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RESEARCH PAPER

Assessment of colour strength properties of cotton and excel fabrics treated with banana pseudo stem sap

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Abstract: Banana (*Musa paradisiaca*) is one of the most important oldest cultivated horticultural crops grown almost everywhere in India which is rich source of phytochemicals, minerals, carbohydrates, proteins and phenolic compounds. Ney Poovan variety of banana pseudo stem sap was used for finishing of excel and cotton fabrics. The banana pseudo stem sap was boiled for 30min and 60min and optimized using colour spectrophotometer. The 30 min boiled BPS exhibited maximum colour strength as compared with pure and 60min boiled BPS. The excel and cotton fabrics were finished with 30 min boiled BPS in varied concentrations (20, 40 and 60%) and assessed for colour strength, reflectance and colour difference. The 60 per cent BPS finished cotton and excel fabric exhibited greater colour strength followed by 40 and 20 per cent finished fabrics which showed better dye uptake and colour yield. It can be concluded that, optimum utilization of banana pseudo stem sap for textile colouration and functional finishing became the effective means for value addition to renewable bioresources.

Key words: Banana, Colouring property, Cotton fabric, Stem sap

Introduction

With the growing demand for more comfortable, healthier and environmentally friendly products, efforts in research and development activities in the textile industry have focused on the utilisation of renewable and biodegradable resources as well as environmentally sound manufacturing processes in textiles like modified cellulosic rayon which are called as regenerated cellulosic fibres. Regenerated cellulosic fibers are derived from natural sources comprising of organic polymers by chemical processing to both extract the fiber-forming polymer and to impart novel characteristics to the resulting fibers. Cellulose can be chemically modified for manufacturing of wide range of products including viscose, paper and plastics. The popular variants of viscose rayon are modal, tencel and excel. Among these, viscous rayon is the first generation fibre, modal fibre is a second generation and tencel, excel and bamboo are the third generation fibres. Viscose rayon originated by wood pulp from a number of different trees like pine, spruce, hemlock trees and cotton linters. Bamboo fibre is originating from bamboo trees, modal fibre is originating from beech tree, tencel fibre is originating from eucalyptus tree which are made of cellulose wood.

The Excel is the latest manmade cellulose fibre from Birla Cellulose of the Aditya Birla group. It is made from a highly refined eco-friendly and sophisticated process after a rigorous scientific research and development conducted at the Birla Research Institute.

It is third-generation ecofreindly cellulose fibre with engineered precision, which answers to fashion conscious consumers who look for comfort and luxury of a natural fibre. Excel is made from the choicest selection of wood pulp, a natural and renewable resource with a unique set of properties like higher strength, better dimensional stability, high absorbency, smoothness and skin-friendliness. Among the regenerated cellolusics, excel fibre possessed improved fibre orientation with high degree of polymerization, increased strength and elongation aptly suitable for high fashion apparel. Further, regenerated cellulosic fibre has a unique semi-micro fibrillar structure, which gives excellent moisture transportation and comfort properties. Because of environmental sustainability and excellent aesthetic properties, there has been a gradual increase in consumption of these in apparel and home textile sector.

Use of plant extracts not only provides protection from environmental hazard but also safeguards the environment, prevents pollution and promotes eco-friendly textiles. Use of such products also ensures the health benefits to the individual as well as the masses. Hence, in this study banana pseudo stem is selected as finishing agent on textile material. Banana pseudo stem is abundantly available in India as well as other countries and it is normally considered as waste material. Banana (*Musa paradisiaca*) is one of the most important gigantic and oldest cultivated fruit crops grown almost everywhere in India. It is the largest produced fruit in India. Karnataka is one of the leading states in the country for production of banana with the area of cultivation 110.55 ('000 ha) and production rate of 2328.90 ('000 MT). After harvesting fruits, banana pseudostem is hardly been utilized for technical application (compost preparation) by the farmers due to technological gap. The screening of banana pseudo stem sap showed the presence of large bioactive compounds *viz.,* phenols, ketones, aldehydes, alkanes, esters and terpenes (Jyothirmayi *et al.*, 2014). Minerals that were detected in different parts of banana pseudo stem wastes were Na, K, Cr, Mg, Zn, Fe, Cu, P and Pb and high amount of carbohydrate was found

(Akpabio *et al.,* 2012). The aqueous, methanolic and ethanolic extracts of pseudostem exhibited significant amount of antioxidants along with carbohydrate, protein and phenolic compounds. The pseudostem extracts exhibited antimicrobial efficiency against the bacterial strains *viz., Escherichia coli, Klebsiella sp., Pseudomonas aeruginosa* and *Streptococcus faecalis* (Kumar *et al.,* 2014).

Banana pseudo stem sap is abundantly available in India as well as across the globe which is rich source of phytochemicals, minerals, carbohydrates, proteins and phenolic compounds. It has multifunctional properties such as dyeability, antimicrobial property, flame retardancy, UV protection property and can be used for preparation of bioresins. The application of banana pseudo stem sap in textile for colouration and functionalization will give the advantages of value addition using renewable resources. Utilization of bio resource provides an immense opportunity to the farmers, entrepreneurs, planners and scientists to take proper initiatives for sustainable environment. Thus, there is an urgent intervention required to our farmers on banana pseudostem management for sustainable livelihood. Therefore, the application of banana pseudo stem sap in textile industry for colouration and functionalization will give the advantages of value addition using renewable resources. Hence, the present study is designed to know the effect of banana pseudo stem sap treatment on colour strength of cotton and excel fabrics.

Material and methods

"Ney Poovan" (*Yelakki bale*) variety of banana pseudo stem was selected and procured from the ICAR- All India Co-ordinated Research Project on Fruits, Kittur Rani Channamma College of Horticulture, Arabhavi, Gokak Taluk, Belagavi dist, Karnataka.

2/40s, 2 ply, S twisted pure excel yarn was used for production of pure excel and cotton fabric. The fabric was interlaced with rib weave using 1×2 rib structure with cloth density of 56 ends and 48 and50 picksat Department of Textile and Apparel Designing, College of Community Science, University of Agricultural Sciences, Dharwad.

Extraction of banana pseudo stem sap

Fresh pseudostem of post-harvest banana plant was procured and cut into required length and the leaf sheaths were separated manually. The separated leaf sheaths were fed into sugarcane crusher for extraction of sap. The extracted sap/juice (Plate 1) was filtered by using muslin cloth and subjected to optimization. The 15 per cent ofsap was yielded from per kg of banana pseudo stem of Ney Poovan variety.

Optimization of banana pseudostem sap

The extracted pseudostem sap was subjected to boiling at 50 to 60 °C temperature for different time intervals *i.e.,* 30 min and 60 min. The fresh and boiled banana pseudo stem sap (BPS) were centrifuged at 6000 rpm for 30 min, the clear filtrate was subjected to colour spectrophotometer for optimization of extract.

Plate 1. Ney Poovan pseudostem sap

Finishing of excel and cotton fabric using banana pseudostem sap

Premordanting

Pre mordanting is a technique of treating the textile material with mordant to take hold on the applied or impregnated molecules. The plain woven scoured and bleached excel and cotton fabrics were soaked in the 5 per cent of potash alum mordant solution prepared with 1:30 material-to liquor ratio for 20min at room temperature.

Finishing methods

The pre-mordanted excel and cotton fabrics were treated with optimised BPS in varied concentration *viz.,* 20, 40 and 60 per cent through exhaust and pad dry cure method.

Exhaust method

The exhaust technique is the most common method for application on fabrics. It comprises of two steps *viz.,* exhaustion and fixation. A required amount of water bath was subjected to heating and BPS concentration (20,40 and 60 per cent) was added to the finishing bath with continuous stirring. The premordented excel and cotton fabrics were loaded to the bath treatmentwise and stirred continuously for 30 minutes and the bath temperature was slowly increased up to 60 °C. After completion of finishing process the fabric remained in the bath for 10 - 15 minutes, squeezed and cured at 100-120 °C for 3-5 minutes.

Pad dry cure method

Pad-dry-cure method is a widely used technique for textile finishing and can be used to add a variety of coatings. Lab pneumatic padding mangle was used for finishing excel and cotton fabrics with BPS treatments (Plate 2). The excel and cotton fabrics were immersed in the finishing bath containing

BPS solution and passed between the rollers and ran for 6-8 folds at a uniform pressure of 1kg/ cm^2 to remove excess solution ensuring the wet pick up of 70 per cent (Selvi and Rajendran, 2014). Later, the fabric was dried and cured at 100-120 °C for 3-5 minutes.

Assessment of Colour strength (K/S)

Colour is sensation which occurs when light enters the eyes. Colour of any substance decides the ultimate appearance of the article. Colour strength (K/S) values of the banana pseudo stem sap treated fabrics were measured by using colour spectrophotometer (Plate 3). Five readings recorded for each and an average value will be calculated. To study the colour change of treated samples in comparison to the control, the reflectance spectrum of the treated samples was measured by spectrophotometer.

Results and discussion

Colour strength(K/S) of banana pseudo stem sap

Ney Poovan pseudo stem sap was boiled for 30 and 60minutes and optimised using colour spectrophotometer. A significant difference was observed between the boiled and unboiled Ney Poovan sap. The colour strength was found to be greaterin 30min boiled Ney Poovan sap (1.35) followed by 60min (1.34) and pure sap (1.01) respectively. Further, the greater transmittance value was exhibited by pure sap (4.89) followed by 60min sap (3.35) and 30min sap (3.16) respectively. Moreover, the 30 min boiled sap was showed greater colour difference (14.80) than 60min boiled sap (12.55) respectively.However, the maximum time of boiling with high temperature may cause the degradation of colour pigment and organic compounds which depicts less colour strength values (Najm *et al.,* 2017). Therefore, among the extracts, the 30min boiled banana pseudo stem sap was used for the finishing of cotton and excel fabrics (Table 1).

Plate 2. Pad dry cure method of finishing of fabrics

Plate 3. Colour spectrophotometer analysis

Effect of banana pseudo stem sap treatment on colour strength(K/S) of cotton and excel fabrics

The colour strength (K/S) parameter of untreated and treated fabrics samples were determined on a colour spectrophotometer (Table 2) and results revealed that, all the treated samples showed significantly increase in colour strength (K/S) compared to control samples. The cotton and excel fabrics treated with BPS with varied concentrations (20, 40 & 60 %) through pad dry cure method showed significant increase in colour strength than the fabrics treated through exhaust method. This may be due to more absorption and penetration of phenolic compounds present in banana pseudo stem sap on the surface of the fabrics.

Among the fabrics, the cotton fabrics treated with 60 per cent of BPS through exhaust (0.378) and pad dry cure method (0.320) showed significant increase in colour strength followed by 40 per cent BPS (0.267 and 0.282) and 20 per cent BPS (0.244 and 0.275) respectively. Further, Same trend was seen in the excel

Table 1. Colour strength (K/S)of banana pseudo stem sap

Source	Colour strength (K/S)	Transmittance	Colour difference (dE)
BPS	1.01	4.89	-
BPS30	1.35	3.16	14.8
BPS60	1.34	3.35	12.55
S.Em ±	0.125	0.146	0.162
C.D. (5%)	0.043	0.506	0.563
C.V.	1.95	1.68	0.872

Table 2. Effect of banana pseudo stem sap treatment on colour strength (K/S) of cotton and excel fabrics

Types of fabrics	Concentrations of BPS	Colour strength (K/S)	
		Exhaust method	Pad dry cure method
Cotton	Control	0.145	
	20% BPS	0.244	0.275
	40% BPS	0.267	0.282
	60% BPS	0.378	0.320
Excel	Control	0.192	
	20% BPS	0.196	0.223
	40% BPS	0.197	0.343
	60% BPS	0.210	0.499

Parameters	F value	S.Em. ±	C.D. (5%)	C.V.
A (Types of fabric)	9.25 *	0.001	0.003	7.10
B (Methods of finishing)	2.98 *	0.001	0.003	
C (Concentrations)	4.20 *	0.002	0.005	
A x B	4.71 *	0.003	0.009	
A x C	6.80 *	0.003	0.009	
B x C	1.37 *	0.002	0.005	
A x B x C	10.5 *	0.0006	0.019	

* Significant at 5% level NS – Non-significant

fabrics, where in the excel fabric treated with 60 per cent of BPS through pad dry cure (0.499) and exhaust (0.210) method exhibited greater colour strength followed by 40 percent (0.343 and 0.197) and 20 per cent (0.223 and 0.196), respectively.

In general, all BPS treated fabrics possessed increase in colour strength (K/S) due to the absorption and deep penetration of bananas pseudo stem sap in the fabric structure. However, BPS recorded greater total phenolic content indicating presence of phenols, tannins and flavonoids which are polyphenolic compounds known for dye fixation on the textile materials and also BPS contains colours pigment *i.e.,* anthocyanin responsible for red, brown and black colours. The results are on par with the results of Mariamma and Jose (2018) reported that, the dyeability of cotton fabric with banana stem extract mordant *viz.,* tannic acid was increased in dye uptake and colour yield due to the use of tannic acid as a mordant along with BPS which gives additional tannin content resulting into dye uptake and colour yield. The highest K/S value was obtained in the cotton sample dyed with banana pseudo stem sap using horitoky as a mordant (Dhar *et al.,* 2017).

Effect of banana pseudo stem sap treatment on colour reflectance of cotton and excel fabrics

Irrespective of fabrics, method of finishing, treatment and concentrations, all the treated fabrics exhibited significantly lower reflectance values than the control samples. Whereas in treated samples, the reflectance value decreased as the concentration percentage of banana pseudo stem sap (20 to 60 %) increased. This indicates that the fabric became more darker, greener and bluer than the control samples.

However, it is true that, as the colour strength increases, there is decrease in reflectance values as reflected in Table 3. Among the fabrics, the cotton fabric treated by 60 per cent of BPS through exhaust and pad dry cure method (43.16 and 41.60) significantly decreased in reflectance followed by 40 per cent BPS (48.56 and 42.38), 20 per cent BPS (50.35 and 44.49) respectively. Further, the reflectance values of treated excel fabrics followed similar trend as the cotton treated fabrics. Among the excel fabrics, the fabrics treated with 60 per cent BPS through exhaust (36.00) and pad dry cure (32.84) significantly decreased in reflectance value followed by 40 per cent BPS (34.69 and 33.53), 20 per cent BPS (39.00 and 31.95) finished excel fabrics through exhaust and pad dry cure method respectively (Table 3).

Effect of banana pseudo stem sap treatment on Colour difference (dE) of cotton and excel fabrics

Table 4 explains the effect of banana pseudo stem sap treatment on colour difference of cotton and excel fabrics, the colour difference (dE) was found to be non significant in all the treated samples. Among the treated samples, the colour difference increased slightly as with increase in the concentration of BPS *i.e.,* 20, 40 and 60 per cent resulting into more darker, greener, bluer and duller fabrics compared to control fabrics. Among the fabrics, the excel (8.76 and 6.05) and cotton fabrics (5.35 and 4.85) treated with 60 per cent BPS through exhaust and pad dry cure method possessed slightly increase in colour difference as compared with other treated fabrics.

Table 3. Effect of banana pseudo stem sap treatment on Reflectance of cotton and excel fabrics

Types of fabrics	Concentrations of BPS	Reflectance	
		Exhaust method	Pad dry cure method
Cotton	Control	58.74	
	20% BPS	50.35	44.49
	40% BPS	48.56	42.38
	60% BPS	43.16	41.60
Excel	Control	41.71	
	20% BPS	39.00	31.95
	40% BPS	34.69	33.53
	60% BPS	36.00	32.84

Parameters	F value	S.Em.±	C.D. (5%)	C.V.
A (Types of fabric) N	6.87 *	00.56	0.165	2.10
B (Methods of finishing) S	9.28 *	0.056	0.165	
C (Concentrations) F	8.62 *	0.084	0.248	
A x B	5.36 *	0169	0.495	
A x C	8.76 *	0.169	0.495	
B x C	2.18 NS	0.084	0.248	
A x B x C	4.06 *	0.338	0.990	

* Significant at 5% level NS – Non-significant

Table 4. Effect of banana pseudo stem sap treatment on Colour Difference (dE) of cotton and excel fabrics

Types of fabrics	Concentrations of BPS	Colour Difference (dE)	
		Exhaust method	Pad dry cure method
Cotton	Control	2.84	
	20% BPS	4.44	3.65
	40% BPS	4.55	4.69
	60% BPS	5.35	4.85
Excel	Control	4.45	
	20% BPS	2.84	2.85
	40% BPS	4.08	3.89
	60% BPS	8.76	6.05

Parameters	F value	S.Em.±	C.D. (5%)	C.V.
A (Types of fabric)	0.85 NS	1.804	5.291	4.65
B (Methods of finishing)	1.26 NS	1.804	5.291	
C (Concentrations)	1.05 NS	2.706	7.937	
A x B	0.69 NS	5.413	15.874	
A x C	0.73 NS	5.413	15.874	
B x C	1.24 NS	2.706	7.937	
A x B x C	0.76 NS	10.825	31.749	

* Significant at 5% level NS – Non-significant

Conclusion

Banana pseudo stem is widely available biomass in the local region of Karnataka and it has multifunctional properties due to the presence of total phenolic content indicating presence of phenols, tannins and flavonoids which are polyphenolic compounds known for dye fixation on the textile materials. Banana pseudo stem sap was boiled for different time intervals and found that extract with 30 min boiling possessed greater colour strength property. Among the fabrics, colour strength was found to be high in excel

fabric treated with greater concentration of sap (40 and 60%) through pad dry cure method followed by cotton fabrics. The total colour differences of all the treated fabrics were found to be slightly increased as compare to control sample. Banana pseudo stem sap can be an excellent bio auxiliary for finishing of cellulosics with improved colour strength properties. Hence, the optimum utilization of widely available banana pseudo stem sap for textile colouring and finishing can minimize the effluent load and a effective means for green environment.

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