0809**	8.2102**
T_{EC}	0.94	9.3	9.7980**	13.4164**
T_{EA}	0.923	7.33	7.0387**	6.5172**
T_{BM}	0.957	11.28	11.4938**	13.8571**
TV_0	0.937			
TV_{EF}	1.721	83.67	28.0517**	33.8636**
TV_{EC}	1.62	72.89	78.5179**	107.8421**
TV_{EA}	1.705	81.96	109.0976**	96.0000**
TV_{BM}	1.754	87.19	131.9574**	157.8828**

Table VI A: LOOP Length

Samples	Mean	% Loss or gain over original	't' value	
			General	Paired
T_0	9.69			
T_{EF}	7.29	-24.77	66.28140**	65.72670*
T_{EC}	7.52	-22.39	58.22720**	51.3060**
T_{EA}	7.28	-24.87	50.49650**	50.0110**
T_{BM}	7.19	-25.8	40.79460**	40.6745**
TV_0	10.52			
TV_{EF}	8.87	-15.68	56.41050**	48.3071**
TV_{EC}	8.25	-21.58	75.66670**	75.6667**
TV_{EA}	8.47	-19.49	52.5430**	45.2157**
TV_{BM}	8.2	-22.05	55.7246**	79.8367**

Table VII A: Spirality Percent

Samples	Mean	% Loss or gain over original	't' value	
			General	Paired
T_0	28.5			
T_{EF}	27.06	-5.05	5.9656	5.8124
T_{EC}	26.35	-7.54	12.0926	11.4289
T_{EA}	27.35	-4.04	33.6686	26.8582
T_{BM}	27.44	-3.72	34.6966	31.1825
TV_0	27.14			
TV_{EF}	25.46	-6.19	12.5686	11.8269
TV_{EC}	26.53	-2.25	6.2222	8.8353
TV_{EA}	25.92	-4.5	6.7731	7.2112
TV_{BM}	26.26	-3.24	4.8459	4.8232

Table VIII A: Bursting Strenght

Samples	Mean	% Loss or gain over original	't' value	
			General	Paired
T_0	3.56			
T_{EF}	2.46	-30.9	20.1580**	22.2486**
T_{EC}	3	-15.73	11.2250**	9.6355**
T_{EA}	3.02	-15.17	7.9048**	14.5480**
T_{BM}	2.95	-17.13	14.0769**	11.5972**
TV_0	2.59			
TV_{EF}	2.24	-13.51	9.1047**	10.247**
TV_{EC}	1.87	-27.8	15.6703**	13.5000**
TV_{EA}	1.97	-23.94	8.2362**	8.7102**
TV_{BM}	2.38	-8.11	2.9865**	3.1942**

Table IX A: Drape Co-efficient

Samples	Mean	% Loss or gain over original	't' value	
			General	Paired
T_0	67.14			
T_{EF}	71.24	6.11	9.8328**	9.4281**
T_{EC}	68.64	2.23	2.3474*	2.4143*
T_{EA}	70.77	5.41	4.7435**	5.1450**
T_{EM}	70.98	5.72	7.8059**	12.2915**
TV_0	61.47			
TV_{EF}	62.53	1.72	1.5180^{NS}	1.2160^{NS}
TV_{EC}	59.81	-2.7	2.5118*	2.4666*
TV_{EA}	58.68	-4.54	4.5678**	4.0673**
TV_{EM}	62.22	1.22	1.2121^{NS}	1.1767^{NS}

Key:

- **** - Significant at One per cent level;**
- *** - Significant at Five per cent level;**
- **^{NS} - Not significant.**

Table IB

Two-way Anova - CPI	Mean	'F' value
Within dyed Tencel	30.5	55.1724**
Within dyed Viscose – Tencel	30.5	6.4598 NS
Between dyed Tencel + dyed Viscose – Tencel	30.5	5.1464 NS

Table IIB

Two-way Anova - CPI	Mean	'F' value
Within dyed Tencel	44.43	823.7143**
Within dyed Viscose – Tencel	44.43	8.1587 NS
Between dyed Tencel + dyed Viscose – Tencel	44.43	22.6349 *

Table IIIB

Two-way Anova - CPI	Mean	'F' value
Within dyed Tencel	22.46	8.1433 NS
Within dyed Viscose – Tencel	22.46	1.7628 NS
Between dyed Tencel + dyed Viscose – Tencel	22.46	42.2926**

Table IVB

Two-way Anova - CPI	Mean	'F' value
Within dyed Tencel	22.46	8.1433 NS
Within dyed Viscose – Tencel	22.46	1.7628 NS
Between dyed Tencel + dyed Viscose – Tencel	22.46	42.2926**

Table VB

Two-way Anova - CPI	Mean	'F' value
Within dyed Tencel	1.32	1833.7926**
Within dyed Viscose – Tencel	1.32	3.4268 NS
Between dyed Tencel + dyed Viscose – Tencel	1.32	2.1998 NS

Table VIB

Two-way Anova - CPI	Mean	'F' value
Within dyed Tencel	7.88	7013.8276 **
Within dyed Viscose – Tencel	7.88	136.4943 **
Between dyed Tencel + dyed Viscose – Tencel	7.88	174.9310 **

Table VIIB

Two-way Anova - CPI	Mean	'F' value
Within dyed Tencel	44.43	823.7143**
Within dyed Viscose – Tencel	44.43	8.1587 NS
Between dyed Tencel + dyed Viscose – Tencel	44.43	22.6349 *

Table VIIIB

Two-way Anova - CPI	Mean	'F' value
Within dyed Tencel	2.51	213.7742 **
Within dyed Viscose – Tencel	2.51	12.0789 *
Between dyed Tencel + dyed Viscose – Tencel	2.51	22.0824 *

Table IXB

Two-way Anova - CPI	Mean	'F' value
Within dyed Tencel	65.61	1005.5896 **
Within dyed Viscose – Tencel	65.61	19.3128 *
Between dyed Tencel + dyed Viscose – Tencel	65.61	7.5425 NS

To select the best dyed Tencel and Tencel-Viscose Dyed sample, one way Anova was followed and the results are shown in Table X.

From Table X, to analyse best dyed Tencel sample, TEA knit sample had the higher number of course per inch where as TEM knit sample had the higher number of Wales per inch. The lengthwise shrinkage percent was more in TEM sample where as the same sample showed least widthwise percent. The GSM of the Tencel knit fabric also increased for TEM. The performance of loop length was high in TEC followed by TEA, TEF and TEM. TEM sample also exhibited a good spirality percent. TEF dyed knit sample showed good resistance to bursting strength followed by TEC and TEM samples. The drape co-efficient of TEA was good followed by TEM dyed knit sample.

From Table X to analyse best dyed Tencel-Viscose sample, TVEC knit sample had the higher number of course per inch whereas TVEA knit sample had the higher number of Wales per inch. The TVEM sample showed good lengthwise and widthwise shrinkage percent. The GSM of the Tencel-Viscose knit fabric also increased for TVEM. The performance of loop length was high in TVEA followed by TVEF ,TVEC and TVEM. TVEM sample exhibited a good spirality percent and a good resistance to bursting strength. The drapability of TVEA was good followed by TVEM dyed knit sample.

Hence, it could be concluded that TEM and TVEM was selected as the best Tencel and Tencel-Viscose dyed knit sample. This shows that the mordant Myrobalon used as a natural mordant with Eupatorium natural dye exhibited excellent fabric properties in Tencel-Viscose also.

Table X

Selection of Best Dyed Tencel & Tencel-Viscose Dyed Sample

One-way Anova	Tencel sample		Tencel-Viscose sample	
	Mean	'F' value	Mean	'F' value
CPI	29.5	126.0000**	31.5	42.0000**
WPI	46.75	27.1429**	42.1	66.6667**
Lengthwise Shrinkage per cent	21.285	18.7334**	23.585	130543*
Widthwise Shrinkage per cent	17.385	99.6085**	1.7	126.6278**
Loop Length	0.9432	9.1230*	8.4475	195.9825**
Spirality Per Cent	7.32	9.2093*	26.0425	17.4308**
Bursting Strength	27.05	2440.667**	2.115	9.0461*
Drape co-efficient	2.8575	15.0459**	60.81	36.4577**

Key:

**** - Significant at one per cent level;**

*** - Significant at five per cent level;**

Summery

Tencel fabric is an amazing eco friendly fabric that represents a milestone in the development of environmentally sustainable textiles, made with wood pulp from sustainable tree farms, Tencel textiles are created through the use of nanotechnology in an award-winning closed-loop process that recovers or decomposes all solvents and emissions. Natural dyes are safer and more ecologically sound than synthetic dyes. They are less permanent, more difficult to apply and often involve the use of highly toxic mordants. Therefore its far time that the use of natural dyes prevails that our beloved nature survives for the future. The natural dye helps to create a demand for these products providing income and incentive for people to maintain practices of local sustainability, remaining close to family and tradition. It would be a prosperous living if we support the nature with each individuals contribution to make Textiles eco friendly.

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