Natural Bioactive agent of Aloe Vera Leaf Gel Extract for Antimicrobial and UV-Protection Finishing of Cotton and Bamboo

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***Abstract*- In the present scenario of environmental consciousness, the Natural Bioactive agent requirements not only emphasize on the intrinsic functionality and long service life of the product but also a production process. Therefore, research on Natural Bioactive agent for textile application is gaining worldwide interest. This paper reports a comprehensive review on natural product based bioactive agents such as Aloe Vera Leaf gel extract finishing of textile substrates. The Aloe Vera Leaf gel Extract which have been applied to cotton fabric in presence and absence of free formaldehyde crosslinking agent (Glyoxal) using pad-dry-cure method. Antimicrobial and UV-Protection properties of treated fabric have been improved which make it more important and inevitable finish for Garments. The sample were examined of cotton and Bamboo including, Colour Strength Value and The novel feature of this study was the use of FT-IR spectroscopy to identify the major chemical groups in the extract as well as its attachment on cotton and bamboo.**

Keywords: **Aloe Vera Leaf gel, Herbal extract, Microorganisms, Anti microbial, Glyoxal crosslinking, Cotton and Bamboo Fabric.**

1. INTRODUCTION

The worldwide increasing awareness of hygienic life style has made it essential for the textile industries to develop textile products with finishes using Natural Bioactive products. Textiles have always played an important role in the evolution of human culture by being at the forefront of both technological and artistic development. Textile finishing involves treating a textile material in such a way that the product has the desired functional properties required for its intended use and therefore has greater market value. The desired properties may include the fabric's dimensions and their stability, its weight, drape, appearance, softness and handle, as well as any required functional properties such as resistance to creasing, flames, water, oil, dirt or bacteria. For the treatment of diseases inhibitory chemicals employed to kill micro-organisms or prevent their growth. Today, however, with increased knowledge of the causative agents of various infectious diseases, antibiotic has come to denote a broader range of antimicrobial compounds, including anti-fungal and other compounds [1].

The Aloe vera botanical name is Aloe barbadensis miller. It belongs to Asphodelaceae (Liliaceae) family, and is a shrubby or arborescent, perennial, xerophytic, succulent, pea- green colour plant [2]. Aloe Vera is essentially an African wild plant. The name Aloe vera derives from the Arabic word "Alloeh" meaning "shining bitter substance," while "vera" in Latin means "true." 2000 years ago, the Greek scientists regarded Aloe vera as the universal panacea. The Egyptians called Aloe "the plant of immortality" [3].

The plant has triangular, fleshy leaves with serrated edges, yellow tubular flowers and fruits that contain numerous seeds. Each leaf is composed of three layers: the outer leaves including the vascular bundles, the middle layer of latex which is the bitter yellow sap, and inner leaves, colourless gel [4]. The aloe plant, which is a cactus plant is about 95% water, with an average pH of 4.5. The skin absorbency of Aloe Vera gel is four times faster than water. Aloe Vera leaf extracts consist of 75 nutrients and 200 active compounds including 20 minerals, 18 amino acids and 12 vitamins [5].

Aloe Vera's active enzyme joins the substrate and forms chemical bonds to the substratum. The enzyme acts as a catalyst and constitutes an unstable medium compound with the substrate, known by the 'lock and key' mechanism as an enzyme substrates complex. The catalyst subsequently weakened the relations between the substrate and the materials of size. They also have protection against UV, anti-protozoal, and injury. Aloe Vera presents good wound healing effects with glycoprotein and mannose-6 phosphate. The primary antimicrobial function is polysaccharides and barbaloin in aloe gel [4]. These polysaccharides also known as mucosaccha rides, since they are plant-derived, and also have anti-inflammatory, anti-allergic, and anti-microbial properties, as well as retarding the progression of tumors. The antifungal

and antibacterial properties of Aloe Vera can be exploited for medical textile applications, such as wound dressing, sutures, and other bioactive textiles [6].

2. MATERAIL AND EXPERIMENTAL METHOD

2.1. Material

The desized, scoured and bleached cotton and Bamboo fabric and purchased from local market were used for the study. The fabric was purified by scouring at 100 ^{0}C for 60 min. using a solution containing Na_2CO_3 (2g/l, wetting agent, 1%), to remove dust particles and finishing chemicals, then all the fabric were neutralized, thoroughly washed with water and dried at ambient conditions.

2.2 Methods and procedures

2.2.1 Extraction of Aloe Vera Leaf Gel

The fully expanded leaves of Aloe Vera were selected form the plant and washed with water. When a leaf of Aloe Vera is cut, an orange yellow sap drips from the open end. Carefully cut solid cubes the inner part while avoiding the yellow sap (latex). The solid cubes of Aloe Vera leaf (inside material) as shown in Figure 1 containing some of the desired compounds (mainly anthraquinones) were placed inside a thimble made from thick filter paper, which was loaded into the main chamber of the Soxhlet extractor as like shown in figure 2. The chamber containing the Aloe Vera material got slowly filled with warm Water or Methanol. Some of the desired compounds get dissolved in the warm Water or methanol [7].

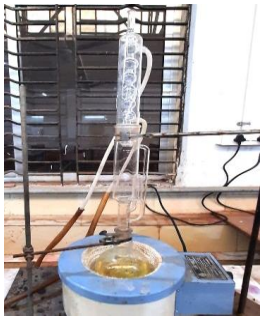

Figure 1: Aloe Vera gel cubes **Figure 2: Soxhlet extractor**

Two extraction Techniques were used to extract from the Aloe Vera.

1. **Water (aqueous) Extraction:** The 10 gm of obtained Aloe vera cubes was added to 100 ml of water. The mixture was 80 ^{0}C for 3-4 hrs, until the cubes get small and the desired materials are extracted, then filtered through wattmen filter paper no.1.Finally the total volume of extract was increased to 100ml with distilled water. This solution was used as stock solution of 10:100 strength.
2. **Methanolic Extraction:** In the case of methanolic extraction 10 gm of obtained Aloe vera cubes was extracted in 100 ml of methanol at 50 ^{0}C for 3-4 hr. in Soxhlet apparatus. The extract was cooled and filtered through wattmen filter paper no.1. This extract was used as stock solution of 10:100 strength.

(a) White Extraction **(b) Methanolic Extraction**

Figure 3: Aloe Vera Extraction Through obtained Coloured

2.2.2. Cotton and Bamboo Fabric Dyeing with Reactive Dye

The smooth paste is prepared by using Reactive dye and water. Finally add remaining amount of water to make 100ml of dye stock solution with constant stirring (The strength of this dye stock solution is 1:100). Accurately weigh given fabric sample and find out the total liquor of the dye bath. Then dye stock solution, Glauber's salt & soda-ash in Introduced the given fabric sample in prepared dye-bath and treat in this dye-bath at room temperature for 10-15 min. Then gradually raise the temperature of dye-bath up to the boil. Add calculated amount of soda ash after 30 min. The dyeing is continuing at this temperature for further 30 min. Then cool down the temperature of dye-bath and take out the cotton sample & wash thoroughly with water. The fabric sample after dyeing is treating with 1 g/l Non-ionic

detergent at boil temperature for 15-20 min. By this soaping, the unfixed dye particles are removed from the sample and held in suspension form in the solution. Then again, the cotton sample is rinse with water and finally dried.

2.2.3 Cotton and Bamboo Fabric Finishing with Natural Bioactive agent of Aloe Vera Leaf Gel Extract

The Cotton and Bamboo Dyed fabric was treated with the product of the two Extract methods Water (aqueous) or methanol extract method. The first part in cotton and bamboo fabric were treated with herbal extract by Exhaust method. And second part in fabric is crosslinking through pad-dry-cured method in natural bio-active extract was mixed with 6% of glyoxal as crosslinking agent and 4% aluminium sulphate $Al_2(SO_4)_3$ was added as a catalyst at PH is about 4.5-5. Then the treated fabric was dried at 80 ^{0}C for 5 min. and cured at 120 ^{0}C for 3 min.

2.3 Characterization of Treated Cotton and Bamboo fabric

Evaluation of Dyed Samples. The dyed samples were assessed for $L* \ a* \ b*$ colour coordinates and K/S values (illuminate D65/10^0 observer) on spectra scan 5100 (RT) spectrophotometer (Premier Colour scan Instrument). The antibacterial activity was checked against both Gram positive bactria and Gram negative bacteria according to Test Methods as per AATCC - 147 for E.Coli and Bacillus subtilis (Agar well diffusion method). Ultraviolet protection factor (UPF) optimum treated and untreated sample was analysed using UV-2000F instrument make lab sphere were used for this purpose in the UV wavelength range (290 to 400nm). IR spectra of untreated and treated fabric samples were structural analysis in Shimadzu FTIR 8300 infrared spectrometer.

3. RESULTS AND DISCUSSION

The Cotton and Bamboo fabric sample were prepared for dyeing then dyed with Reactive dye (Coracion Blue HERD) and then Finished with Natural Bioactive Agent choice. The dyed sample were subjected to finishing with natural bioactive agent Finishing Choice for work Aloe Vera Leaf Gel Extract. This finished samples were analysed to study the antimicrobial and UV-Protection Functionality. The results include the evaluation of various of functional properties including antimicrobial and UV-Protection with the help of colour Strength Value and structural analysis of the sample obtained using various variables.

3.1 Effect of Natural Bioactive Finishing Techniques on Colour Strength Value (K/S Values)

The Cotton and Bamboo being a Cellulosic material can be dyed with Coracion Blue HERD Reactive dye then finishing with natural finishing agent such as Aloe Vera Leaf gel Extract. The control sample is considered dyed fabric is considered before finishing. In the present study the cotton and bamboo on functional finishing through the colour strength and colour co-ordinate values is evaluated and mentioned in Tables 1. The colour strength measurement of colour strength sample was evaluated by a light reflectance technique using Spectrophotometer with computer colour matching system; Spectra Scan 5100 (RT) (Premier colour scan instrument), India. The colour co-ordinate in value (Lab value), 'L*' represents colour shade i.e., lower the value of 'L*', darker the sample and vice versa. Tone of any colour is specified by two components, namely, 'a*' and 'b*'. Negative values of 'a*' indicates that tone is on greener side and positive values will indicates tone on redder side. Whereas negative values of symbol 'b*' indicates bluer tone and positive values indicate yellower tone.

Table 1: Colour strength (K/S Values) and Colour co-ordinates of Aloe Vera bioactive finishing on Cotton and bamboo

Sr. No.	Sample code No.	Cotton				Bamboo			
		Colour strength (K/S Values)	**Colour co-ordinates**			**Colour strength (K/S Values)**	**Colour co-ordinates**		
			L*	**a***	**b***		**L***	**a***	**b***
1	Control	2.414	49.75	-8.56	-17.95	1.894	51.51	-7.60	-14.44
2	A.W 1	1.698	47.91	-6.73	-15.35	1.278	50.10	-7.37	-10.54
3	A.W 2	1.755	48.04	-6.89	-15.41	1.349	50.37	-7.52	-10.88
4	A.W 3	1.721	48.29	-7.06	-15.71	1.418	50.47	-7.33	-11.81
5	A.W 4	2.003	48.27	-6.96	-15.83	1.770	51.29	-7.81	-12.61
6	A.M 1	1.509	46.91	-6.69	-12.05	1.297	49.93	-7.18	-10.51
7	A.M 2	1.492	47.95	-8.05	-12.79	1.349	50.65	-7.933	-11.61
8	A.M 3	1.800	48.07	-7.43	-13.62	1.568	501.56	-7.88	-12.71

9	A.M 4	1.855	47.60	-7.78	-11.40	1.629	50.99	-7.20	-12.69

NOTE: A.W- Aloe Vera leaf gel Water Extraction Treated Sample, A.M- Aloe Vera leaf gel methanolic Extraction Treated sample. The described to parameters of the Concentration, Time, Temperature in numbers. Were, **1**- 20% Conc., 60 min, 80 ^{0}C, **2**- 30% Conc., 30 min, 80 ^{0}C, **3-** 30% Conc., 60 min, R.T (35-40 ^{0}C), **4-** 30% Conc., 60min, 80^{0}C.

Observation of above table 1 in clearly indicate that cotton and Bamboo fabric sample on Colour Strength value and Colour co-ordinates value of A.W Treatment in higher colour strength value is A.W 4 at 30% Conc., 60min, 80 ^{0}C. and Lower colour strength value at A.W 1 at 20% Conc., 60 min, 80 ^{0}C. The control dyed fabric has colour strength value is higher than the A.W 1, A.W 2, A.W 3 and A.W 4 is treated with on both Cotton and Bamboo fabric. and A.M Treatment on cotton as well as bamboo has results are shown in table 19 in higher colour strength value is A.M. 4 at 30% Conc., 60 min, 80 ^{0}C and lower colour strength at A.W 2 at 30% Conc., 30 min, 80 ^{0}C on cotton and lower colour strength value on bamboo is A.M 1 at 20% Conc., 60 min and 80 ^{0}C. The control reactive dyed material has colour strength value is higher than Aloe Vera Leaf gel methanolic extract finish of A.M 1, A. M 2, A. M 3, and A. M 4 on cotton and bamboo. In Water and methanolic extracts of Aloe Vera Leaf gel Bioactive agent the colour strength value was decreased to compared control Reactive dyed sample of cotton and bamboo fabric.

Application of function finishing on cotton and bamboo by natural bioactive agent is present in water as single molecules (ionized) as well as clusters of many molecules (aggregates). Aggregates are too large to enter the interior of fibres at a given temperature. Raising the temperature leads to the breaking down of aggregates. So, the number of single molecules existing in the solution increases. When a single molecule deliberate form the aggregates, which are, in turn, taken up by the fabric, resulting in a complete colour strength [8].

3.2 Qualitative Evaluation of the Anti-Anti-Bacterial Activity of the Cotton and Bamboo Fabric

The control sample is considered dyed fabric is considered before finishing. The sample after finishing with various bioactive agent mention earlier under different condition described is earlier. The cotton and bamboo fabric sample were Finishing with Natural Bioactive agent are Aloe Vera Leaf gel Extract. The antibacterial activity of treated fabric was evaluated quantitatively by measuring the number of colonies of Bacillus subtilis (Gram-positive) and E. coli (Gram-negative) as per the test method discussed in the experimental section. Qualitative assessment of the antibacterial activity of the treated cotton and bamboo fabrics were carried out by Parallel Streak Method (AATCC 147).

The mechanism of the antimicrobial effect on textiles fibres, and indicated that the fibre surface bonded to antimicrobial agents, which disrupt the cell membrane of the microorganisms by an electrochemical mode of action [6, 9]. Anti-bacterial and antifungal characteristics of Aloe Vera extract can depend on the polysaccharides and anthraquinones, ace-mannan and salicylic acid ingredients [4]. The acetyl group in ace-mannan is one of the main essential cell growth activity compounds [10].

The zone of inhibitions obtained in the different treatments was observed and illustrated in Table 2. The untreated sample of cotton and bamboo has no antimicrobial activity was found.

Table 2: Aloe Vera Leaf gel Extract on cotton and bamboo the bacterial activities

Sr. No.	Sample code No.	Cotton		Bamboo	
		Zone of inhibition "W" (mm)		**Zone of inhibition "W" (mm)**	
		Bacillus (Gram Positive)	**E. coli (Gram negative)**	**Bacillus (Gram Positive)**	**E. coli (Gram negative)**
1	Control	-	-	-	-
2	A.W 1	23	10	26	11
3	A.W 2	21	12	23	12
4	A.W 3	21	12	25	13
5	A.W 4	24	17	30	17
6	A.M 1	21	11	29	13

7	A.M 2	27	13	28	12
8	A.M 3	21	15	25	16
9	A.M 4	30	18	30	19

There is a clear in observation table 2 in zone of inhibition around the fabric finishing with Aloe Vera leaf gel Extract bioactive agent against both the test organisms in contrast with untreated fabric sample which allowed the growth of organism. The control cotton and bamboo fabric sample found to have no antibacterial activity with zero area. Zone of inhibition detected in treated fabric specimen against both bacteria (Figure 4) and increases with increase in concentration of complex mixture of natural bioactive agents. This clearly indicates that cotton and Bamboo acquires antibacterial activity as a result of treatment with natural bioactive agents and protection against both bacteria enhanced drastically with increase in concentration.

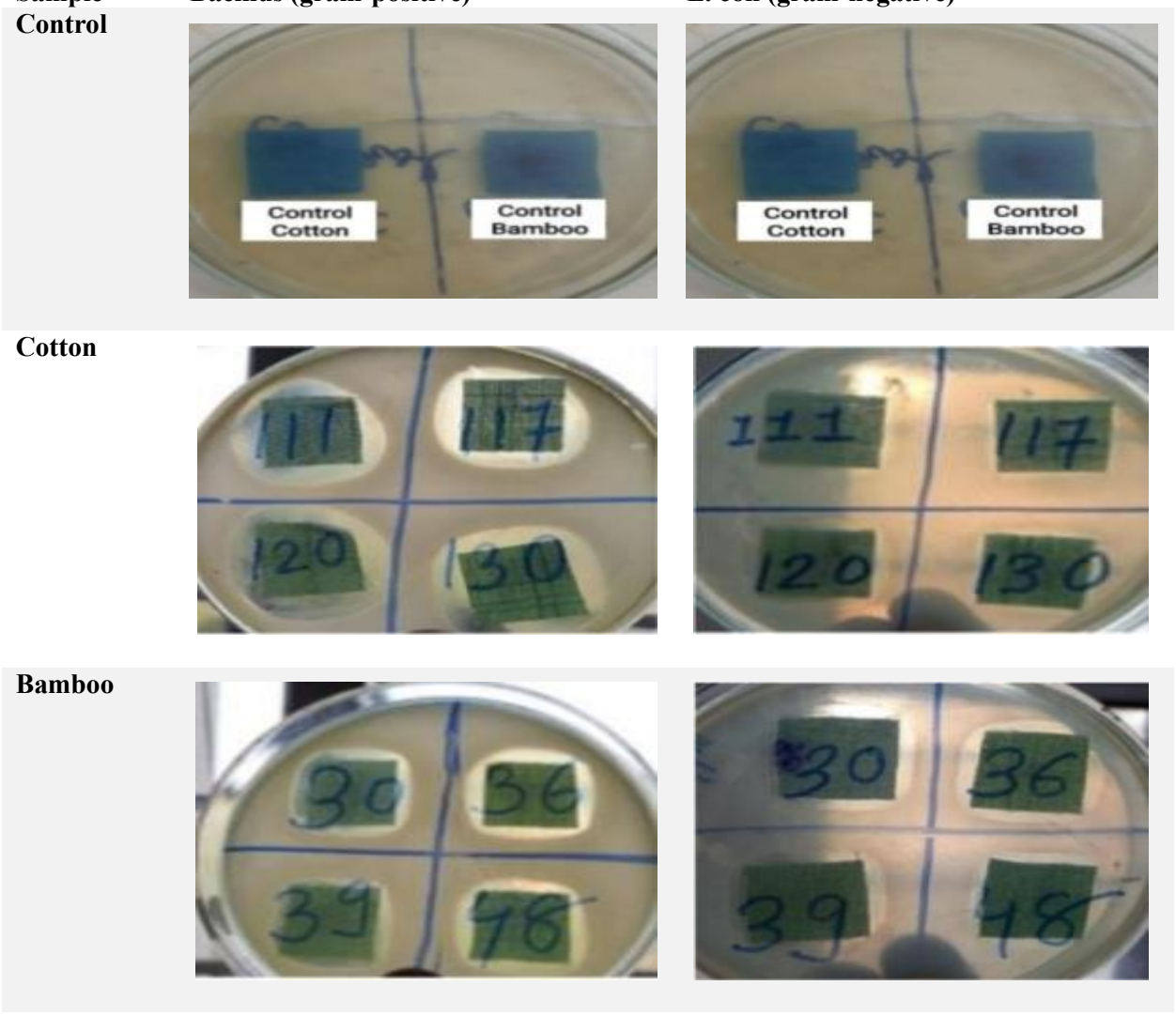

Figure 4: Anti-Bacterial Activity of cotton and bamboo fabric by AATCC 147-2004 Test Method

The Water extract of Aloe Vera Leaf gel Against bacteria Bacillus (gram-positive), zone of inhibition increases from 23 to 24 mm on cotton and zone of inhibition increases from 26 to 30 mm on Bamboo with increase in concentration from 20 to 30%. Similarly, an increase from 10 to 14 mm on Cotton and increase from 11 to 17 mm on Bamboo fabric sample was observed against bacteria E. coli (gram-negative) under the same conditions. The methanolic extract of Aloe Vera Leaf gel Against bacteria Bacillus (gram-positive), zone of inhibition increases from 21 to 30 mm on cotton and zone of inhibition increases from 29 to 30 mm on Bamboo with increase from 11 to 18 mm on Cotton and increase from 13 to 19 mm on Bamboo fabric sample was observed against bacteria E. coli (gram-negative) under the same conditions. The Aloe Vera on cotton and bamboo was tested for its antibacterial property on cotton fabric. It was investigated that tested sample presented 98% reduction against the growth of Bacillus even after number of launderings [11]. The treated fabric with Natural bioactive extract with cross linking-agent, shows good resistance to bacteria attack.

3.3 Ultra-Violet Protection

Ultraviolet (UV) protection Finishes, which are sometimes referred to as UV shielding agents, rep-resent one of the most important groups of chemical finishing agents applied to textile materials, with the goal of protecting people and textile materials from the harmful effects of UV radiation. The energy of UV radiation, which is significantly higher than that of visible light, has the potential to initiate different chemical reactions that may be hazardous to human health and can deteriorate textile fibres. Although moderate sun exposure has beneficial health effects, overexposure to UV radiation may result in serious harmful health effect since both UVA (320–400 nm) and UVB (280–320 nm) rays induce different cellular responses that manifest as pigmentation, sunburn, skin ageing, skin cancer and DNA damage [12–13]. Effect of clouds and elevation interface on UV transmission, it has been determined that for each kilo-meters above sea level, there is a 6% increase in the magnitude of UV. It is also known that UV radiation is absorbed by clouds, which reduces the intensity of UV that hits Earth's surface. According to the 'Environmental Protection Agency(EPA)':100% of UV transits when no clouds are present, 89% transmitted when clouds are spotty, 73% transmitted through broken clouds and 31% transmitted when it is completely overcast [14]. UV radiation causes degradation of textile materials, due to excitations in some parts of the polymer molecule and a gradual loss of integrity.

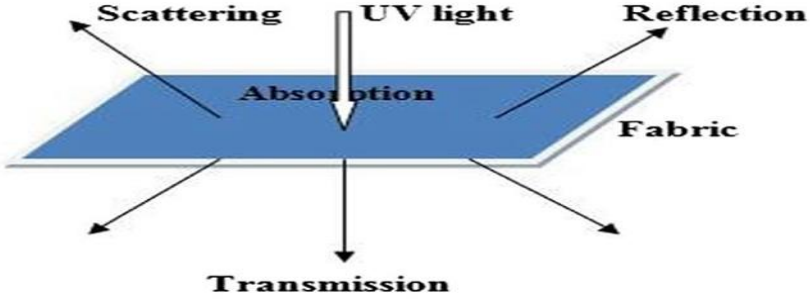

Figure 5: Schematic Representation of a Textile as a Barrier to UV Radiation

Ultra Violet Protection Factor (UPF) is measured on natural Bioactive finishing sample using standard method EN ISO 13758-1:2002 by lab sphere UV-2000F Ultra transmittance analyser. The natural Bioactive agent is used as UV blocking agent because of its non-toxic, chemical and thermal stabilities and durability. Even though they are efficient in the UV region, there is a possibility of decline mechanical properties of the textile materials. Schematic Representation of a Textile as a Barrier to UV Radiation shown Figure 5. The results are as follow table 3.

Table 3: Blocking Percentage of Cotton Fabric Sample

Sr. No.	Sample code No.	UVA blocking %	UVB blocking %	MEAN UPF	Calculated UPF rating	Protection Category
1	Control	24	18.8	10.08	4.2	No Protection
2	Control Bamboo	47.13	44.75	42.40	24	Good Protection
3	A. M Cotton	75.269	65.332	68.35	35	Very good Protection
4	A. M Bamboo	81.557	78.294	74.63	45+	Excellent Protection

The above Observation of table 3 it is clearly that all treatment which describe above restricts the UV Blocking in the region between 260 nm to 440 nm in all the fabric. The UPF is strongly dependent on the chemical structure and other additives present in the fiber.

Table 3 indicate the effect of light exposure on UPF values, percentage UV Blocking for control and methanolic extract natural bioactive agent through finished treated cotton fabric sample. The calculated UPF value of Control cotton fabric 4.2 so, it is not protection and Control bamboo fabric 24 so, it is good protection against UV-Radiation. The UPF of methanolic extract through finishing Cotton fabric sample A.M has UPF rating about 35 and Bamboo fabric sample A.M has UPF rating about 45+.

Observation of results indicates bamboo fabric is given greater protect to ultraviolet irradiation compare to cotton fabric. Because of count of cotton fabric is low and also it is produced higher transmittance of UV rays compared to bamboo fabric [15]. The Dyed sample Cotton and Bamboo was finished with Aloe Vera water extract the UV Absorbency value increased because of Aloe Vera extract contains water with vitamins (A, C, B12). metals, sugars compound. The UPF is further enhanced with colorant od Dark hues and with high concentration of the colorant in the fabric [16]. Aloe Vera polyphenols can aid secure and absorb UV rays [10]. This property of natural bioactive agent has successfully been

utilized in finishing of cotton and bamboo as an absorbing agent. An effective UV absorber must be able to absorb throughout the spectrum to remain stable against UVR and to avoid degradation or loss of colour [17].

3.4 Structure Analysis of Fourier Transform Infra-Red (FTIR)

The fibrous samples the potassium bromide (KBr) disk technique has been shown to be the best suitable. Infrared (IR) spectra of cotton and bamboo fabric samples were recorded under normal slit program and at a scanning speed of 20 sec/cm¹. The fabric samples were cut into small pieces with scissor and then sieved through a 100-mesh screen. The KBr pellets were made by mixing about 3 mg of the sample with 200 mg of KBr at a pressure of about 15 psi for 5 min run under pressure. A KBr pellet with sample was used as a reference 102 The frequency range of IR absorption spectra taken was 3500 - 500cm^{-1} and the spectra are shown in figure 5 and 6 respectively.. IR spectra of untreated and treated fabric samples were structural analysis in Shimadzu FTIR 8300 infrared spectrometer. It is well known that the IR absorption gives information about atomic vibration frequencies and is closely related to type of chemical bonds present.

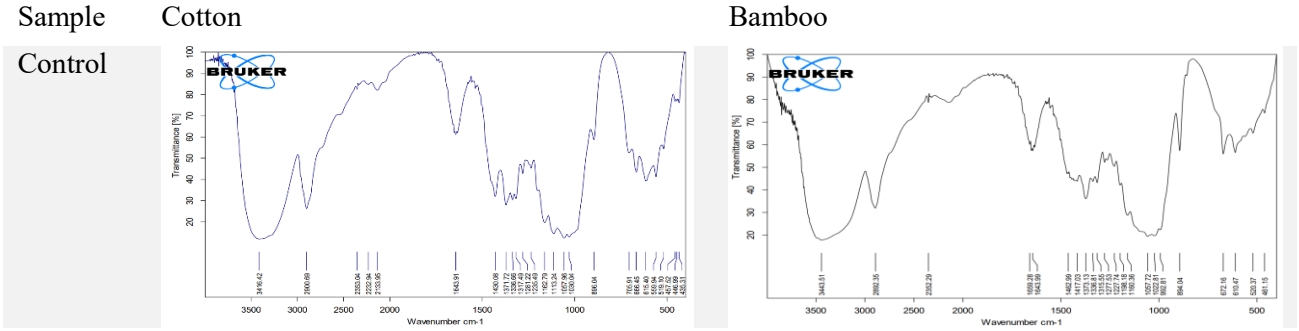

Figure 6: FTIR spectrum of untreated Cotton and Bamboo Fabric

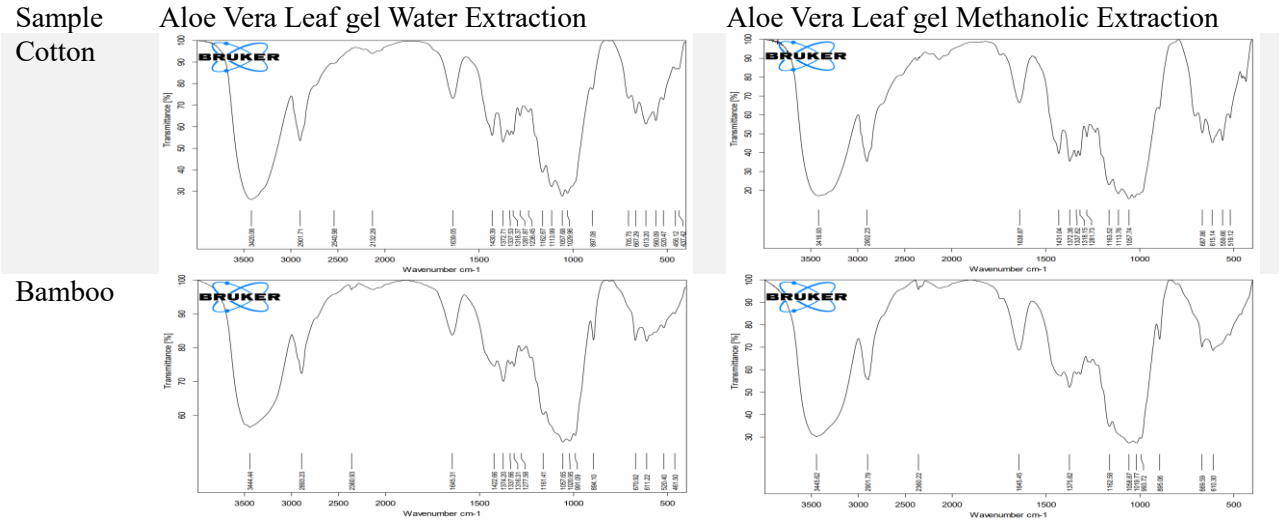

Figure 7: FTIR spectrum of Cotton and Bamboo fabric Treatment with Aloe Vera Leaf gel Extract

The above observation Figure 6 and 7 as untreated and treated with natural Bioactive agent Respectively the change in intensity and position of various picks in different sample we can say that the change in a pick corresponding to a particular component indicates the change in composition of the particular component.

The FT-IR spectrum of untreated and treated Cotton as well as Bamboo with Water and methanolic extract of Aloe Vera Leaf gel are shown in Figure 6 and 7 respectively, The strong absorption band was seen near at 343.51cm^{-1}, indicate stretching of -NH stretch of amino groups –OH group mainly from phenolic groups. The peaks at 2892,35cm^{-1} are due to the C-H stretching of alkanes compounds. The absorption band nearer to 1659.28 cm-1is indicates the presence of -C=O and -C=C- stretch respectively of aromatic rings and peak at 1643.99 N–H bend of 1˚ amines. The absorption band near at 1462.99 cm^{-1}is C–H bend of alkanes. The FT-IR peak near at 1227.74 cm^{-1}indicated about C-N stretching. Weak adsorption band nearer to 1,000 cm^{-1}indicates presence of ether linkages.

From this observation of change in intensity and position of various picks in different sample we can say that the change in a pick corresponding to particular component indicate the change in composition of the particular component. So, compared to untreated fabric the position of picks in conventionally as well as natural bioactive agent with treated sample in chemical composition analysis. Thus, IR Spectroscopy of untreated and treated sample provide the evidence of change in chemical composition on treatment.

4. CONCLUSIONS

In this research work Antimicrobial and UV-Protection Functionality using Natural Bioactive agent of Aloe Vera Leaf gel Extract on Cotton and Bamboo having study. In this work Aloe Vera leaf gel extract are applied to Cotton as well as Bamboo Fabric with the help of Crosslinking agent (Glyoxal) this resulted in enhanced Antimicrobial and UV-protection activity both the substrate. The extract finishing on Cotton as well as Bamboo on three different Parameters are concentration, Time and Temperature is increased, when the colour strength (K/S Value) is also increased. The cotton and bamboo, the given result of Bacillus (Gram Positive) zone inhibition is better than that E. coli (Gram negative). It means that bacterial species belong to gram positive has high rate of inhibiting growth as compared to the gram negative. The conclude that when increase percentage (%) of concentration, Time and temperature with increased zone inhibition in both Gram positive and Gram Negative on Cotton and Bamboo fabric. The Aloe Vera Leaf gel methanolic Extract gives protection against UV radiation in very good category on Cotton and Excellent category on Bamboo Fabric. The Structure Analysis of FTIR investigated the presence of mainly compounds in Aloe Vera Leaf gel extract which is known to have Antibacterial and UV-protection properties giving on Cotton and Bamboo.

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