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EFFECT OF ECOFRIENDLY BIOPOLYMER FOR ENHANCING FUNCTIONAL PROPERTIES OF COTTON FABRIC THROUGH DYEING

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INTRODUCTION

The textile dyeing industry growth is accelerating rapidly to fulfill the consumer's demands and colouration technology has dominated this industry. Colour of textile material play an important role in marketability of fabrics due to its psychological effect and catches the attention of the consumers. The global consumption of textiles is estimated to grow at the rate of 3 percent per annum. The colouration of this huge quantity of textiles need about 7,00,000 tonnes of dyes and such a huge amount of required textiles substrate cannot be dyed and printed with natural dyes only. Reactive dyes are most common classes which are used for colouration of cotton textiles but these are most unfavorable class of dye from the ecological point of view because effluent produced gives very high values of biological oxygen demand (BOD), chemical oxygen demand (COD) and increases salinity of river water which affect the delicate biochemistry of aquatic life. The best approach would obviously be to modify the textile processing technologies and chemistry to reduce the environmental discharge occurring during dyeing. So, most researchers focus on introducing salt-free/low-salt dyeing technology for reactive dyes.

When the cotton fabric is immersed in water, it carries the anionic charge on its surface. Reactive dyes are also anionic in nature. Thus the anionic surface of cotton fibre repels the anionic dye molecules. To overcome this problem huge amount of synthetic mordants to create forces of attraction between dye molecules and cotton fibre by developing cationic charge on cotton surface. At the same time these synthetic mordants are harmful and carcinogenic in nature. Cationic modification agents consist of two functional characteristics such as multiple functional groups that could react with cotton under alkaline conditions and cationic amino groups that could reduce the negatively charged barrier between fiber and dye. Modification is possible with the help of biopolymers, an environmentally benign route. It is well-known that biopolymers are capable of forming ionic interactions with cotton cellulose by rendering positive charge and provide other functional properties to fibre. In the present study the different biopolymers were tried to enhancing the dyeability of cotton fabric with anionic dyes.

Key words- Effect, Ecofriendly, Biopolymer, Cotton Fabric, dyeing

1.Objectives:

i. Selection of biopolymer and synthetic dye on the basis of dye absorption, colour strength and wash fastness
ii. Application of synthetic dye on biopolymer treated fabric and its effect on functional properties on cotton fabric.

1. Material and Methods:

Materials: Pure cotton fabric, biopolymers i.e. Chitosan, beta-cyclodextrin, Sericin, direct dyes, reactive dyes and acid dyes. Percent dye absorption, colour strength (k/s) value and wash fastness rating were used for selection of one synthetic dye and biopolymer.

Methods:

i. **Colour measurement**: The colours of dyed samples were measured numerically through computerized colour matching machine. The reference spectra of dyed samples were observed by using spectrophotometer SS5100A, K/S value and CIE LAB co-ordinates L*, a* and b* were noted down directly from the computer screen. This spectrophotometer uses CIE LAB (1976) colour space, D65 illuminate matching and appraisal and 420 nm wavelength to measure the actual colour and change in colour. The CIE LAB colour space uses L*, a* and b* scales to describe colour. L* is a measure of darkness/lightness of colour of an object and range from 0 (black) to 100 (white), a* of redness (+ve a*) or greenness (- ve a*), b* of yellowness (+ve b*) or blueness (-ve b*), C* of dullness/brightness and H* is a measure of hue.
ii. **Fastness to washing:** Wash fastness test was carried out as per recommendation of IS: 3361-1979 method (BIS, 1979). The change in colour of dyed samples was assessed with grey scale no.1 as per the recommendation of the ISO 105 method. The visual differences were compared between the original and tested material with the difference represented by the Grey Scale.
iii. **Crease recovery angle:** Wrinkle recovery is the resistance to and recovery from creasing. Resistance to creasing depends on the rigidity while recovery depends on the elasticity. The measure of crease recovery is the angle at which the sample recovers from creasing. The wrinkle recovery was determined on the Shirley crease recovery tester using BS 3086:1972 test method.
iv. **Antibacterial property**: Colony forming unit (CFU) were determined to know the microbial load on controlled, treated and dyed fabric. The bacterial resistance of the control and treated samples against Gram-positive bacteria (*Staphylococcus aureus)* and Gram-negative bacteria (*Escherichia coli)* was quantitatively tested by AATCC Test Method 100.

2. Results and Discussion:

Table 2: Effect of chitosan treatment and reactive red dye on crease recovery angle of V fabric

S. No.	Treated samples	Properties			
		Crease recovery angle (degree)			
		Warp Mean ± S.E.(m)	Weft Mean ± S.E.(m)	Mean (warp +weft)	Percent change
1.	**Scoured fabric (control)**	85.4 ± 0.24	82.6 ± 0.67	84.00	-
2.	**Alkali treated**	88.4 ± 0.68	84.2 ± 0.66	86.30	+2.67
3.	**Alkali treated dyed fabric**	89.4 ± 0.51	86.4 ± 0.51	87.90	+4.44
4.	**Chitosan treated**	92.4 ± 0.58	90.8 ± 0.81	91.60	+8.29
5.	**Chitosan treated dyed fabric**	100.6 ± 0.92	99.4 ± 0.74	100.0	+16.0
	C.D C.V. F cal	1.86 1.54 83.86*	2.05 1.73 100.04*	-	-

+ = Increase, - = Decrease, S.E. (m) = Standard Error of Mean, C.V. = Coefficient of Variance, F value =Fisher Ratio

* Significant at 5% level of significance, NS= Non- Significant

The chitosan treated and the chitosan treated dyed fabrics showed higher crease recovery angle than the alkali treated and alkali treated dyed fabric. **Yang *et al.* (1997)** reported that cross-linking with polycarboxylic acids (PCAs) also caused significant improvement in crease recovery behaviour of treated cotton fabrics. Crosslinked cotton fabric resisted deformation.

Effect of chitosan treatment and reactive red dye on antibacterial property of cotton fabric:

From the table it can be noted that when the chitosan treatment was applied to the scoured cotton fabric, it provided 84.14 and 84.16 percent reduction in the growth of *E.coli* and *S. aureus* bacteria respectively. Further chitosan treated dyed cotton fabric exhibited 85.50 percent reduction in the growth of *E.coli* bacteria and 84.28 percent in the growth of *S.aureus* bacteria. Thus it is envisaged that chitosan treated reactive red dyed fabric displayed the higher percent reduction in growth of

E.coli and *S. aureus* bacteria in comparison to alkali treated dyed fabric. The results of the study supported by **Malik and Kumar (2005)** developed antibacterial cotton textile by coating it with chitosan 3-amino-1,2,4-triazolehybrid at different concentrations. The antibacterial activities of the treated cotton materials displayed excellent antibacterial effects against gram-positive bacteria, *S. aureus* and gram- negative *E. coli*.

FTIR analysis of chitosan treated cotton fabric: FTIR analysis of chitosan treated fabric was done and data related to presence of functional groups are presented in figure 1.

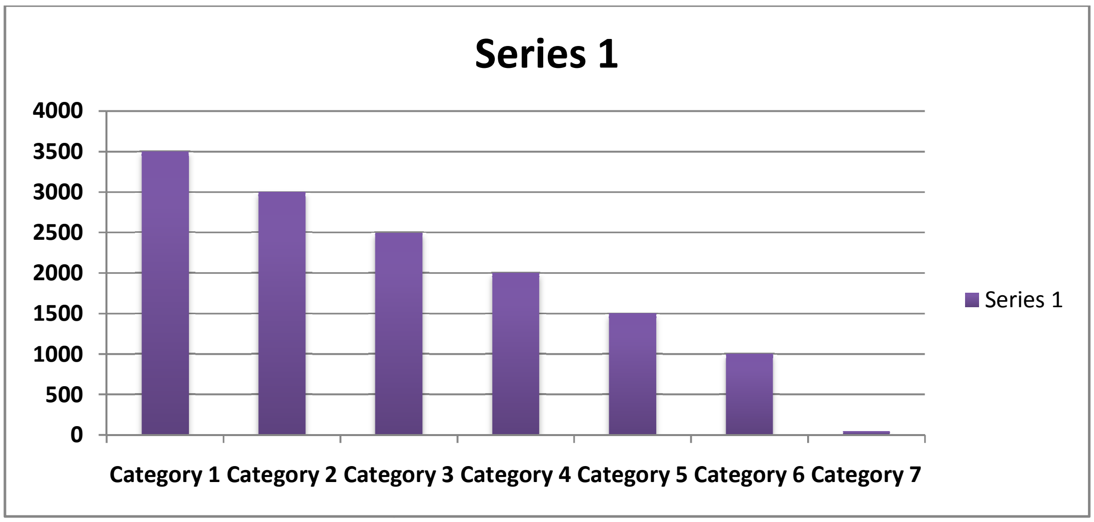

Figure 1: FTIR analysis of chitosan treated cotton fabric

FTIR analysis of chitosan treated fabric demonstrated the presence of functional groups i.e. hydroxyl group (H-bonded–OH- stretch) alcohol, C-H stretching, O-H stretching, alkanes, carboxylic acids, cyano compounds, disubstituted alkynes, -OH bend , tertiary amine –CN- stretch, secondary amine –CN- stretch, C-O stretching - alcohol, carboxylic acids, esters, ethers. According to **Hollen and Saddler (1979)** chemical reactivity of cellulose is related to three hydroxyl groups (OH groups) of the glucose unit. These groups readily react with moisture, dyes, and many finishes. FTIR analysis of chitosan treated cotton fabric indicated the presence of amine groups (NH_2) which are the active sites for many chemical reactions. It revealed that the chitosan imparted its cationic character to the cotton fabric and provided more cationic sites for the attachment of anionic dye. Due to the presence of amino groups the chitosan treated cotton fabric showed bacterial resistance against *E.coli* and *S. aureus* bacteria.

FTIR analysis of chitosan treated reactive dyed cotton fabric: The figure 2 consists of the FTIR spectrum of chitosan treated cotton fabric dyed with reactive red dye.

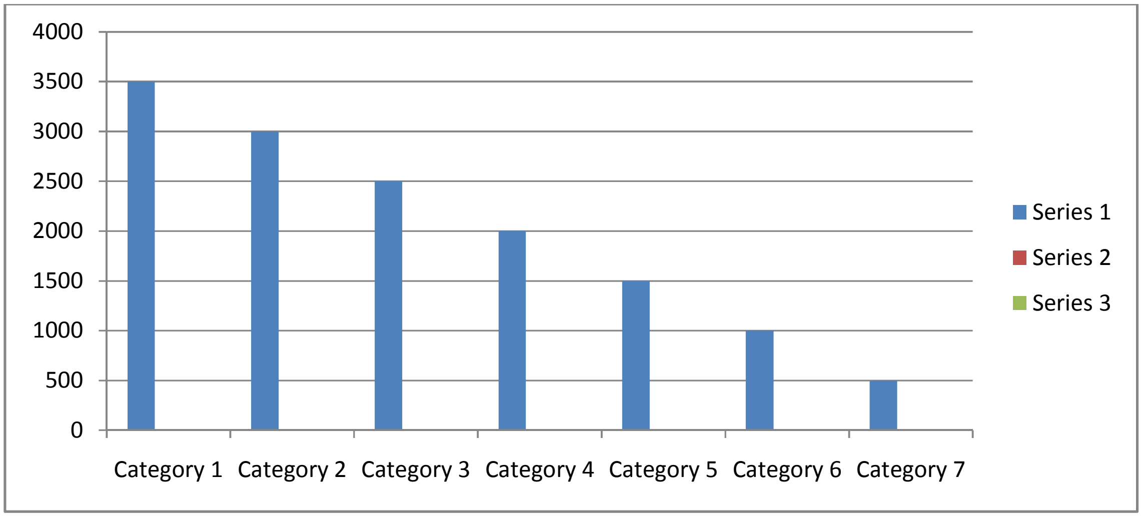

Figure 2: FTIR analysis of chitosan treated reactive red dyed cotton fabric

FTIR spectrum of chitosan treated cotton fabric dyed with reactive red dye depicted different functional groups namely hydroxyl group (H-bonded–OH- stretch), alkanes and cyano compounds, distributed alkynes, C-triple bond-C-stretch, -C-double bond-C stretch, primary amine and N-H bend, **-**OH bend (aromatic primary amine stretch), The tertiary amine, –CN- stretch and secondary amine, –CN- stretch. The result of the study supported by **Chattopadhyay (2001)** revealed that pretreatment of cotton with polyamide epichlorohydrin (PAE) polymer resulted excellent exhaustion of reactive dye from dye bath in absence of salts but the exhaustion and fixation reached the maximum at 2.0 % (owf). The dye exhaustion found more in acidic condition. The improvement in dye might be attributed to the presence of secondary and tertiary amino groups of polyamide epichlorohydrin (PAE) polymer.

CONCLUSION

Thus it was concluded that the combination of dyes with biopolymer is the promising approach to fulfill the requirement of the consumers for safe and eco-friendly products. This approach enhanced dyeing efficiency of cotton fabric without using salts and alkalis and also improved other properties such antibacterial and crease recovery ever demanded by consumers.

IMPLICATIONS:

- The study will increase income of the farmers who are engaged in production of cotton; dyers and manufacturers occupied in business and trade of natural dyes in small scale industry and will also generate employment.
- Chitosan treatment makes the dyeing process more eco-friendly, safe and it will also reduce the cost of production and waste generation.

Recommendation:

- Chitosan treatment and dyeing process of natural and synthetic dye enhanced the dyeing efficiency and provided very good wash fastness to cotton fabric without any salts or electrolyte. Thus it makes the dyeing process more eco-friendly, safe and it will also reduce the cost of production and waste generation.
- Chitosan treatment can also be used for enhancing the dye efficiency of other cellulosic fabric. It may also be used for imparting the crease resistant and antibacterial property to the cotton fabric.

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