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A Study on the characteristic improvement of property of *Terminalia chebula* (Myrobalan) on Cotton Fabric

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ABSTRACT

Now a days the importance for natural sources is eminent due to the increased awareness created due to most of the adverse effects of synthetic products. In this work, *Terminalia chebula* (Myrobalan), an important natural source is chosen as the main coloring (dye) ingredient and applied on cotton fabric. To enhance the coloring capacity, the natural sources such as *Indigofera tinctoria* (Indigo), *Rubia cordifolia* (Madder) and *Pterocarpus santalinus* (Red sandal wood) were combined with *Terminalia chebula*. To achieve the additional functional properties *Vitex negundo* (Nocchi), *Emblica officinalis* (Amla), *Aloe barbadensis* (Aloevera) and *Azadirachta indica* (Neem) were mixed with these combinations. The effect of these results were studied by colour fastness properties, antimicrobial assessment, K/S colour strength values, FTIR spectural analysis and the results obtained are convincible suitable for garments.

Keywords: Natural dye, application, antimicrobial, FTIR, K/S, colour fastness.

INTRODUCTION

Natural dyes have been used as a means of colouring textiles for centuries. For thousands of years stems, leaves, barks, woods, berries and flowers of various plants and trees as well as from certain insects and shell fish natural colours have been derived[1]. Before the sixteenth century, dyers were largely dependent on dyestuff, which could be grown in, or were indigenous to Europe and similar temperature regions[2]. There is a significant trend towards quality and longer lasting products. Another very significant and lasting trend in the market for textile in many countries is the increasing environment and health concerns of a fast growing number of consumers[3]. The world is becoming increasingly aware of environmental issues, such as Green House Effect, Ozone layer depletion, Water pollution and Waste disposal problems. In this trend, there is now an ever increasing lobby for using natural colouring matters for textile substrates both natural and synthetic[4,5]. The problems caused by pathogenic micro organism of bacteria, mold and fungi cause cross infection, lung related disease and degradation of textile substrates[6,7]. The environmental friendly natural dyes are enjoying resurgence in popularity as a result of concerns with the carcinogenic, mutagenic and sensitizing characteristics of synthetic dyes[8]. One example of a natural dye obtained from plants is madder, which is obtained from the roots of the madder plant. The plants are dug up, the roots washed and dried and ground into powder. During the nineteenth century, the most widely available fabrics were those which had been dyed with madder. The turkey red that was so popular at that time was based on madder. This red was considered brilliant and exotic. The madder plant continued to be used for dyeing until the mid 1800s when a synthetic substitute was developed[9]. Growing awareness about risk to health and damages to the environment has been noticed in the last few years and particularly in past two decades all over the world. This has necessitated eco friendly approaches in production of articles of day to day life. Environmental considerations are now becoming vital factors during the selection of consumer goods including textiles all over the world. India's textile industries have shown a remarkable dynamism in terms of growth and export performance of natural dyes[10]. In this study, hence few natural resources are taken to apply on the

maximum used textiles, cotton and to study the effects suitable for textiles and garments.

MATERIALS AND METHODS

Cotton fabric, natural sources, and chemicals

Textile cotton fabric of specification 1/1 plain weave, 60/50 ends and picks per inch respectively and 60s count was used for dyeing.

Natural sources selected for this study were terminalia chebula (major colouring source) and indigofera tinctoria, rubia cardifolia and pterocarpus santalinus (additional natural source).Vitex negundo, emblica officinalis, aloe barbadensis and azadirachta indica were used to impart functional properties on the coloured (dyed) fabric. These were procured from M/s.Mithun Natural Products, Madurai, (South India).

The chemicals used as dye fixing agents mentioned elsewhere in this study were of AR grade. Pure de-ionized water was used for dye extraction, application and for washing purposes.

Apparatus and Equipments

A laundrometer (Eureka, India) was used to asses the wash fastness property. Lamp Xenon Arc Lamp (Atlas,HSL) was used to asses light fastness and Crock meter (Eureka, India) was used to asses the rubbing fastness property of the natural dyed cotton fabric. Laminar set (Clean air, Japan) was used to assess the microbial and bacterial properties of the dyed samples. Datacolour SF 600 plus Spectrophotometer interfaced to a PC was used to measure the colour strength of original natural sources. FTIR Spectrophotometer (FTIR 8400's Shimadzu, Japan) was used to determine the dye adsorption capacity[11,12].

Extraction of natural sources

Natural dye solutions of major dyeing ingredients terminilia chebula; and supporting dyes indigofera tinctoria, rubia cardifolia, pterocarpus santalinus; and vitex negundo, emblica officinalis, aloe barbadensis and azadirachta indica were extracted by aqueous method as per the establishment technique mentioned earlier. Conventional extraction of the dyes were carried out with distilled water using varying amount of the dye material (10-15%) over the weight of the material and was carried out on different time intervals (20-60 min). Filtration was done after obtaining satisfactory optical density[13,14,15].

Application of extracted solutions on cotton fabric

The extracted natural dye solution was applied on conditioned cotton fabric.

Dyeing temperature for the application method with respect to the fabric varied from 45°-90°, depending upon the dye characteristics. The usage of natural dye supporting agents like sodium chloride, sodium carbonate and alum were treated by pre, post and simultaneous mordanting treatments and the best method recorded is according to the effective result obtained. The combination of terminilia chebula dye with indigofera tinctoria included all these supporting agents (sodium chloride, sodium carbonate and alum) and the rest of the combinations included sodium chloride and alum. Maximum usage of the dye supporting agents was set to 2.5% over the weight of the material. Material Liquor (M: L) ratio was maintained constantly 1:20 for all the dyeings and the number of dye bath for each dye application is one. The duration of dyeing varied from 60-90 min. Table (1) shows the application method of all the natural dye sources on cotton fabric.

The dyed samples were rinsed and washed in a bath of liquor ratio 1:50 using 2% of non-ionic detergent for 30 min, then rinsed and finally dried at ambient temperature.

Colour fastness assessment on dyed cotton fabric

The dyed samples were washed under condition IIIA of the AATCC Test Method 124-2001 to determine the colour change effect of dyed fabrics[10]. Light fastness tests were carried out according to AATCC Test Method 16 E-1998[10]. The samples were exposed to 5, 10 AFUs (AATCC Fading Unit) to determine the colour change. AATCC standardized crock meter was used to determine the rubbing fastness under wet and dry condition to asses the colour change and staining property[10].

Antimicrobial assessment on cotton fabric applied with natural sources

AATCC Test Method 100-1999 was used to determine the antimicrobial activity of the dyed samples. *Escherichia coli* (*E. coli)*, a gram-negative bacterium, was selected due to its popularity of being selected as a test organism and its resistance to common antimicrobial agents1. *Staphylococcus aureus* (*S. aureus*), a pathogenic gram-positive bacterium, was used because it was the major cause of cross-infection in hospitals and it is the most frequently evaluated species. The gram negative *E. coli* and the gram-positive *S. aureus* cultures were left to grow in specific conditions and used to test the antimicrobial effect of all the dyed and undyed samples. The dilution medium was nutrient broth and the neutralizer was sodium hydroxide. To evaluate the antimicrobial activity the number of reduction colonies were compared between the dyed and undyed samples after incubation.

The results are expressed as percent reduction of bacteria by $R (\%) = 100(A-B)/A$[16,17]. Where A and B are the numbers of bacterias recovered from the dyed and undyed cotton samples after inoculation and incubation.

K/S analysis

Colorimetric data of natural dyed samples were determined using a Datacolour SF 600 plus Spectrophotometer interfaced to a PC. Measurements were taken regarding colour presence, brightness, dullness and colour intensity with the specular component of the light excluded and the UV component included using illuminant D65 and 10° standard observer. Each fabric was folded once so as to give two thickness and average of five readings were taken each time.

FTIR analysis

Fourier Transfer Infra-Red Spectrophotometer was used to analyze the functional group of the dye sample terminalia chebula which in turn reveals about the colour absorption properties of the organic dye molecules. Data with respect to the functional groups, aromatic and achromatic ring chains indicated the presence of structural groups in the dye molecules.

RESULTS AND DISCUSSION

Application of terminalia chebula on cotton fabric in different forms

The results of the effect of Terminalia Chebula (Tc) by its own and its various combinations with other natural colorants are given in Table 1. From the table , it is seen that there were three types of treatments such as pre treatment (Pr), post treatment (Po), and simultaneous treatment (S) followed on the cotton fabric using the Tc combinations. Trials were carried out many times in order to reduce the involvement of the concentration of supporting chemicals, such as sodium chloride, sodium carbonate and alum. The favourable results with minimum conditions such as concentrations of the supporting chemicals, time, temperature and pH in the natural colouration bath for colouring cotton fabric, are recorded. The Tc combinations applied on cotton fabric give various good shades, particularly with green and red tones. The other effect of the Tc combinations (color fastness, anti microbial, color density, and color intensity) are given in the forthcoming tables and graph.

Fastness properties of terminalia chebula on cotton fabric

The results of fastness properties towards light, washing and crocking (rubbing) on the natural dyed cotton fabric are given in Table 2. Table 2 indicates that there is a moderate light fastness exhibited by the natural dyed cotton fabric. The light fastness property is almost in the range of 3 and 3-4 which is in the good to moderate range, and accepted for textile and garment products. Since natural dyes are not so good in colour strength, obviously the light fastness is not excellent or very good. The washing fastness property is, as an average 4 which is in the rate of good value. This result shows that there is a good interaction and reaction between the cotton cellulose and natural sources, thereby good washing fastness property. The crocking fastness of cotton fabric dyed with different natural sources is also good, as an average. Compared to wet rubbing fastness, in dry state there is slight more effect which is due to the fact that in wet state, since there is no very strong reaction, there is a mobility of dyes leads to transfer of dyes. The effect of fastness properties on the

natural dyed cotton fabric is slightly promoted by the combinational dyeing which may support for more reaction leading to good fastness property.

Antimicrobial Properties of Terminalia Chebula Cotton Fabric

The data of antimicrobial properties of different natural dyed cotton fabric are given in Table 3. From Table 3, it is evident that the bacterial count as BC gram +ve and BC gram –ve is more on undyed cotton fabric (1967 and 2004 respectively). The cotton fabric dyed with different natural dyes exhibits very good resistance towards the growth

Table 1: Application of *Terminalia chebula* (Tc) combination on Cotton Fabric

S. No	Dye	Dye Ingredients % Salt		Soda		Alum		Tempin °	Time	pH in min	Colour obtained
1	Tc	0.5	Pr	-	-	-	-	70	60	6	Olive
2	Tc +If	0.5	Pr	-	-	-	-	+32	60	7.5	Green
3	Tc +Rc	0.5	Pr	-	-	0.5	Pr	+60	60	6.8	Reddish green
4	Tc +Pp	0.5	Pr	-	-	0.5	Pr	+70	90	7.5	Greenish orange
5	Tc +If+Rc	0.5	Pr	-	-	0.5	Pr	+60	90	6.2	Reddish green
6	Tc +If+Pp	0.5	Pr	-	-	0.5	Pr	+70	90	6.4	Reddish green
7	Tc +Rc+Pp	0.5	Pr	-	-	-	-	+70	90	7	Red
8	Tc +Vn	0.5	Po	0.5	S	0.5	Pr	+45	60	8	Olive
9	Tc +If+Vn	0.5	Pr,Po	0.5	S	0.5	Pr	+45	60	7	Green
10	Tc +Rc+Vn	1	Pr,Po	0.5	S	0.5	Pr	+60	90	7.6	Greenish yellow
11	Tc +Pp+Vn	1	Pr,Po	0.5	S	0.5	Pr	+60	90	7.4	Greenish red
12	Tc +If+Rc+Vn	1	Pr,Po	0.5	S	0.5	Pr	+70	90	7.1	Reddish green
13	Tc +If+Pp+Vn	1	Pr,Po	0.5	S	0.5	Pr	+70	90	6.5	Reddish green
14	Tc+Rc+Pp+Vn	1	Pr,Po	0.5	S	0.5	Pr	+70	90	6.3	Red
15	Tc +Eo	0.5	Pr	-	-	-	-	70	60	7	Olive
16	Tc +If+Eo	0.5	Pr	-	-	-	-	+32	60	6.4	Green
17	Tc +Rc+Eo	0.5	Pr	-	-	0.5	Pr	+60	90	6.5	Reddish green
18	Tc +Pp+Eo	0.5	Pr	-	-	0.5	Pr	+70	90	6.5	Greenish orange
19	Tc +If+Rc+Eo	0.5	Pr	-	-	0.5	Pr	+60	90	7.2	Reddish Green
20	Tc +If+Pp+Eo	0.5	Pr	-	-	0.5	Pr	+70	90	6.4	Reddish Green
21	Tc +Rc+Pp+Eo	0.5	Pr	-	-	0.5	Pr	+70	90	7	Red
22	Tc +Ab	0.5	Pr	-	-	-	-	70	60	8	Olive
23	Tc +If+Ab	0.5	Pr	-	-	-	-	+32	60	7	Green
24	Tc +Rc+Ab	0.5	Pr	-	-	0.5	Pr	+60	90	6.5	Reddish Green
25	Tc +Pp+Ab	0.5	Pr	-	-	0.5	Pr	+70	90	7.5	Greenish orange
26	Tc +If+Rc+Ab	0.5	Pr	-	-	0.5	Pr	+60	90	7.4	Reddish green
27	Tc +If+Pp+Ab	0.5	Pr	-	-	0.5	Pr	+70	90	7.6	Reddish green
28	Tc +Rc+Pp+Ab	0.5	Pr	-	-	0.5	Pr	+70	90	6	Red
29	Tc +Ai	0.5	Pr	-	-	-	-	70	60	7	Olive
30	Tc +If+Ai	0.5	Pr	-	-	-	-	+32	60	6	Green
31	Tc +Rc+Ai	0.5	Pr	-	-	0.5	Pr	+60	90	7.5	Reddish green
32	Tc +Pp+Ai	0.5	Pr	-	-	0.5	Pr	+70	90	6.9	Greenish orange
33	Tc +If+Rc+Ai	0.5	Pr	-	-	0.5	Pr	+60	90	7.2	Reddish green
34	Tc +If+Pp+Ai	0.5	Pr	-	-	0.5	Pr	+70	90	7.4	Reddish green
35	Tc +Rc+Pp+Ai	0.5	Pr	-	-	0.5	Pr	+70	90	6	Red

Pr- Pre treatment, Po-Post treatment, S- Simultaneous treatment. Tc – *Terminalia chebula*, If – *Indigofera tinctoria*, Pp - *Pterocarpus santalinus*, Rc - *Rubia cardifolia*, Vn - *Vitex negundo;* Eo - *Embellica officinalis*, Ab - *Aloe barbadensis*, Ai - *Azadirachta indica*

of microbes. The bacterial count is much reduced in BC gram +ve compared to BC gram –ve. The reduction of the growth of microbes is around 65% as an average for BC gram +ve, whereas for BC gram –ve the value is slightly more than 60%. The combinations of application of natural dyes promote the character of antimicrobial property on the cotton fabric. Hence, the selected natural dyes have adherent anti microbial property on textile materials, suitably for fabrics, apparels and garments.

Colour strength analysis (K/S) of the Terminalia Chebula on Cotton Fabric

The colour strength values of different dye combinations applied on cotton fabric are shown in Table 4. Standardized method of interpretation of data

Table 2: Colour Fastness ratings of Terminalia chebula combination on Cotton Fabric

S. No.	Dye Combination	Light Fastness	Wash Fastness	Rubbing fastness Dry	Wet
1.	Tc	2-3	3	3-4	3
2.	Tc +If	3	4	4	3-4
3.	Tc +Rc	3	3	4	4
4.	Tc +Pp	3	4	3	3
5.	Tc +If+Rc	4	3-4	4	3
6.	Tc +If+Pp	4	3	3-4	3
7.	Tc +Rc+Pp	3	3	3	4
8.	Tc +Vn	3	3	4	4
9.	Tc +If+Vn	3	4	4	3
10.	Tc +Rc+Vn	3-4	4	4	4
11.	Tc +Pp+Vn	4	4	3	3-4
12.	Tc +If+Rc+Vn	3	3-4	4	4
13.	Tc +If+Pp+Vn	3	4	3-4	4
14.	Tc +Rc+Pp+Vn	3	3	3	3-4
15.	Tc +Eo	4	4	3	4
16.	Tc +If+Eo	3	3-4	4	3
17.	Tc +Rc+Eo	3	4	3-4	3-4
18.	Tc +Pp+Eo	3	4	4	3
19.	Tc +If+Rc+Eo	3-4	4	3	3
20.	Tc +If+Pp+Eo	4	3-4	3	4
21.	Tc +Rc+Pp+Eo	4	3	4	4
22.	Tc +Ab	3	3	3-4	3
23.	Tc +If+Ab	3	4	4	3
24.	Tc +Rc+Ab	3	3	3	3
25.	Tc +Pp+Ab	3-4	4	3-4	4
26.	Tc +If+Rc+Ab	3	3-4	4	3
27.	Tc +If+Pp+Ab	3	4	3	3-4
28.	Tc +Rc+Pp+Ab	3-4	3	3	4
29.	Tc +Ai	3	4	4	3-4
30.	Tc +If+Ai	3	3	4	4
31.	Tc +Rc+Ai	3	3	3	3
32.	Tc +Pp+Ai	4	3-4	3-4	4
33.	Tc +If+Rc+Ai	3	4	3	3
34.	Tc +If+Pp+Ai	3	3-4	3	3
35.	Tc +Rc+Pp+Ai	3	3	3	3

with respect to sunlight and artificial lights was done according to AATCC method and K/S values were determined from ΔE. From Table 4, it is seen that the data represents good colour strength values. The K/S values obtained for all dyed samples range above 10, with marginal differences reveal that the colour strengths are good and suitable for dyeing of textile fabric, apparels and garments.

Table 3: Antimicrobial assessment of *Terminalia chebula* (Tc) combination on Cotton Fabric

S. No	Dye	B.C gram(+)ive	B.C gram(-)ive	% R gram(+)ive	% R gram(-)ive
	Undyed	1967	2004	-	-
1	Tc	698	745	64.51449	62.82435
2	Tc +If	658	712	66.54804	64.47106
3	Tc +Rc	645	715	67.20895	64.32136
4	Tc +Pp	725	725	63.14184	63.82236
5	Tc +If+Rc	726	824	63.091	58.88224
6	Tc +If+Pp	614	856	68.78495	57.28543
7	Tc +Rc+Pp	698	736	64.51449	63.27345
8	Tc +Vn	745	732	62.12506	63.47305
9	Tc +If+Vn	728	856	62.98932	57.28543
10	Tc +Rc+Vn	761	736	61.31164	63.27345
11	Tc +Pp+Vn	684	832	65.22623	58.48303
12	Tc +If+Rc+Vn	716	765	63.59939	61.82635
13	Tc +If+Pp+Vn	695	825	64.66701	58.83234
14	Tc +Rc+Pp+Vn	645	736	67.20895	63.27345
15	Tc +Eo	618	864	68.5816	56.88623
16	Tc +If+Eo	725	732	63.14184	63.47305
17	Tc +Rc+Eo	735	831	62.63345	58.53293
18	Tc +Pp+Eo	665	861	66.19217	57.03593
19	Tc +If+Rc+Eo	773	845	60.70158	57.83433
20	Tc +If+Pp+Eo	691	712	64.87036	64.47106
21	Tc +Rc+Pp+Eo	759	852	61.41332	57.48503
22	Tc +Ab	664	765	66.24301	61.82635
23	Tc +If+Ab	715	823	63.65023	58.93214
24	Tc +Rc+Ab	645	745	67.20895	62.82435
25	Tc +Pp+Ab	765	815	61.10829	59.33134
26	Tc +If+Rc+Ab	625	725	68.22572	63.82236
27	Tc +If+Pp+Ab	736	736	62.58261	63.27345
28	Tc +Rc+Pp+Ab	798	755	59.4306	62.32535
29	Tc +Ai	736	756	62.58261	62.27545
30	Tc +If+Ai	665	732	66.19217	63.47305
31	Tc +Rc+Ai	625	856	68.22572	57.28543
32	Tc +Pp+Ai	755	712	61.61668	64.47106
33	Tc +If+Rc+Ai	645	831	67.20895	58.53293
34	Tc +If+Pp+Ai	781	765	60.29487	61.82635
35	Tc +Rc+Pp+Ai	629	815	68.02237	59.33134

BC – Bacterial Counts

Colour absorption properties of the Natural Dye, Terminalia Chebula

The infra-red spectrum curve deviations indicate the presence of different groups in the natural dye Terminalia Chebula, which is shown in the Figure. The data from the figure indicate the presence of various groups which may be functional, aromatic, or asymmetric.

3328 cm: γ (O-H) hydroxyl group, 3200 – 3400cm: γ (N-H) amine group, 3300 cm: γ H≈ (C-H) alkyl group, 1610 – 1680: γ (C=N) cyano group, 1000: γ (C-C) carbonyl group 800 – 900: γ (C-O-C) ether group, 1500 – 1900: γ (C=C) carbonyl group 1610: γ (C-C) aromatic ring chain vibrations, 1112: γ (C-O-C) asymmetric. The groups like hydroxyl, amino and carbonyl involve with fibre interaction to give good colour and quality fastness properties. The natural dye Terminalia Chebula contributes

Table 4: Colorimetric data K/S of *Terminalia chebula* (Tc) combination on cotton Fabric

S.No	Dye	L*	a*	B*	c	h°	K/S
1	Tc	34.15	-5.54	-15.84	22.65	246.65	12.65
2	Tc +If	33.50	-5.02	-15.75	23.74	255.74	13.98
3	Tc +Rc	33.65	-4.65	-15.95	22.01	244.01	12.41
4	Tc +Pp	34.32	-4.98	-16.62	21.23	257.22	14.57
5	Tc +If+Rc	35.95	-5.74	-15.30	22.65	249.65	12.20
6	Tc +If+Pp	34.99	-5.02	-16.40	23.98	255.98	12.54
7	Tc +Rc+Pp	25.04	-5.58	-15.58	22.74	264.70	14.10
8	Tc +Vn	25.45	-5.65	-14.95	21.01	261.65	12.65
9	Tc +If+Vn	36.21	-5.94	-15.60	22.25	250.14	13.30
10	Tc +Rc+Vn	26.62	-6.12	-16.45	22.63	242.12	12.58
11	Tc +Pp+Vn	35.30	-5.65	-15.13	22.68	253.02	14.74
12	Tc +If+Rc+Vn	34.65	-4.30	-14.62	23.74	265.32	12.05
13	Tc +If+Pp+Vn	33.98	-6.21	-15.65	23.65	255.65	13.65
14	Tc +Rc+Pp+Vn	33.70	-5.45	-16.98	23.84	248.98	12.98
15	Tc +Eo	26.15	-4.89	-15.76	21.74	259.74	14.46
16	Tc +If+Eo	28.62	-5.65	-14.02	22.15	266.01	11.15
17	Tc +Rc+Eo	33.30	-6.74	-15.56	23.23	253.25	12.65
18	Tc +Pp+Eo	34.25	-5.84	-16.48	22.65	240.65	13.98
19	Tc +If+Rc+Eo	35.48	-4.95	-15.23	21.98	254.32	12.10
20	Tc +If+Pp+Eo	35.96	-5.02	-15.59	22.74	267.65	13.25
21	Tc +Rc+Pp+Eo	36.30	-6.65	-15.14	23.01	255.98	12.65
22	Tc +Ab	29.21	-5.94	-14.48	22.23	248.74	14.98
23	Tc +If+Ab	32.54	-4.87	-15.26	21.98	250.01	12.63
24	Tc +Rc+Ab	33.51	-5.41	-14.35	22.65	252.54	14.30
25	Tc +Pp+Ab	33.32	-5.02	-15.65	23.23	246.32	12.25
26	Tc +If+Rc+Ab	34.41	-5.36	-16.98	22.54	259.68	13.65
27	Tc +If+Pp+Ab	27.51	-6.59	-15.74	21.12	262.44	12.74
28	Tc +Rc+Pp+Ab	28.87	-5.35	-14.01	22.32	254.65	14.12
29	Tc +Ai	33.63	-4.69	-15.20	23.65	240.32	12.65
30	Tc +If+Ai	35.21	-5.87	-15.36	22.98	251.65	12.32
31	Tc +Rc+Ai	33.80	-6.45	-15.59	22.41	265.98	13.98
32	Tc +Pp+Ai	34.61	-5.65	-15.87	21.56	258.74	14.70
33	Tc +If+Rc+Ai	36.40	-5.12	-15.40	22.26	247.01	12.45
34	Tc +If+Pp+Ai	26.50	-5.42	-15.51	23.98	254.25	13.62
35	Tc +Rc+Pp+Ai	35.32	-5.36	-15.65	22.32	256.32	14.30

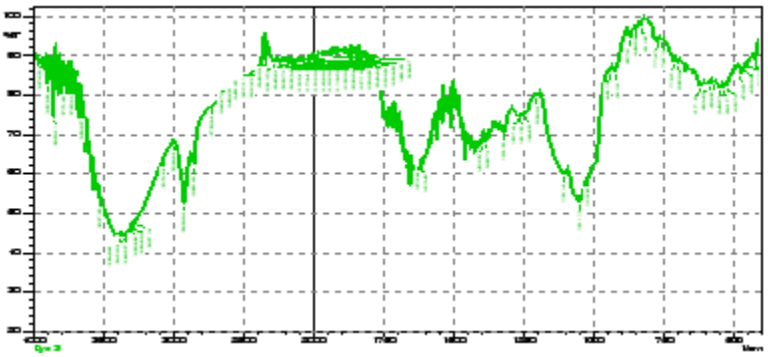

Fig. 1: FTIR analysis of *Terminalia chebula* dye sample

important functional groups that are responsible for the property achievement on the natural dyed cotton fabric using the single dye as well as by its various combination with other natural dyes.

CONCLUSION

From this study the following conclusions are arrived;

1. The natural resource Terminalia Chebula gives good colour appearance on the cotton fabric.
2. The fastness properties towards wash, light and cracking are moderate to good.
3. The Terminalia Chebula combinations give very good anti microbial characters on the cotton fabric.
4. The natural resource terminalia chebula contains considerable colour strength for the application on cotton fabric.
5. Terminalia chebula has the required reactive groups for the attraction and fixation on the cotton fabric. Based on all these considerations, the natural resource terminalia chebula would be considered for the responsible properties on textile fabric particularly cotton by the combined application.

REFERENCES

1. Glover., Brain and J.H. Pierce, JSDC., Jan **109**: 5 (1993).
2. Jill Goodwin, A Dyers Manual, Pelham Books/ Stephen Greene Press., Penguin group (1982).
3. Klus Schatz, International Dyer, June 17 (2001).
4. Helmut Mucha., Dirk Hofer., Sigrid and Maximilian Swerev, Milliand International., May **83**: 148 (2002).
5. Deo H.T and Paul's, International Dyer, Nov **188**: 25 (2003).
6. Leian.Y.,Yuilan.M and Boiling, International Dyer, April **188**: 25 (2003).
7. Paul.S., Grover and Sharma A, International Dyer, October **188**: 55 (2003).
8. Cautisicos.M, Milliand Textrileberge, March **87**: 149 (2006).
9. http://www.quilthistoty.com/dye.htm
10. Padfield T., Landi S, Studies in Conservation., **11**: 181 (1996).
11. Crews PC, J.American Institute for Conservation., **21**: 43 (1982).
12. Crews PC, Studies in Conservation., **32**: 65 (1987).
13. Crews PC, Studies in Conservation., **33**: 87 (1988).
14. Vankar PS., Mishra A., Ghorpade B and Tiwari V, Colourage., **9**: 25 (2000).
15. Singh S., Jahan S and Gupta KC, Colourage., **8**: 33 (1983).
16. Akira A, Functional fibres and finishes for humans, Sakagami Suehara, Japan, 21 (1995). Chapter- I
17. HirokoK, Antimicrobial and anti-odor finish, Sakagami Suehara, Japan, 48 (1990).