ORIGINAL ARTICLE

Investigating Aqueous Extract of banana Peel on Functional Properties of Plasma Treated Cellulose Fabrics for Medical Applications

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ABSTRACT

Cellulosic fabrics were treated withthe alkaline fractions of banana peel . In this study, banana peel was evaluated as UV protective agent and multi-functional antibacterial agent on the cellulose substrate. The solution was extracted using 0.1% NaOH and was analyzed by Fourier Transform Infrared Spectroscopy analysis technique. The fabrics taken were cellulose fabrics such as cotton, viscose, tencel. Here two sets of fabrics were taken. One was normal set of fabrics and another one was plasma treated set of fabrics. The dye extracted was applied to the pre mordanted cellulosic fabrics (for both set of fabrics). Mordent used wasFerrous sulphate. Effectiveness of cellulosic fabrics dyed with banana peel extract against ultraviolet radiation was evaluated in terms of ultraviolet protection factor value (UPF). Antibacterial activity was analyzedin terms of percentage reduction in bacteria. Dyeing performance in terms of colour parameters were studied. These results are very important for industrial application with the production of a natural dye, antibacterial, and UV protected as an inexpensive source from waste banana peel as a by product. The optimum treatment and dyeing conditions were applied on two sets of fabrics.

Keywords: Cellulose fabrics, Plasma treated fabrics, Banana Peel, UPF, Antibacterial Activity, Colour Parameters.

INTRODUCTION

Banana is grown in the tropical and subtropical countries. At the global level, the banana production is estimated around 72.5 million metric tonnes, of which 21.77 million metric tonnes is contributed by India.Since storage and postharvest losses are critically high,considerable interest has been generated in the recent years for value addition of banana such as the production of banana juice ,banana wine ,banana powder ,banana chips etc. During the production of these products the banana peel accumulates in bulk posing serious environmental problems. To prevent this, it has become necessary to develop alternative, commercial application of these agro-industrial waste.

Bacteria are the micro organisms that survive on textiles for many days and contribute in the transmission of disease.The degree of protection from the infection causing bacteria can be obtained by using appropriate protective clothes.Bacteria usually attacks a textile material and antibacterial property is analyzed by the bacterialistic reduction percentage. There has been increasing interest in building antibacterial properties into textiles. Consumers are looking for clothing which provide greater comfort and remains fresh and odour -free in use. The antimicrobial activities of some of these dyes are reported as potent owing to the existence of phenol, tannin and quinone in their extracts. Ultraviolet (UV) radiation is harmful to human health. The transmission of UV radiation through fabrics is greatly influenced by different parameters such as fibre type and chemical composition, fabric construction, additives, textile processing aids, colour and fabric finish . UV protection finish is that it absorbs the ultraviolet radiation and blocks its transmission through a fabric to the skin Chemical treatment of banana peel and leaves may be suitable for natural dye extraction used from textile dyeing. Banana should be considered to be a good source of natural antioxidant and antibacterial.The component isolated from banana peel was studied also and their activities were determined. The main objective of the present study is to evaluate the antibacterial activity, dyeingperformance in terms of colour parameters and Effectiveness of banana peels extract against ultraviolet radiation in terms of ultraviolet protection factor value.

MATERIALS AND METHODS

Cotton, Viscose, Tencel fabric: The fabrics have the following specification: plain weaved, warp 92 EPI, weft 76PPI and 144 GSM.

Desizing, Scouring, bleaching and mercerizing treatments for cotton fabric: Enzyme desizing was

done to the fabricat 80℃ for 1hour.Scouring for the fabric was done with 4% NaOH,3% sodium carbonate,0.5 ml/litre soap solution and few drops of wetting agent and kept in water bath at 100℃for 60 minutes. The scoured fabric was washed with water and dried.Then hydrogen peroxide bleaching was done to the scoured fabric at 85℃ for 40 minutes.After that mercerization process was done with 18% NaOH at 85℃ for 90 minutes.

Soaping for viscose and tencel fabric: The material-liquor ratio is 1:30 and with the help of soap solution soaping process was done.

Plasma treatment for fabrics: After the above processes one set of all three fabrics were plasma treated. One set of three fabrics were plasma treated with hydro peno vac technologies plasma reactor machine. Plasma treatment is an intrinsically environmentally friendly process which can be used to functionalise the surface of textile without altering the bulk properties of the material in any way.

Banana peel pigments extraction: About 100 g of the banana peel that contains the dye component was cut to small pieces and boiled in one litre in a solution of 0.1% NaOH and concentrated to 500cc. The slurry was left to react for a period of time wherein a yellow supernatant forms at the top. This yellow supernatant changes to amber and then to an opaque black as the reaction proceeds. The entire slurry was then filtered and any solid material discarded. The extracted liquor was used as the foundation of the dye.

Dye material: The both normal and plasma treated fabrics were premordanted with ferrous sulphate (FeSO4). The banana peel extraction liquor was used in the dyeing bath at 80° for 90 min under continuous stirring. The pH of the dye was adjusted to 9. After completion of dyeing, the fabrics were thoroughly rinsed and washed with water and air dried.

FTIR analysis of the banana peel extracts: Fourier Transform Infrared Spectroscopy is a technique which helps to identify the chemical compounds in the given product. FTIR identifies chemical bonds in a molecule by producing an infrared absorption spectrum. FTIR is an effective analytical instrument for detecting functional groups and characterizing covalent bonding information.

Antimicrobial assay: The antibacterial activity of fabrics dyed with the alkaline soluble fractions of banana peel has been used as a natural dye against E. coli and Klebsiella pneumoniae according to AATCC 147 method. In this method bacteria test organisms such asE. coli and Klebsiellapneumoniae are streaked onto agar plates in a series of five streaks. Treated and untreated fabric samples are placed over the streaks and the plates are incubated. Following incubation, the samples are visually examined for zones of clearing and the treated materials are compared to the untreated materials to draw conclusions about the degree of anti bacterial activity observed. No regulated limits currently exist for general anti bacterial claims made using this method. The bacteriostatic reduction rate was estimated by the standard equation:

Reduction (%) = [(X-Y) / Y] × 100

Where X and Y is the bacteria colonies of untreated and treated fabrics respectively.

Colour strength: The colour strength expressed as (K/S) was measured using Data colour 400 dual beam spectrophotometer . The diffuse transmittance was detected at the wavelength 360nm to 700nm.

K/S = (1-R)^2/2R

Where R is the reflectance of the coloured fabric, and K/S is the ratio of the absorption coefficient (K) to scattering coefficient (S): the higher the value, the greater the colour strength. The colour parameters L*(lightness-darkness), a*(red- green), b*(blue-yellow component), R % (reflectance), and ΔE were measured by using the following equation.

$$\Delta E^*_{ab} = \sqrt{(L^*_2 - L^*_1)^2 + (a^*_2 - a^*_1)^2 + (b^*_2 - b^*_1)^2}$$

Fastness to washing: Colour fastness of dyed samples to laundering was tested at 5 and 10 cycles. This accelerated test was carried out in accordance to the IS:765:79. . Putting into consideration that one commercial laundering at 40℃ for 45 min is equivalent to 5 home washing cycle.

Application: Banana peel extract can be used as an inexpensive source of dye on cellulosic fabric can be used on a large scale because of its functional properties

RESULTS AND DISCUSSIONS

FTIR analysis of the banana peel extracts: FTIR is an effective analytical instrument for detecting functional groups and characterizing covalent bonding information. The Banana peel extract contains phenol group which possess antibacterial property.

The existence of phenols shows antibacterial effect. The FTIR result shows that the banana peel extract had phenol group shown in fig.3.2. Therefore the extract had antibacterial activity.

Antibacterial activity of banana peel extracts dyed fabrics against E. coli and Klebsiella pneumonia: The antibacterial activity of dyed fabrics against E.coli and Klebsiella pneumonia is illustrated in Table 2 and table 3. The plasma treated fabrics

dyed with the soluble fractions of banana peel extracts displayed good antibacterial activities against Staphylococcus aureusand Klebsiella pneumonia than untreated normal cellulosic fabrics. The reduction percentage of bacteria for untreated normal viscose, cotton, tencel were shown in table 3,4,5 respectively. The reduction percentage of bacteria for plasma treated viscose, cotton, tencel were shown in table 6,7,8 respectively.The antibacterial activity might be due to the presence of phenol group which is one of the more commonly known antibacterial and antioxidant. Natural colourant extracts are composed of main component and many unknown components. since it is a natural dye it is very difficult to identify the exact components that have antibacterial activity against micro-organisms.

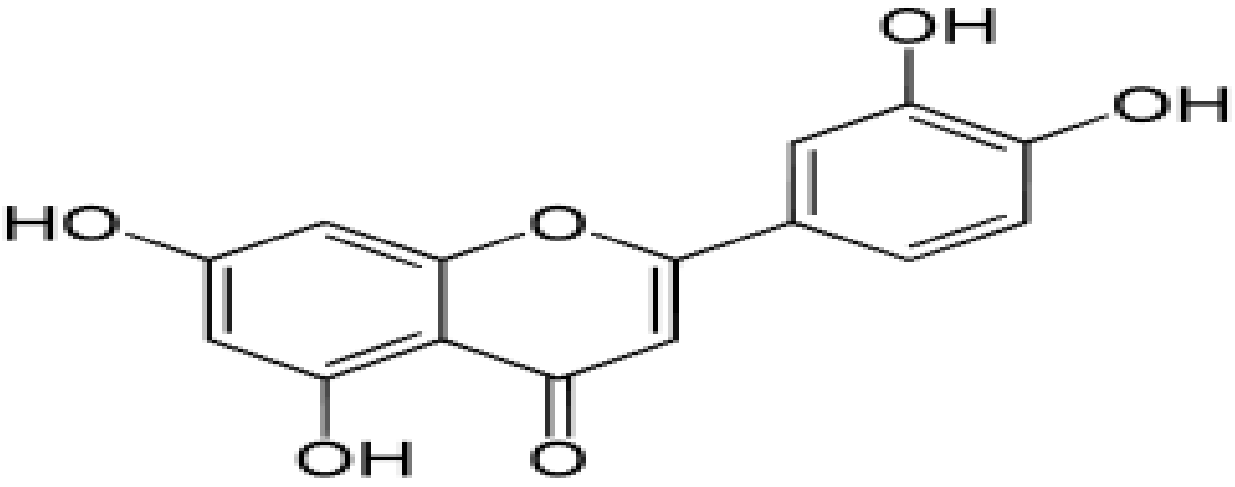
Colourimetric data: Colourimetric data depends on the type of material and percentage of dye absorption. mordent Fe metal form coordination complexes, and readily get chelated with the dye. Since the coordination numbers of Fe is 6, some coordination sites are unoccupied when they interact with the fiber. These unoccupied sites are accessible to functional groups on the fiber. Thus Fe metals can form a ternary complex on one site with the fiber and on the other site with the dye. Such a strong coordination tendency enhances the interaction between the fiber and the dye, resulting in high dye uptake. The colourimetric value of normal untreated fabrics were shown in table 9 The plasma treated fabrics shows high colourimetric value than untreated normal fabrics. The plasma treatment increases the hydrophilic properties of the fabric. Due to this absorbency of the fabric increases which results in high dye uptake. The colourimetric values of plasma treated fabrics were shown in table 10.

UPF values, percentage UV transmission and percentage UV absorbance: Factors that contribute to the UPF rating of a fabric are composition of yarns, tightness of weave, colour, stretch, moisture and finishing. UPF value strongly dependent on the chemical structure and other additives present in the fibre. A high correlation exists between the UPF and the fabric porosity but it is also influenced by the type of the fibres. UV resistance for the fabric might be due to the properties and absorption of banana peel dye Table 11 indicates the effect of light exposure on UPF values, percentage UV transmission and percentage UV absorbance for normal untreated viscose cotton and tencel fabrics. The UPF values for plasma treated fabrics were shown in table 12. Due to higher absorbency and high dye uptake the plasma treated fabric shows little higher UPF value than normal untreated fabrics.

By studying economical feasibility we find out that the use of waste banana peel increase the value of this waste in addition to the good eco-image of the natural dye in addition to health, antibacterial and environmental protection issues added to the dyed samples. Matched results to the research samples were obtained . This proves the applicability on the industrial scale and a further communication will be done for application on the large scale. The fastness values were shown in table 8.

Fastness to washing: The fastness to washing from 5 and 10 washing cycle. The samples fast to washing for both staining on white cotton fabric and colour alteration of the original colour of the samples.

Structure of the banana peel alkaline extracted compound.



FTIR graph of banana peel extract.

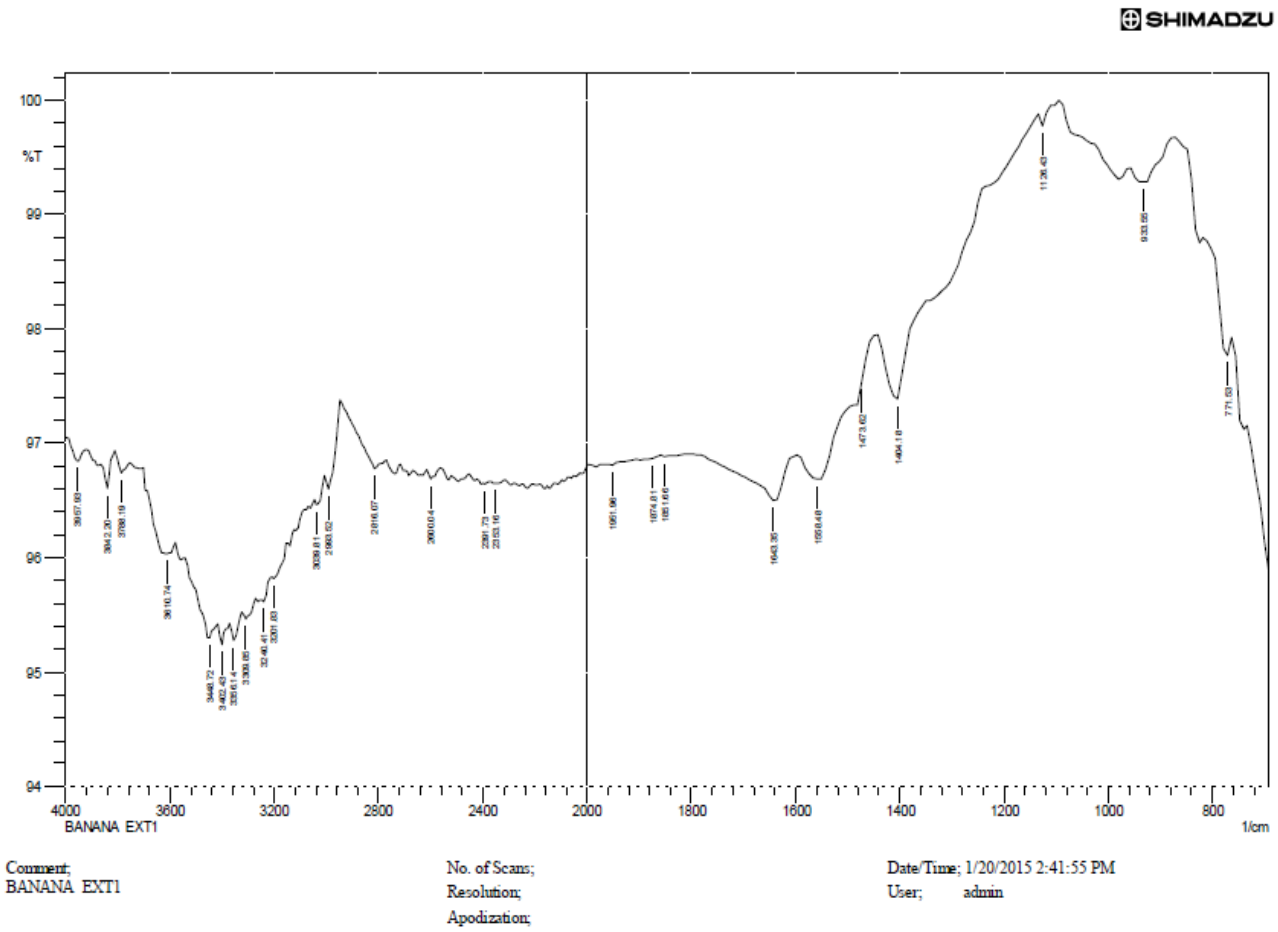


Table1: Antimicrobial activity against K. pneumoniae

Sample	Number of colonies					
	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}
Dyed fabric (0 hrs)	TNTC	TNTC	TNTC	74	44	21
First wash	TNTC	TNTC	TNTC	75	45	22
Third wash	TNTC	TNTC	TNTC	75	45	21
Dyed fabric (18 hrs)	117	84	69	44	27	16
First wash	82	65	41	36	19	11
Third wash	69	40	34	28	14	6

A. 0 hours, third wash B. 18 hours, third wash

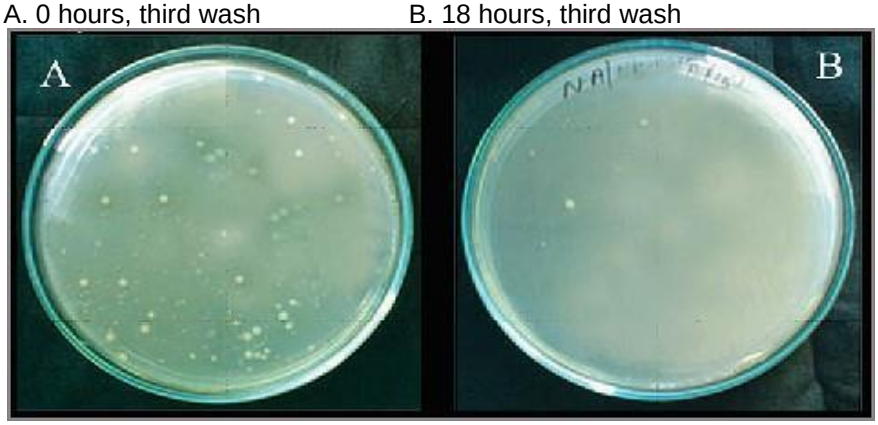


Table 2: Antimicrobial activity against E. col

Sample	Number of colonies					
	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}
Dyed fabric (0 hrs)	TNTC	TNTC	TNTC	74	44	21
First wash	TNTC	TNTC	TNTC	75	45	22
Third wash	TNTC	TNTC	TNTC	75	45	21
Dyed fabric (18 hrs)	97	78	56	34	20	11
First wash	78	69	45	26	12	6
Third wash	45	37	29	19	9	4

A. 0 hours, third wash B. 18 hours, third wash

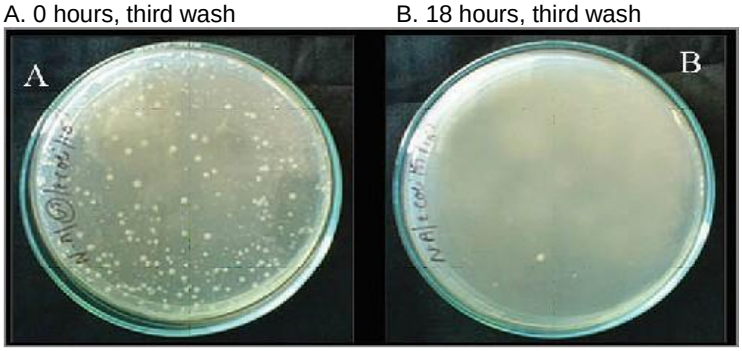


Table 3: Reduction percentage of Bacteria for viscose fabric

Samples	K pneumonia			E coli		
	Before wash	Single wash	Triple wash	Before wash	Single wash	Triple wash
Undyed fabric	0	0	0	0	0	0
Dyed fabric	>70%	>75.56%	>82.2%	>79%	>74.14%	>79.31%

Table4: Reduction percentage of Bacteria for cotton fabric

Samples	K pneumonia			E coli		
	Before wash	Single wash	Triple wash	Before wash	Single wash	Triple wash
Undyed fabric	0	0	0	0	0	0
Dyed fabric	>75%	>80.66%	>85.4%	>82%	>80.34%	>82.9%

Table 5: Reduction percentage of Bacteria for tencel fabric

Samples	K pneumonia			E coli		
	Before wash	Single wash	Triple wash	Before wash	Single wash	Triple wash
Undyed fabric	0	0	0	0	0	0
Dyed fabric	>81.1%	>86.7%	>88.6%	>84%	>8.37%	>85.3%

Table 6: Reduction percentage of Bacteria for plasma treated viscose fabric

Samples	K pneumonia			E coli		
	Before wash	Single wash	Triple wash	Before wash	Single wash	Triple wash
Undyed fabric	0	0	0	0	0	0
Dyed fabric	>71.2%	>76.70%	>83.92%	>80.2%	>75.24%	>80.23%

Table 7: Reduction percentage of Bacteria for plasma treated cotton fabric

Samples	K pneumonia			E coli		
	Before wash	Single wash	Triple wash	Before wash	Single wash	Triple wash
Undyed fabric	0	0	0	0	0	0
Dyed fabric	>76.7%	>81.66%	>86.6%	>83.2%	>81.68%	>83.45%

Table 8: Reduction percentage of Bacteria for plasma treated tencelfabr

Samples	K pneumonia			E coli		
	Before wash	Single wash	Triple wash	Before wash	Single wash	Triple wash
Undyed fabric	0	0	0	0	0	0
Dyed fabric	>82.6%	>87.34%	>89.6%	>84%	>83.37%	>84.63%

Table 9: Colorimetric data of cellulosic fabrics dyed with banana peel extracts

FABRIC	K/S value	L*	a*	b*	ΔE

Cotton	2.63	65.9	3.60	18.20	36.24
Viscose	2.23	63.7	2.47	17.33	32.62
Tencel	2.90	68.2	3.72	20.21	40.11

Table 10: Colorimetric data of plasma treated cellulosic fabrics dyed with banana peel extracts

FABRIC	**K/S value**	**L***	**a***	**b***	ΔE
Cotton	2.82	67.9	3.70	18.50	37.64
Viscose	2.53	65.7	2.90	17.93	33.82
Tencel	2.99	69.6	3.92	22.21	41.51

Table 11: UPF factor values of normal fabric

TYPE OF FABRIC	**UPF FACTOR**	**UVA**	**UVB**	**UV %**
Cotton	40	3.62	2.42	97.38
Viscose	38	3.21	2.22	96.50
Tencel	42	3.81	2.63	97.92

Table 12: UPF factor values of plasma treated fabrics

TYPE OF FABRIC	**UPF FACTOR**	**UVA**	**UVB**	**UV %**
Cotton	41	3.89	2.72	97.98
Viscose	39	3.65	2.54	96.90
Tencel	42	4.05	2.73	98.02

Table 13: Washing fastness values

FABRIC	**WASHING CYCLES**	
	5	**10**
Cotton	4	4/5
Viscose	3/4	4
Tencel	4/5	5

Table 14: Washing fastness values of plasma treated fabrics

FABRIC	**WASHING CYCLES**	
	5	**10**
Cotton	4	4/5
Viscose	3/4	4
Tencel	4	4/5

CONCLUSIONS

In the current study, the alkaline fractions of banana peel were used as a dye, multi-functional antibacterial and UV protective agent on normal cellulosic fabrics and plasma treated cellulosic fabrics. The data obtained showed that the plasma treated cotton, viscose and tencel fabrics have good antibacterial activity, good dye uptake with good UV protection properties than untreated normal cellulosic fabrics. The plasma treatment increases the antibacterial activity, dye uptake and UV properties upto certain extent. The addition of Fe as a mordant increase all the above mentioned parameters due to ternary complex of Fe on one site with the fibre and on the other site with the dye and also the coordination sites of Fe metal which are unoccupied can absorb UV incorporated into the fibres convert electronic excitation energy into thermal energy. These results are very important for industrial application with the production of a natural dye, antibacterial, and UV protected as an inexpensive source from waste banana peel as a by product.

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