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EFFECTS OF APPLICATION OF SERICIN ON SPUN POLYESTER

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Abstract: Sericin is a protein material, which is adhered to the fibroin filaments while the formation of natural silk by silk worm. Proteins in general can be those, which are closely associated with the life phenomenon as vital constituents of the protoplasm or structural proteins, which are building materials, which sustain the individual. The silk fibre is almost a pure protein fibre composed of two types of proteins, namely, fibroin & sericin. In the field protein chemistry, sericin is classified as hard protein along with fibroin, keratin, collagen and elastin. The solution behavior resembles closely with gelatin. The cocoon, fibre sericin gets dissolved when cooked in water. Concentrated sericin solution can be converted to gel and can be converted into powder.
Cross-links are the bonds that link one polymer chain to another. They can be covalent bonds or ionic bonds. When the term "cross-linking" is used in the synthetic polymer science field, it usually refers to use of cross-links to promote a difference in the polymer physical properties. When "cross-linking" is used in the biological field, it can be in reference to its use as a probe to link protein together to check protein-protein actions, as well as other creative cross-linking methodologies. Cross-linking is used in both synthetic polymer chemistry and in the sciences.
As the sericin extracted will be in the aqueous form, which is biodegradable material, needs proper process in order to preserve it for storage and further utilization. Sericin being complex protein proper handling is a need for effective use. Further the effect of fixing the sericin on to the polyester fabric and some physical properties as well as the moisture content has been studied

I. INTRODUCTION

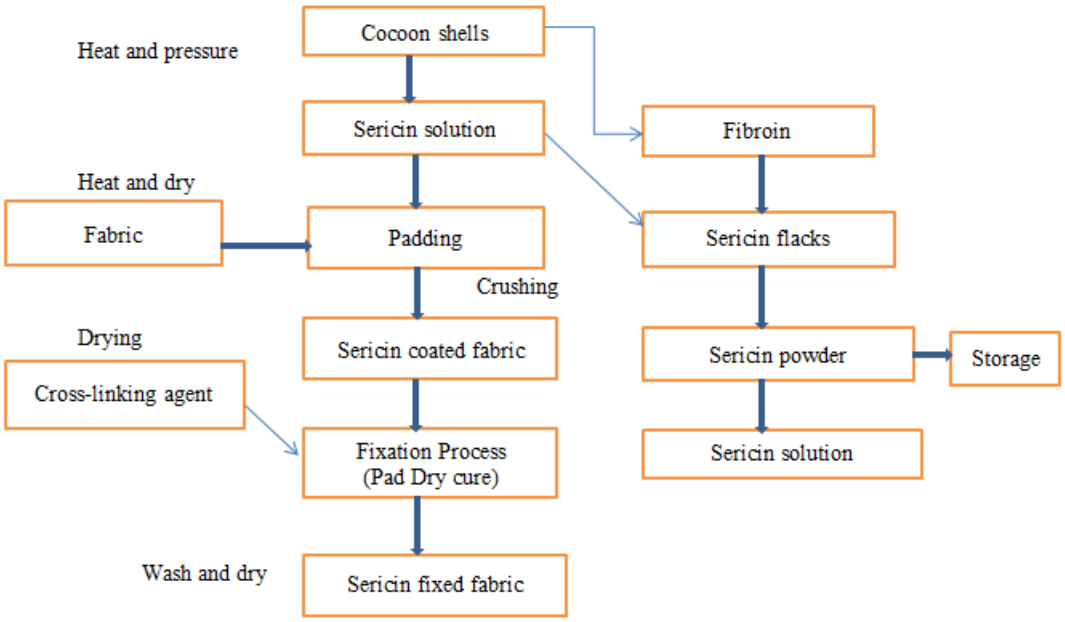
Sericin is a protein material, which is adhering to the fibroin filament while the formation of natural silk by silk worm. The sericin content and its characteristics in natural silk vary from one variety to the other. There are four variety of silk, either cultivated or naturally grown. They are Mulberry silk(Bombyx mori), Tassar(Autherea Mylitta), Muga and Eri. In India all the four variety of silk is available. The sericin content varies from 6-7% to 21-28%. Sericin mainly consists of protein material which has wide range of applications. India has a glorious sericulture tradition on its own, which no other country in the world can share; the muga and tropical tassar silk is originated in India & Muga silk is exclusively confined to India, besides Muga, Tassar, Eri and Mulberry silk are also cultivated in a larger quantity, making Indis is also a largest user of silk and it has very strong domestic market which is real a strength of Indian silk production. During the project an attempt has been made to extract the sericin from silk cocoon and to apply it on spun polyester.

1.1 Objectives of Study:

- To extract sericin by eco-friendly way.
- To analyze degumming and degumming loss.
- Application of sericin in finishing to enhance comfort properties.
- Optimization of finish.
- Characterization of finished sample.

II. MATERIALS AND METHODS

Experimental work: At the first step, the sericin which is a natural protein gum present on silk filament has to be extracted to the fullest extent possible. Then the preserving the extracted sericin in suitable manner for further use, later the test is been conducted on sericin to check on its moisture content, Moisture regain, ash content, UV absorption. After finding the values the sericin is been applied to spun polyester fabric. Once the sericin is been applied on to the fabric, fixation of sericin on the fabric is done, followed by checking the changes in the properties of fabrics.
Comparison of original fabric properties with the fabric applied with sericin is done at last.



Flow chart 2.1; Flow chart of process involved in developing the fabric with sericin coating

2.1 Properties of Sericin powder

2.1 a. Moisture content & moisture regain;

The sericin sample is conditioned for 48 hours at 65% RH. The conditioned sample of known weight is dried in the hot air oven at 105±2ºc temperature for 1 hour. The weight of the sericin is noted which gives the dry weight of the sericin. Moisture content and regain is calculated on the basis of initial & final weight.

$$\text{Moisture content}(\%) = \frac{\text{Initial weight-Final weight}}{\text{Initial weight}} \times 100$$

$$\text{Moisture regain}(\%) = \frac{\text{Initial weight – Final weight}}{\text{Final regain}} \times 100$$

2.1. b. Ash content;

5 grams of sericin sample was weighed and put into a crucible which was previously been ignited, cooled in desiccators and weighed accurately. The material was burned continuously in the furnace and when material reached the glowing stage the crucible was moved towards the rear of the furnace. The door was closed and aching was allowed to complete for 1 hour at 600ºC the ash percentage was calculated using the formula

$$\text{Ash content } (\%) = \frac{W2-W1}{W} \times 100$$

W – Weight of the test specimen in grams
W1 – Initial weight of crucible
W2 – Final weight of crucible with ash after cooling

2.1. c. UV absorption spectra;

The UV spectrum of the extracted sericin solution is presented in the fig., The UV absorption spectrum shows a characteristic peak of sericin in the region of 275mm. Because the sericin absorbs UV light, it may act as UV protective agent.

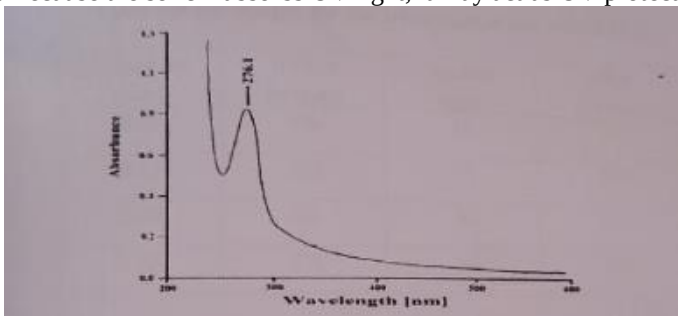


Fig 2.1 Showing the UV absorption spectra of sericin

2.2 Application of sericin to polyester

2.2.a.Glutaraldehyde as cross-linking agent

The polyester fabric was pre-treated with 15% NaOH(o.w.f), with the material to liquor ratio of 1:40, at 60ºC for 30min to get a weight loss of 5%. This weight loss was expected to give sufficient number of end groups so that further treatment could be carried out. The pre-treated fabrics were padded(80% expressions) with the sericin solution along with glutaraldehyde, magnesium chloride and acetic acid in a laboratory padding mangle by 2-dip/2nip process. The padded fabric was dried and cured. The cured samples were washed at 60ºC and dried.

Table no 2.1, Recipe for the treatments of fabric with glutaraldehyde

SAMPLE CODE	GLUTARALDEHYDE (ml/l)	SERICIN(gpl)	$Mgcl_2$ (gpl)	Acetic acid(ml/l)
G10	5.0	10	10	1.0
G15	5.0	15	10	1.0
G20	5.0	20	10	1.0
G30	5.0	30	10	1.0

2.2.b.BTCA as cross-linking agent

The polyester fabric was padded with sericin solution along with BTCA, sodium hypo phosphate in laboratory padding mangle by 2-dip/2nip process. The padded fabric was dried and cured. The cured samples were washed at 60ºC and dried.

Table no 2.2, Recipe for the treatment of fabric with BTCA

Sample code	BTDA(o.w.m)	Sericin(gpl)	SHP(o.w.m)
B 10	6%	10	3%
B 15	6%	15	3%
B 20	6%	20	3%
B 30	6%	30	3%

Note: 10,15,20,30 are the concentration respectively

Performance properties of the treated fabric

The bending length of the treated fabric was measured according to British standards BS 3356-1961

The air permeability of the fabric was measured according to IS 11056-1964 standard

The moisture content of the fabric is determined according to IS 15090-2002 standard

III.RESULTS AND DISCUSSION

3.1Sericin extracted and quantification

The results of degumming experiments are given in the table

Table no.3.1; degumming trials with different cocoon weight

Wt.of cocoons(g)	20.14	50.06	25.39
Material to liquor ratio	1:40	1:40	1:40
Water taken(ml)	806	2002	1016
Wt.of degummed shell	18.61	39	18.65
Sericin obtained	3.95	9.5	4.9
Degumming%	22.07	26.33	29.27

The degumming loss is observed

3.2 Basic properties of sample

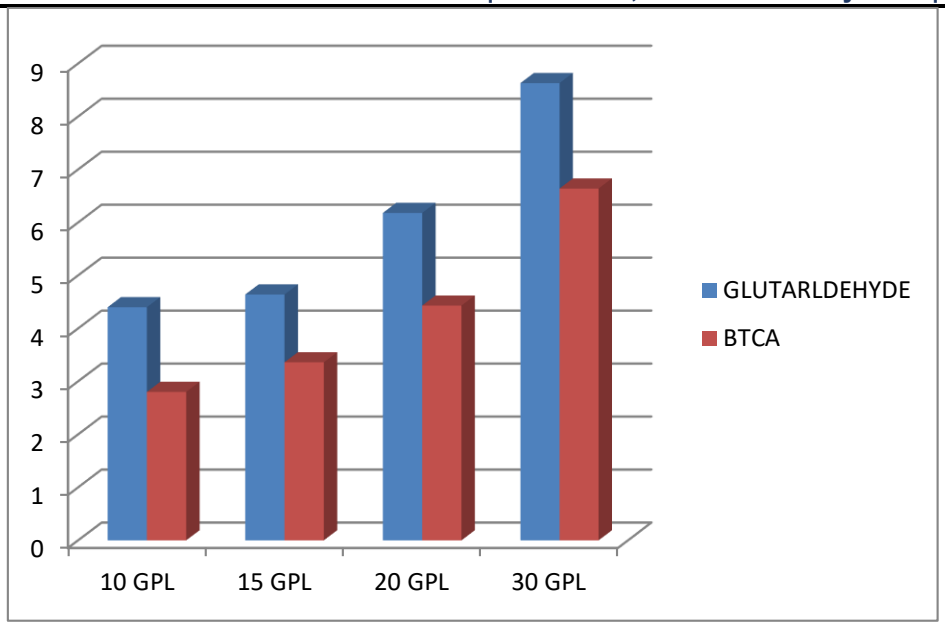
The fabric is tested for geometric parameters such as fabric count, thread count, cover factor , fabric thickness and GSM. The fabric count is determined using Beesley balance, Thread count is determined manually using counting glass, Thickness of the fabric is determined using thickness guage. GSM of the fabric is determined by cutting the sample of dimension 10×10cm. Cover factor of the fabric is determined and the fabric is tested for its functional properties like bending length, air permeability and moisture content.

Table no,3.2: Basic properties of sample

Parameters	Warp	Weft
Threads/cm	34	31
Yarn count,Tex	7	7
Cover factor	13	11
Thickness,mm	0.20	
GSM	83	
Moisture content,%	0.77	

Table no.3.3: Sericin pick up %

Sample	Glutaraldehyde %	BTCA %
10gpl sericin	4.4	2.8
15gpl sericin	4.64	3.36
20gpl sericin	6.18	4.43
30gpl sericin	8.63	6.64

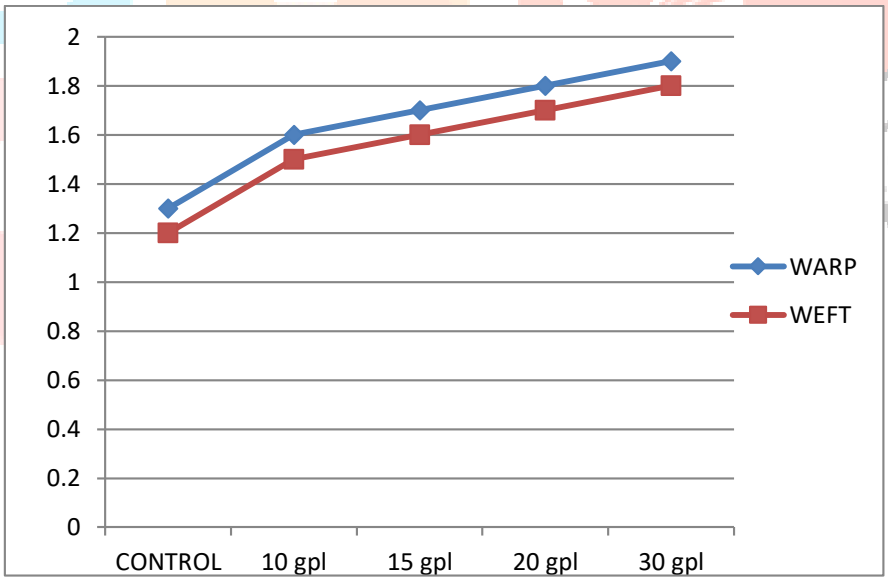


Graph no 3.1, showing the sericin pickup

3.3 Results of bending length of original and treated fabric

Table no 3.4, showing the bending length value of glutardehyde treated fabric

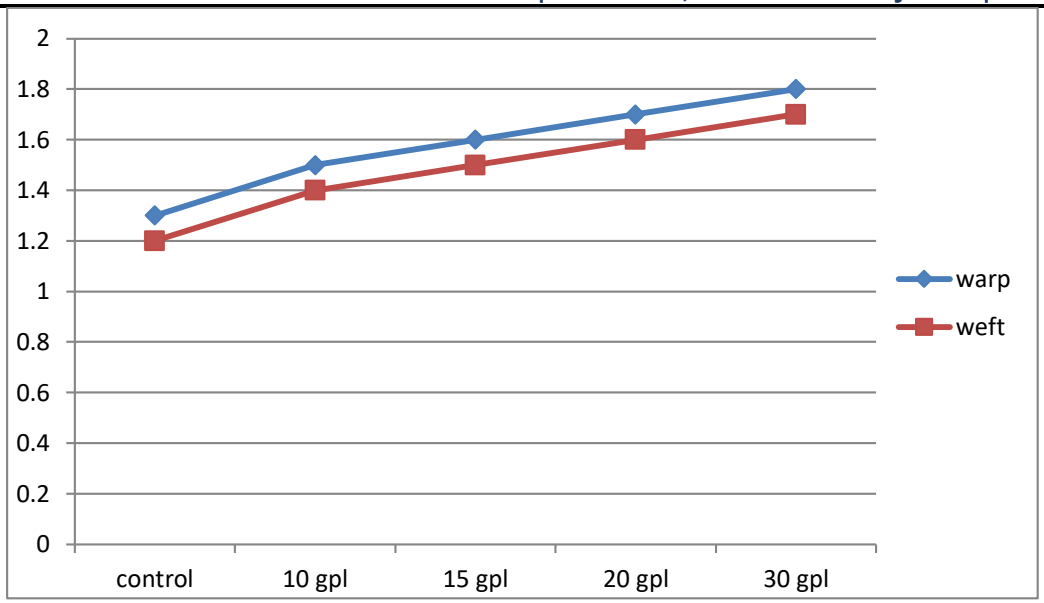
Sample	Bending (in cm)	
	Warp	Weft
Control	1.3	1.2
10 gpl	1.6	1.5
15 gpl	1.7	1.6
20 gpl	1.8	1.7
30 gpl	1.9	1.8



Graph no 3.2 Showing the bending length of glutaraldehyde treated fabric

Table no 3.5 showing the bending length of BTCA treated fabric

Sample	Bending(cm)	
	Warp	Weft
Control	1.3	1.2
10 gpl	1.5	1.4
15 gpl	1.6	1.5
20 gpl	1.7	1.6
30 gpl	1.8	1.7



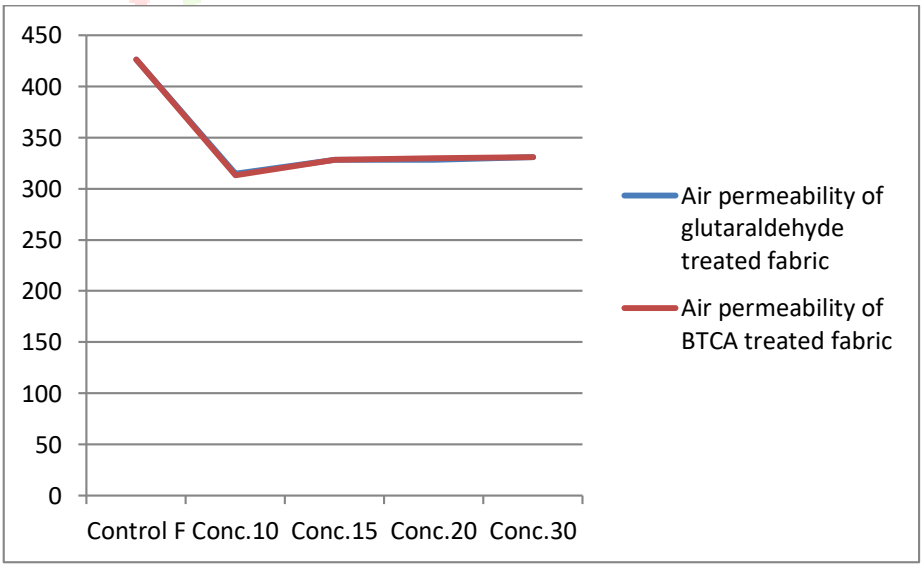
Graph no.3.3 showing the bending length of BTCA treated fabric

Table no 3.6 showing the ANOVA of bending length

Source	Type III sum of Squares	df	Mean square	F	Sig
Direction	.830	1	.830	153.578	.000
Agents	.443	1	.443	81.855	.000
Conc.	11.374	4	2.844	525.974	.000
			.014		
Error	1.622	300	.005		
Total	818.530	320			
Corrected Total	14.935	319			

Table no 3.7 showing the Air permeability values of Glutaraldehyde & BTCA treated fabric

Sample code	Air permeability($m^3/m^2/min$)	Sample code	Air permeability($m^3/m^2/min$)
C	426.20	C	426.20
G 10	314.68	B 10	313.18
G 15	328.00	B 15	328.00
G 20	328.11	B 20	329.67
G 30	330.72	B 30	331.02



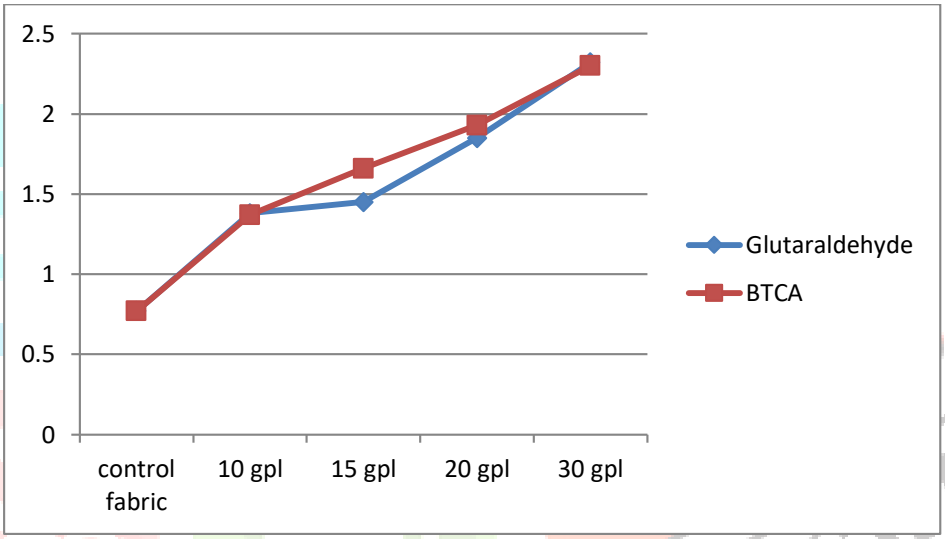
Graph no 3.4 showing the results of air permeability

Table no.3.8 showing the ANOVA of Air permeability

Source	Type III sum of squares	df	Mean square	F	Sig
Agents	.000	1	.000	.000	1.000
Conc	352675.000	4	88168.750	12.883	.000
Error	273750.000	40			
Total	47047500.00	50			
Corrected Total	679050.000	49			

Table no 3.9 Showing the result of moisture content of treated fabrics

Sample	Glutaraldehyde	BTCA
Original	0.77	0.77
10 gpl	1.38	1.37
15 gpl	1.45	1.66
20 gpl	1.85	1.93
30 gpl	2.32	2.3



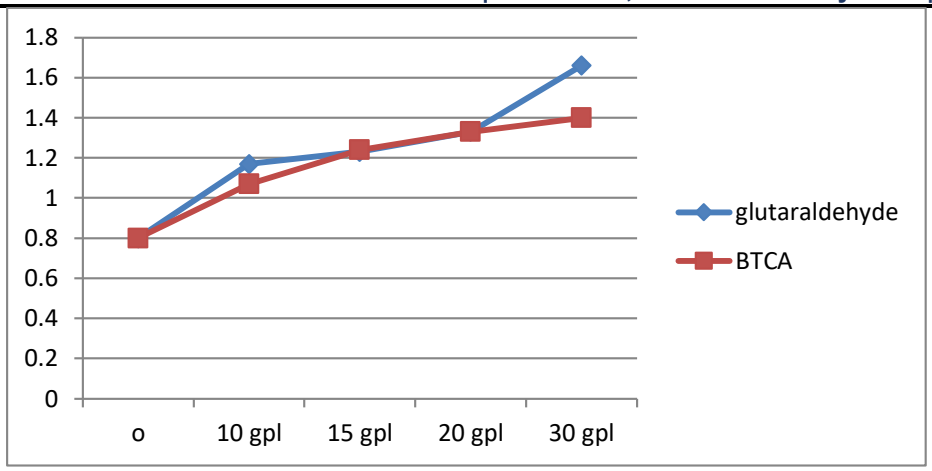
Graph no.3.5 Showing the results of moisture content value of both glutaraldehyde and BTCA

Table no.3.10 Showing the ANOVA of Moisture Content

Source of variation	SS	df	MS	F	P-Value	F crit
Agents	0.00845	1	0.008	1.487	0.310	10.128
Conc.	1.01525	3	0.338	59.545	0.004	9.277
Error	0.01705	3	0.006			
Total	1.04075	7				

Table no.3.11 Showing the K/S value of dyed fabric

Sample	k/s value	
	Glutaraldehyde	BTCA
Original	0.8	0.8
10 gpl sericin	1.17	1.07
15 gpl sericin	1.23	1.24
20 gpl sericin	1.33	1.33
30 gpl sericin	1.66	1.4



Graph no 3.6 Showing the results of K/S of treated fabrics

Table no.3.12 showing the ANOVA of K/S value

Source of Variation	SS	df	MS	F	P-value	F crit
Agents	0.015313	1	0.015	1.952	0.257	10.128
Conc.	0.180738	3	0.060	7.679*	0.064	9.277
Error	0.023538	3	0.008			
Total	0.219588	7				

*Significant at 0.1

DISCUSSIONS

- Sericin is obtained from HTHP (High temperature High pressure) degummimg method in which we get purest form of sericin
- Sericin has been tested for properties like moisture content, ash content and UV absorption spectra
- The control fabric is tested for performance properties and the results are compared with the sample treated with sericin cross linked with glutaraldehude and BTCA
- When the fabric is treated with the sericin the hydroxyl(OH) group is introduced in the fabric by cross-linking
- As the sericin concentration increases the moist content and K/S value increases
- Due to the treatment of sericin the bending length gets affected by direction, agents and concentration. Stiffness increases with concentration of sericin content
- Due to the treatment of sericin air permeability gets affected by concentration. The air permeability decreases with treatment and further with change of concentration no perceptible change is seen
- The K/S and Moisture content is only affected by concentration of the treatment.(The K/S is significantly different at 0.1) The high correlation exists between, sericin concentration and these properties
- Glutaraldehyde can be replaced by BTCA because it is a formaldehyde free crosslinking agent

IV.CONCLUSION

From the results of experiments following was the conclusion

- High Pressure, high temperature extraction technique is the best method of extraction of sericin. It also provides the purest form of sericin
- The sericin stored in dry form(powder)is also a convenient storage method and does not involve in any preservative
- Sericin can be fixed by both glutaraldehyde and BTCA fixatives
- As the sericin concentration increases the properties like Moisture absorption, bending length and dye uptake(acid dyes) will increase.
- As the sericin concentration increases air permeability decreases
- BTCA may be preferred because it is formaldehyde free cross-linking agent

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