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Effect of sericin treatment on physical properties of cotton fabric

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ABSTRACT : During silk processing, a gummy substance known as sericin is discarded in wastewater. If it can be utilized in textile treatment for enhancing mechanical properties it would not only provide an eco-friendly approach in textile finishing but also a viable source of income to people engaged in silk processing. In this study, cotton fabric was treated with silk sericin powder following a pad dry cure method. The treatment was given to cotton fabric using optimized conditions of variables. There was no significant change in fabric count, weight and thickness of fabric after treatment with sericin. Tensile strength increased by 8.5 per cent whereas elongation decreased by 8.3 per cent. Gain in flexural rigidity and bending length was observed.

Key words: Cotton fabric, physical properties, silk sericin, sericin treatment

Using fabric of natural origin in apparels is considered safe both for the human skin and environment after disposal. Now a days consumers prefer natural products in both national and international market. Use of cotton fabric is increasing due to increasing health and environmental awareness regarding hazardous effect of man made products. Cotton is one of the most important natural fibers and is used extensively in textile industry alone or in blend with synthetic fibers. Cotton is considered appropriate for apparel purposes due its moisture absorbing properties, durability and withstands multiple laundering.

In India sericulture is a small scale industry providing livelihood security to rural poor. The post rearing operations are fairly cost effective and silkworm rearing is still only considered as a side activity to the main farm activity. India is the second largest producer of silk in the world and has the distinction of producing all the four varieties of silk (Sundari and Lakshmi , 2015). Sericin is gummy substance present on raw silk filaments and gets removed during degumming of silk filaments. Sericin or silk glue is a globular protein obtained from Bombyx mori silk worm (Rajendran *et al.,* 2011) that constitutes 25 to 30 per cent of silk proteins and it also has some impurities such as waxes, fats and pigments. This protein allows the adhesion of silk filaments to maintain the structural integrity of the cocoon during its formation (Hoa *et al.,* 2012). Sericin is yellow, brittle and inelastic substance. It consists of amino acids, most of which have strong polar side chains such as hydroxyl, carboxyl and amino groups. It is hydrophilic in nature due to the presence of chemical groups like hydroxyl, carboxyl and amino groups (Xu and Zhang, 2011). Also it has been successfully used in textiles to increase hydrophilicity and crease recovery properties (Xing *et al.,* 2011, Gupta *et al.,* 2015). Recovering and reusing sericin from degumming liquor can reduce effluent load and thereby less impact on environment (Rangi and Jajpura, 2015).

Physical properties play an important role in the buying and selling of fabrics as well

as in consumer use. In this paper effect of silk sericin on the physical properties of cotton fabric which was later dyed with natural dye has been reported.

Materials used: The mill bleached plain-weave medium weight cotton fabric was procured from local market Hisar, Haryana. Silk sericin powder was procured from Maharashtra. Specification details of sericin have been given in Table 1 which was provided by the supplier. All other chemicals of laboratory grade were used in the study.

Methods : Prior to treatment, cotton fabric was desized in a solution containing 1 per cent sulphuric acid (H_2SO_4) at 50°C with MLR 1:40 for 60 min. Afterwards the fabric was weighed and soaked prior to introduction in the scouring bath. Scouring was done using aqueous solution containing 1 per cent soap, 3 per cent soda ash and 0.5 per cent sodium sulphite at boiling temperature with MLR 1:40 for 60 min. The fabric was rinsed thoroughly to remove any residues, if left and dried on a flat surface. Fabric was pre treated in a solution containing 0.50 per cent sericin, 4 per cent citric acid and per cent catalyst at 50°C for 45 min. maintaining pH 8 keeping material to liquor ratio 1:30. Afterwards samples were dried in hot air oven at 70°C for 4 min. and cured at 160°C for 2 min (Bhandari *et al.,* 2015). Sericin treated fabric was dyed with *Manjistha* dye using its standardized procedure. Purpose of dyeing was to assess the dyeability of cotton fabric after sericin treatment.

Table 1. Specification details of sericin powder

Tests	Specifications	Results
Description(Appearance)	White to light yellow	Light yellow
Nitrogen (%)	NLT 10	15.0
Polarity collateral amino acid proportion	NLT 70	73.2
Loss on drying (%)	NMT 6.0 per cent	5.4 per cent
Residue on ignition (%)	NMT 4 per cent	2.5 per cent
Heavy metals	NMT 10.0 per cent	6.3 per cent
pH	5.0 to 7.0	5.5

NLT: Not less than, NMT: Not more than

To determine the fabric properties, samples were conditioned for 24 h under standard test conditions *i.e.* relative humidity: 65±2 per cent, temperature: 27 ±2°C. Bending length of the fabrics was determined by the Paramount stiffness tester using IS: 6490-1971 test method. Tensile strength along with elongation of fabrics was determined on Paramount digital tensile strength tester (Analogue Model), using IS 4169 standard test method. Meaningful inferences were drawn from the data obtained using appropriate statistical tests.

The preliminary data of the fabric to be treated and dyed was obtained under three parameters *i.e.* fabric count, thickness and weight as given in Table 2. The fabric count of the treated cotton fabric slightly increased, which may be due to the presence of the crosslinking agent that bound the cellulose molecules by the crosslinking bonds, bringing the molecules closer and resisting their movement here and there. Hence as a result yarns come closer to each other, hence the fabric count increased.

The thickness of the cotton fabric treated with sericin and dyed with *Manjistha* increased by 3.03 per cent in comparison to the untreated dyed fabric. It may be due to the absorption of the sericin and dye within the fibre. The weight of the cotton fabric increased from 121.8 to 123.2 g/m^2 after sericin treatment and dyeing. The increase in weight may be due to the absorption of the sericin and chemical auxiliaries into the fabric.

The result in Table 3 reveals that there was 3.01 per cent increase in bending length and 7.5 per cent increase in flexural rigidity of the sericin treated dyed fabric. This might be due to the crosslinking reaction taking place during sericin treatment which made the fabric

Table 2, Preliminary properties of dyed fabrics

Preliminary properties		Untreated dyed fabric		Treated dyed fabric		Per cent change
		Mean ± S. E	C.V.	Mean ± S. E.	C.V.	
Fabric count(threads/inch)	Warp	103±0.51	1.80	104±0.50	2.10	+1.86
	Weft	58±0.50	1.40	60±0.50	1.20	
Fabric weight (gm/sq.m)		121.8±0.79	1.46	123.2±.058	1.05	+1.14
Thickness (mm)		0.33± 0.01	1.63	0.34± 0.01	1.58	+3.03

+ = increase; - = decrease; S.E.= Standard error; C.V.= Coefficient of variance

stiff. Because of stiffness of the fabric there was increase in the bending length of the fabric. Gupta *et al.,* 2014 also observed that the bending length increases slightly as the concentration is increased from 5 gpL to 15 gpL. Increase in bending length was also reported in another study on polyester by Gupta *et al.,* 2015. The findings can be supported by Ali *et al.,* (2011), bending length increased after chitosan application using pad dry cure method as compared to the untreated fabric.

The results of the study show that the tensile strength for sericin treated dyed fabric increased to 21.70 from 18.26 kg of the untreated dyed fabric. Possible reason is that the compactness of the weave and bonding in the fibres after sericin treatment might have resulted in increased tensile strength of treated fabric. The results of the study were in accordance with the findings of Jassim *et al.,* (2010) indicating that the tensile strength increased after treatment with 2 per cent sericin. Whereas contradicting with the results of Xing *et al.,* (2011) was found who reported that all treated samples yield lower breaking strength compared with those of untreated samples. Because cotton fabric is alkali fast but not resistant to acid, strength losses were due to acid hydrolysis reactions of cellulose macromolecules. Slight loss in strength was observed by Bhuiyan *et al.,* 2016 on chitosan treated cotton.

It is evident from Table 3 that elongation of the treated dyed fabric decreased after application of sericin from 27.68 to 25.38 *i.e.* 8.3 per cent. It might be due to the stiffness of the fabric which was obtained by cross linking after application of sericin. When the fabric becomes stiff the elongation of the fabric decreased as it restricts the movement of the cellulose molecules within the fiber. As a result of it, instead of stretching, the fabric breaks off.

CONCLUSION

- Sericin can be used in the modification of cotton molecular/surface for further dyeing process without much affecting

Table 3. Physical properties of dyed fabrics

Physical Properties		Untreated dyed fabric			Treated dyed fabric			Per cent change
		Mean ±S.E.	C.V.	**Mean**	Mean ±S.E.	C.V.	**Mean**	
Bending length(cm)	Warp	3.93 ±0.20	11.2	**3.54**	3.99± 0.17	9.3	**3.65**	+3.01
	Weft	3.15 ±0.17	12.0		3.32±0.12	8.10		
Flexural Rigidity(mg-cm)		-	-	**152.60**	-	-	**164.10**	+7.5
Tensile strength(kg)	Warp	20.5 ±0.71	7.7	**18.26**	24.12±0.32	4.0	**21.70**	+18.83
	Weft	16.01± 0.80	11.2		19.28±0.38	5.6		
Elongation(%)	Warp	24.5± 0.60	5.4	**27.68**	23.46±0.70	6.6	**25.38**	-8.3
	Weft	30.87± 0.52	3.5		27.30±0.32	2.8		

+ = increase; - = decrease; S.E.= Standard error; C.V.= Coefficient of Variance

its physical properties.

- Tensile strength of the treated cotton fabric exhibited significant increment.
- Sericin provides an ecofriendly approach in fabric modification for improving tensile strength with less effect on fabric weight and softness.
- Application of sericin biomaterial will reduce the environmental impact of textile wet processing industry by eliminating the use of chemical agents.

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