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Designing and Performance of User Friendly Fabrics

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***ABSTRACT** : Eco-friendly and **e**nvironmental awareness, hazards of chemical industries, dyes and increased health consciousness of consumers have paved way for environmental friendly inventions that include variety of fibres, dyes and chemicals. Natural colour cotton, organic cotton, natural dyes, enzymatic finishes, are few of them. An effort is made to weave eco-friendly fabrics using a combination of lac dyed eri silk with naturally brown coloured cotton. Three fabrics viz., lac dyed pure Eri silk fabric (2/80s), Pure Naturally coloured cotton (NCC X NCC) and Eri (warp) X Naturally coloured cotton (weft) union fabrics formed the test samples. Results revealed that, pure eri silk fabric exhibited greater tenacity, elongation percentage, lower drape co-efficient and colour strength compared to union fabric and pure NCC fabric, whereas, NCC X NCC showed higher values of cloth weight, stiffness, drape co-efficient and lower values of tensile strength and elongation (%). However, Eri X NCC union fabric showed higher values of fabric thickness, weft way bending length, weft way crease recovery angle and abrasion resistance, indicate the fabric to be stiffer and coarser than pure Eri silk fabric. Hand spun, naturally coloured cotton yarn showed unequal distribution of slubs and snarls which gave novelty appearance and textural effect on handloom khadi fabric. Thus, lac dyed Eri silk X NCC union fabric; a unique eco-friendly fabric is best suitable for* suitable for designer's made-ups, shirts and dress materials.

I. INTRODUCTION

Cotton, the king of textile fibre is one of the world's most socially vital and economically important agricultural cash crops that has played a very important role in the lives of Indians and is thus called as the "fabric of India". In recent years the colour linted cotton has gained popularity. Compared to white cotton, naturally colour linted cotton is short, coarse and weak, thus submissive to hand spinning. Of the colour cottons cultivated, brown and green are the most common ones. The recent investigations in brown cottons highlighted various positive features like higher lint yield, acceptable fibre quality, spinnability, colour stability, enhancement of single yarn strength and pigmentation on scouring and mercerization[1]. These inventions further expanded the utility and application of colour linted cotton for bed linen, furnishings and other variegated consumer goods as well as household textiles. Generally colour cotton genotypes have short staple length, weaker fiber strength, low micronnaire value and maturity co-efficient compared to white cotton. Because of these reasons coloured cottons cannot be spun to finer count. However, there is a possibility to improve the above physical properties by blending with other strong fibres. Naturally colour linted cotton can be blended with synthetic fibres to overcome the undesirable and to impart desirable properties in the spun yarn, which is short to produce the blended and union fabrics. Since ages these blended and union fabrics are popular as blending is more likely to produce results superior to those obtained from single fibre alone.

Silk is the natural protein filament fibre known as the "Queen of Textiles", a title well deserved by virtue of its association with royalty, the care required in its culture and the properties and characteristics with which it has been endowed. The silk from broken and damaged cocoons or torn filaments is transferred into spun yarns. Spun silk is relatively less elastic, duller and stiffer than thrown silk and also less expensive. Further, the spun silk is mostly used for low grade silk cloth for apparel, upholstery and draperies. The wooly white eri silk is often referred to as the Ahimsa silk or the fabric of peace as the process does not involve the killing of the silk worm. Eri silk fabric is a boon for those who practice absolute non-violence and do not use any product obtained by killing any living creature. Hence, Vegans and other monks in India prefer this silk.
Lac is the most ancient of animal dyes. Lac is the resinous protective secretion of the tiny lac insect. The insects secrete a thick resinous fluid which envelopes their bodies and the secretions from individual insects coalesce and form a hard continuous encrustation over the twigs. The hard encrustation is available on the surface of different trees and bushes. The twigs are harvested and the encrustation scraped off, dried and processed to yield shellac or dye. The secretions on the twigs of the plant, on which the lac insect thrives, are scraped off to get what is known as the stic lac, harvested from the lac host plants. This contains about 0.5% to 1 % of dye

depending upon the climatic conditions. History of lac goes back to the Vedic period when it was known as 'Laksha'. The term was further used as lake i.e., for the insoluble salt of the dye i.e., pigments. Lake is formed by the action of the mordant and the dye.

The term 'khadi' means cotton khadi, is Indian handspun and hand woven cloth. The raw materials may be cotton, silk or wool, which are spun into threads on a spinning wheel called a charka. It is a versatile fabric, cool in the summer and warm in winter. The fabric got its importance from Mahatma Gandhi when he revived the 5000 year old process of hand weaving as part of his movement of freedom fight in 1920s. Khadi over the decades has moved from a freedom fighter's identity fabric to a fashion garment [2]..Thus, naturally colour linted cotton, eri silk and lac dye being eco-friendly, this research is planned to design exclusively unique, eco-friendly and designer's fabric to assess the performance properties.

II. METHODOLOGY

- The procured Coloured cotton yarn spun to (2/8s) was scoured with 2% NaOH.
- The degummed Eri silk of 2/80s was dyed with 3% lac dye using 2% formic acid mordant to produce a colour which is nearer to the naturally coloured cotton.
- Naturally coloured cotton yarns was interwoven with lac dyed eri silk to produce the following pure and union fabrics

✓ Eri silk X Eri silk plain weave fabric.
✓ Eri silk X DDCC-1 union fabric with plain weave
✓ Production of DDCC -1 X DDCC-1 fabric using plain weave

- The above fabrics were assessed for mechanical and functional properties

III. RESULTS AND DISCUSSION

Table -1 shows the yarn properties of Eri silk and Natural Coloured Cotton. It was found that, the NCC was spun to 2/8s and eri silk of 2/80s with the average twist per inch 5tpi and 7tpi respectively. However, the tensile strength and elongation % of eri silk yarn was found to be more than NCC.

Table 1: Yarn properties

Sl. No.	Type of yarn	NCC	Eri silk
1.	Yarn count **(Numerical Expression)**	2/8s	2/80s
2.	Average twist (tpi)	5	7
3.	Tensile strength (kgf)	0.20	0.24
4.	Elongation (%)	1.22	3.22

Table 2 Presents the Cloth Count of all the three fabrics produced. It Is Seen That, Eri X Eri Pure Silk fabric possessed higher values of Cloth Count (Warp – 47 and Weft – 42) followed by Eri X NCC and NCC X NCC fabrics and was significant. This may be because NCC yarn is coarser than Eri Silk yarn.

Table 2: Cloth count (threads / inch)

Sl. No.	Type of Fabrics	Cloth count	
		Warp	Weft
1.	NCC X NCC	41	27
2.	Eri X Eri	47	42
3.	Eri X NCC	44	40
CD (0.05%)		1.301	1.819
CV		2.321	3.928
CD (0.05%) (2&3)		1.15	NS
CV (2&3)		1.715	4.049

Table 3 shows the cloth weight and thickness of the fabrics. The higher values of cloth weight was found in Eri X NCC (197.6 g/m^2) union fabric and thickness was higher in NCC X NCC (0.62mm) fabric and the increase in thickness and weight was found to be significant.

Table 3: Cloth weight (grams / sq. mt.) and thickness (mm)

Sl. No.	Type of Fabrics	Total weight (g/sq m)	Cloth thickness (mm)
1.	NCC X NCC	258.40	0.82
2.	Eri X Eri	155.20	0.52
3.	Eri X NCC	197.60	0.62
CD (0.05%)		0.006	0.015
CV		0.824	1.570
CD (0.05%) (2&3)		0.010	0.011
CV (2&3)		1.267	1.125

Table 4 reveals the cloth stiffness and cloth crease recovery angle of the fabrics. It is found that the warp way and weft way bending length was higher in NCC X NCC fabric as starched and coarser NCC yarn is used. The higher crease recovery angle was found in Eri X Eri silk fabric both in warp and weft ways as pure Eri silk fabric is pliable and the yarn is finer than NCC.

Table 4: Cloth stiffness (cm) and Cloth Crease recovery angle (degree)

Sl. No.	Type of Fabrics	Bending length		Crease recovery (degree)	
		Warp way	Weft way	Warp way	Weft way
1.	NCC X NCC	2.15	1.65	78	93
2.	Eri X Eri	1.02	1.18	100.5	106.5
3.	Eri X NCC	1.11	0.97	94.75	79.75
	CD (0.05%)	0.145	0.084	4.440	2.395
	CV	2.942	1.916	2.814	1.487
	CD (0.05%) (2&3)	NS	0.151	NS	3.528
	CV (2&3)	4.793	3.122	3.664	1.684

It is seen from the above tables that, among Eri X NCC and Eri X Eri fabrics, Eri X Eri pure silk fabric possessed higher values of cloth count (Warp – 47 and weft – 42), weft way bending length (1.18 cm), warp way (100.5) and weft way (106.5) crease recovery angles than Eri X NCC union fabric. The higher values of cloth weight (197.6 g/m^2), thickness (0.62mm), warp way bending length (1.11cm) and lower values of cloth count (warp- 44 and weft -40), weft way bending length (0.97 cm), warp way (94.75) and weft way (79.75) crease recovery angles of Eri X NCC union fabric reveals that the fabric to be thick and stiff than pure Eri silk fabric may be because of weft NCC yarn which is coarse and posses slubs and snarls. However, non significant difference was obtained in weft way cloth count, warp way bending length and crease recovery angle among both the fabrics. Thus,, cloth count and crease recovery angle of Eri X Eri silk fabric increased while cloth weight and thickness decreased (Rungsima Chollakup *et. al* [3]).

It is observed from Table 5 that, the percent shrinkage in NCC X NCC was more (7%) compared to other two fabrics.

Table 5: Cloth dimensional stability (%)

Sl. No.	Type of Fabrics	Cloth shrinkage	
		Percent Warp	Percent Weft
1.	NCC X NCC	6	7
2.	Eri X Eri	2	3
3.	Eri X NCC	2	5.7

It is found from table 6 that, the warp way (52.92 kgf) and weft way (46.90 kgf) tensile strength of Eri X Eri pure silk fabric was higher than the Eri X NCC fabric. However, the difference in the strength was non significant (Table 2). Thus, there was not much variation in the tensile strength obtained by replacing Eri by NCC yarns in weft way.The elongation (%) of the Eri X Eri silk fabric was higher in warp way (28.04%) and weft way (26.06%) than Eri X NCC fabric. However, in the weft way elongation percentage of Eri X NCC fabric was much lower because of NCC yarns, usually less than silk yarns.

Table 6: Cloth tensile strength (kgf) and Elongation (%)

Sl. No.	Type of Fabrics	Tensile strength (kgf)		Elongation (%)	
		Warp way	Weft way	Warp way	Weft way
1.	NCC X NCC	42.88	25.68	10.66	7.04
2.	Eri X Eri	52.92	46.90	28.04	26.06
3.	Eri X NCC	51.78	41.14	27.08	9.99
	CD (0.05%)	3.926	2.750	0.869	1.336
	CV	7.108	3.833	2.717	6.376
	CD (0.05%) (2&3)	NS	NS	1.911	0.739
	CV (2&3)	4.821	7.844	6.037	1.527

Table 7 shows the cloth abrasion resistance and pilling of the fabrics. It is found that, NCC X NCC need more than 10,000 cycles to get abraded. While Eri X NCC fabric needs 490 cycles to get abraded than Eri X Eri fabric (428 cycles) revealing that Eri X NCC union fabric can withstand more abrasion than Eri X Eri silk fabric.

All the fabrics showed no pilling except in NCC X NCC a slight pilling was observed.

Table 7: Cloth abrasion resistance (cycles) and Cloth pilling (ratings)

Sl. No.	Type of Fabrics	No. of cycles	Pilling (ratings)
1.	NCC X NCC	> 10,000 cycles	1 (slight napping)
2.	Eri X Eri	428	1
3.	Eri X NCC	490	1

The drape co-efficient (%) of NCC X NCC fabrc (130.63) was more than in Eri X NCC fabric (79.72) and Eri X Eri silk fabric (64.59). The no. of nodes found was 4 in NCC X NCC fabric as compared with equal number of nodes i.e 6 in other two fabrics. This shows that, NCC X NCC fabric is more stiff and thick than Eri X NCC union fabric and Eri X Eri silk fabric.

Table 8: Cloth drapability (%)

Sl. No.	Type of Fabrics	No. of nodes	Drape co-efficient (%)
1.	NCC X NCC	4	130.63
2.	Eri X Eri	6	64.59
3.	Eri X NCC	6	79.72

The colour strength (K/S) values of the fabric are depicted in table 9. It is seen from the table that, colour strength value is more in Eri X Eri silk fabric (7.20) since it is lac dyed than in Eri X NCC fabric (4.994) and NCC X NCC (4.267) fabric. However, the colour difference value was found to be ΔE = 19.08 when compared among Eri X Eri and Eri X NCC fabrics and 14.29 when compared among NCC X NCC and Eri X NCC fabrics. As per the L A B values, the colour of the pure eri silk fabric is lighter, towards red and blue colour. While Eri X NCC is lighter in shade of red and yellow colour and NCC X NCC towards darker shade of yellow.

Table 9: Colour Strength (K/S)

Sl. No.	Sample	K/S	ΔE	L*	a*	b*
1.	Control (Eri x Eri)	7.201	--	35.16	18.99	-1.90
2.	Eri x NCC	2.920	19.08	46.65	12.21	11.74
3.	Control (NCC x NCC)	4.267	--	56.62	9.56	21.64
4.	Eri x NCC	4.994	14.29	46.65	12.21	11.74

ΔE : Colour difference = $\Delta a^2+\Delta l^2+\Delta b^2$
L : Lightness or darkness
A : redness/greenness
b: yellowness/ blueness

IV. CONCLUSION

It if found from the findings that, the eco-friendly union fabric showed similar fabric properties of pure eri silk fabric, and as cotton is used in weft it is more comfortable. The results revealed that, lac dyed pure eri silk fabric showed higher tensile strength, elongation (%) and colour strength when compared with other two fabrics.. Thus, the union fabric with unique colour is best suitable for designer's made-ups, shirts and dress materials.

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