International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 2000-2004

Received: 04-05-2019
Accepted: 06-06-2019

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Evaluation of fabric behavior of Eri union twill weaves fabrics for construction of value added products

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Abstract
Union fabrics are those, where fabric are created with warp of one kind of yarn and weft of another yarn. Union fabric can also be produced by using blended yarn in one direction or both warp and weft direction of different blended yarn. In the present work an attempt was made to construct Eri union fabric, the Eri yarn used as warp with Acrylic and Viscose Rayon yarn as weft. In the study the fabrics were prepared with twill weave and were tested for mechanical and functional properties. Moreover, based on fabric texture, handle and the combinations, the products were prepared from the woven fabric and preference was taken from the respondents. The newly designed Eri x Acrylic and Eri x Viscose rayon union fabric showed better result in respect of tensile strength, abrasion resistance, drape coefficient (%) and pilling as comparisons to Eri x union fabric.

Keywords: Eri silk, acrylic, viscose rayon union fabric, mechanical and functional properties

Introduction
India has been famous for its beautiful fabric. Fabric is not just used to cloth a man and to protect him against climate or for modesty but beauty and status are also reasons for a man to wear appropriate cloths. The union fabric is durable, crease resistant, absorbent, lustrous and resiliency etc. The various kind of union fabric can be produced by combination of cotton, rayon, ramie, polyester, acrylic etc. with silk to reduce the cost of the silk fabric as well as the weight of the fabric.

India has the unique distinction of producing the commercial varieties of non-mulberry silk. These varieties of silk fetches premium in the international markets. Specific efforts are required to promote development of basic designs, structures and materials that can be used in production of commercial products. Initiatives are required in creating awareness and promoting uses of silk, in the new areas such as bio-medical applications in medicinal industry, surgical applications, genetic engineering areas and handicrafts home furnishings, life style products, knit wears, fashion products etc. to ensure better value addition to Eri silk products. More such collaborative project should be taken up for the market promotion of Eri Silk. Eri silk appearance like wool mixed with cotton and softness of silk. It has excellent thermal properties like wool. It has ample scope of blending with others fabric like cotton, wool, acrylic and polyester.Eri cocoons can be the best raw material for spun silk mills and finer counts of spun silk are in good demand for export as well as for domestic carpet industry. Eri silk tops (cleaner and finer) can be exported to countries like Japan, China, Italy and Switzerland. By exploiting the iso-thermal properties, eri silk yarn can successfully be converted into knitted fabric which will be ideal for thermal underwear and knitted dress materials. Eri silk can be excellent blends with other fabrics and new products can be evolved for dress materials and suiting's (Barooah *et al*., 2009 and Chowdhury, 2010) [12].

Viscose rayon is regenerated cellulose fibre and is chemically identical with cotton. It is relatively cheap and has a wide range of applications. Viscose rayon is highly absorbent and this enhances its value as a clothing material. Viscose fibre becomes weak and disintegrates when it comes in contact with acids. It has a high degree of resistance to dilute alkalis. Strong solution of alkali cause swelling with loss of tensile strength. Viscose rayon is insoluble in a few complex solutions such as cuprommonium. It produced in a wide variety of types and sizes. It is used in every branch of the textile industry i.e. men's wear, women's wear, children

Outerwear and inner wears, furnishing, carpets, household textiles and medical fabrics (Cook, 2005) [3].

The acrylic fibres are man-made, synthetic polymer based, polyacrylonitrile filaments or staple fibres. The acrylic fibres are regular, translucent and slightly wavy filament or staple fibres. Acrylic has a moisture regain of 1.5-2 per cent at 65 per cent RH. The breaking elongation of acrylic fibre is 5 per cent in both states. It has a good thermal stability. The fibre has a high elastic recovery from small extensions i.e. 85 per cent after 4 per cent extension when the load is released immediately. The tensile strength is 2.5-4.5 g/den in dry state (Cook, 2005 and Gohl, 1985) [3, 4].

Considering the Prospects of Eri silk an attempt is made in the present study to interweave Eri silk with Viscose Rayon and Acrylic and determine its properties so that every consumer can enjoy the unique richness of Eri silk with excellent softness and lustre of Viscose Rayon and wrinkle resistance with light weight of Acrylic .In this work it was highlights to explore the possibilities of weaving Eri union fabric in twill weave and assess mechanical and functional properties of newly designed union fabric for diversified product.

Materials and Methods

Milled spun Eri silk yarn of was collected from Fabric plus Pvt. Ltd. Guwahati, India. Assam. Viscose rayon and Acrylic yarn of were collected from, Gar-Ali market Jorhat, Assam, India. Eri silk of 2/40s as warp and viscose rayon and acrylic as weft were woven on semi-automatic power loom at Fabric plus Pvt. Ltd (boaku) of Kamrup district, Assam, India. The collected yarns were tested before weaving to observe the following parameters: i) Yarn twist ii) Single yarn strength (g/den) and elongation (%) and presented in table.1.Total three sets of fabrics in ½ twill weave were prepared viz. eri silk x eri silk (control) 2/40s, eri silk x acrylic of 2/40s and eri silk x viscose rayonof 2/40s.All the samples were tested for their physical properties. The details information regarding loom used for production of fabrics are presented in table2.

Table 1: Details of physical properties of yarns

Physical properties	Types of yarn		
	Eri silk	**Acrylic**	**Viscose rayon**
Yarn count (Ne)	2/40s	2/40s	2/40s
Average twist (tpi)	12	14	6
Average tenacity (g/den)	2.5	3.0	2.3
Elongation (%)	20	31	22

Table 2: Details of loom particulars of union fabrics

particulars	union fabrics		
	EET	**EAT**	**EVRT**
Type of loom	Semi automatic Power loom	Semi automatic Power loom	Semi automatic Power loom
Reed count	100	100	100
Reed width	50"	50"	50"
Fabric width Denting order Number of Harness	42" 2 threads/dent 4nos	42" 2 threads/dent 4nos	42" 2 threads/dent 4nos

Note:
EET- Eri/Eri Twill weaves
EAT- Eri/Acrylic Twill weaves
EVRT- Eri/Viscose Rayon Twill weaves

Scanning Electron Microscopy (SEM) analysis

The surface morphology of raw, degummed and bleached fibres was examined using emission scanning electron microscope (SEM) (make-Carl Zeiss, model-Sigma) with 1000 X magnification.

Results and discussion

The physical and mechanical properties are assessed to determine the appearance, performance and serviceability of the fabric. The test samples were assessed for yarn count, yarn twist, cloth count, mass per unit area, cloth thickness, cloth stiffness, cloth crease recovery and dimensional stability.

The experimental data pertaining to the fabric count, of twill weave union fabrics were listed in the Table 3. It was evident from the Table that all the woven samples of twill weave have very little difference in the numbers of warp threads. EVRT sample showed highest warp threads (42), followed by EAT (41), while lowest number of warp thread was found in EET (40). This may be due to same yarn used in warp direction for fabric construction and same reed count and may be due to the weaving process, structure of the individual weaves and amount of twist present in the yarns. Fabrics count also the effect of each of the warp and weft variables on the shrinkage ratio (Alkadi, 2015) [5]. In case of weft direction EVRT sample depicted maximum number of picks per unit area which may be due to the used of finer yarns of Viscose Rayon. Among all fabrics EET registered lower numbers of picks per unit area which may be due to the used of Eri silk of 2/40 coarse yarns than acrylic of 2/40s and viscose rayon of 2/40s. More over table also revealed the fabric thickness of twill weave union fabrics. The sample EET has exhibited a maximum thickness (0.53 mm) followed by EAT (0.42 mm) while sample EVRT (0.40 mm) exhibited lowest fabric thickness. The maximum thickness of sample EET may be due to the coarser yarn count and yarn structure which may attribute to higher thickness to the fabric. From table it was observed that the stiffness of twill weaves union fabrics in weft direction were greater than warp for all fabrics. It may be due to the maximum weight and thickness of the fabric. The factors that influence stiffness of a textile material are fiber content, yarn type, compactness of weave, cloth weight and thickness (Sekhri, 2011) [6]. Among all the samples, Eri silk x Eri silk (control) have a highest bending length (3.13 cm) and (3.60)in both direction ,which in turn depicted its stiffness , that may be due to the coarser yarn and higher thickness (Arora and Sharma, 2010) [7]. In case of weft way, sample EET (3.60 cm) has registered maximum bending length followed by EAT (2.83 cm) and EVRT (2.70 cm) respectively.The lowest bending length was noticed in case of fabric Eri silk x viscose rayonof /40s (EVRT)attributed lower thickness values, low twist and finer yarns which leads to fine, soft and pliable fabrics.

Table 3: Mechanical properties of developed Eri Union fabrics

Union fabrics	Fabric weight (g/sq.mt)	Fabric count (numerical Expression)		Fabric thickness (mm)	Fabric stiffness (cm)	
		Warp	Weft		Warp	weft
Eri silk x Eri silk (control)	201.32	40	60	0.53	3.13	3.60
eri silk x acrylic of 2/40s	191.75	41	68	0.42	2.80	2.83
Eri silk x viscose rayonof 2/40s	186.25	42	74	0.40	2.70	2.70

Functional properties of union fabrics

The mechanical properties of any woven fabric are the features that provide basic texture, hand, feel and dimensional to the fabric that in turn decides the functional properties of the woven fabric. Cloth tensile strength, tear strength, abrasion, drapability, pilling etc are some of the functional properties that decide the durability and serviceability of any fabric

Table 4 depicted the functional properties of developed Eri Union fabrics and it was observed that both the way sample EAT exhibited the highest tensile strength (82.34 & 52.06) which may be due to the higher number of twist, maximum strength of the yarn and fabrics thickness and fabric stiffness may also have effect on cloth tensile strength. While lowest tensile strength was found in sample EVRT (59.03). Strength of the union fabrics in warp direction was higher than the weft direction this may be due to the yarn combination and the coarseness of yarn types. Regarding the elongation table 4 reported that in general all the newly developed union fabrics showed higher percent of elongation in warp direction than weft. It was observed that elongation of Eri silk x viscose rayon union fabric was more than Eri silk x Eri silk(control) and eri silk x acrylic, which may be due to the finer viscose rayon was used in weft direction which hasless twist and higher elongation. The lower elongation in Eri silk x Eri silk (control) may be due to its plastic nature than elastic andit may be because of the polymer of eri silk which are already stretched and elongated may not elongate further. These findings are on par with Sanapapamma and Naik (2007) [8].

The crease resistance is that property of the fabric, which causes the fabric to recover from folding deformation that normally occurs during its use. Data obtained from Table 4 indicate that, among the tested samples EAT (125) union fabric showed highest degree of crease recovery while sample EET (106.75) have minimum crease recovery in warp direction. In case of weft direction, EET (99.75) have a lowest crease recovery and EAT (122) had a highest crease recovery which in turn depicts good crease resistance of EAT fabric. The highest crease recovery angle was register in EAT twill weaves union fabrics may be due to its fibre content and also has a high elastic recovery from small extensions (Cook, 2005) [3].

The abrasion resistance of twill weave union fabrics were systematically analysed and the data were recorded in the Table 4. Among all the tested samples EAT (923 cycles) register higher resistance to abrasion compared to sample EET (820cycles) and sample EVRT (623 cycles) respectively. Since eri silk x acrylic was a compact and thicker fabric, hence it possesses a higher value of fabric resistance. The value of loss in thickness (%) was found to be noticeable in sample EVRT (5.13) followed by EET (4.04) and EAT (3.68) respectively. Higher loss in thickness was observed in EVRT (5.13) for its low twist content and finer fiber. At the same time, per cent loss in mass was notice and was found that during the abrasion process breakage of fibre occurs due to the frictional abrasion in multi direction which leads to decrease of thickness and loss in mass per unit area. Low resistance to abrasion attributed to finer yarn count, low thickness value and pliable texture. The loss in mass per unit area was found to be maximum in sample EVRT (5.10) followed by EAT (2.03) and EET (2.13) respectively.

Table 4: Functional properties of developed Eri Union fabrics

Fabric sample	Fabric tensile Strength (Kg f)		Elongation (%)		Fabric Abrasion (cycle)	Loss in Thickness (%)	Loss in mass (%)	Crease recovery (Degree)	
	Warp	Weft	Warp	Weft				Warp	Weft
EET	82.24	51.06	60.26	28.40	823	4.04	2. 13	106.75	99.75
EAT	82.34	52.47	62.10	37.64	920	3.68	2.03	125	122
EVRT	59.03	43.01	64.68	44.38	623	5.13	5.10	112.25	114.75

From Table 4.(A), it was observed that fabric count in warp way there was a positive and significant relation between the independent and dependent variable which depicts that increase in fabric count increase the tensile strength. While in weft way there was very less and not significant relation between the independent and dependent variable. It also observed that in weft way yarn count had positive and high significant relation with tensile strength of Eri and other fabrics. Further, the influence of yarn count and fabric count on tensile strength is explained by R^2 value *i.e.* 40 and 90 per cent respectively.

Analysis of variance for comparison of abrasion resistance indicates that there was a significant difference among union fabrics.

Table 4(A): Influences of Yarn Count and Fabric Count on Tensile Strength of twill weave union fabrics

Source	Warp				Weft			
	Coefficient	Standard error	't'-value	P value	Coefficient	Standard error	't'-value	P value
X_1	1.825	0.744	2.452^{*}	0.037	0.166	0.079	2.108^{NS}	0.064
X_2	-1.570	2.867	0.548^{NS}	0.597	0.205	0.039	5.277^{**}	0.001
R^2	0.401				0.901			

** Significant at 1 per cent level X_1: Fabric count

X2: yarn count

* Significant at 5 per cent level R^2: Coefficient of determination

NS: Non-significant

Table 4: (B) Loss in mass (%)

Variables	S.Ed	CD	CV (%)
Loss in mass (%)	0.205	0.465	6.893

Table.5. depicts the pilling of twill weaves union fabrics. Pilling is a fabric-surface fault characterized by little "pills" of entangled fibre clinging to the cloth surface and giving the garment an unsightly appearance. The pills are formed during wear and washing by the entanglement of loose fibres which protrude from the fabric surface. Under the influence of the rubbing action these loose fibres develop into small spherical bundles anchored to the fabric by a few unbroken fibres. From the table it was observed that all the samples except EET (3) showed severe to very severe pilling. This may be due to the yarn content. Drape is the ability of a fabric to assume a graceful appearance. Fabric drape may be explained as the extent to which a fabric deforms when it is allowed to hang under its own weight. Data revealed from the table showed that the EET (51.42%) sample was found to be having highest drape co-efficient. While EAT (49.64%) union fabric was higher drape co-efficient than EVRS (41.23) which may be caused by cloth cover factor, high bending length and thickness of the fabrics. Hence, it can be inferred that greater the stiffness, higher is the drape coefficient.

Analysis of variance shows that cloth drape coefficient of Eri/Eri sample was a significantly higher than the other fabrics.

Table 5a: Pilling and Drape coefficient of twill weave union fabrics

Union Fabrics	Pilling (rating)	Drape coefficient (%)
EET	4	51.42
EAT	3	49.64
EVRT	5	41.23

Ratingscale:1=Nopilling,2=Slighpilling,3=Moderatepilling,4=Severe pilling,5=extremelyhighpilling

Table 5 b: Respondents opinion for suitability of the fabric for the prepared diversified products Drape coefficient (%)

Variables	S.Ed	CD	CV (%)
Drape coefficient (%)	1.571	3.554	4.684

Table 6 illustrates the suitability of prepared products according to the types of fabrics. Considering the cost and quality of products prepared, in their opinion the suitability of the waist coat, stole, skirt, embroider stole, cushion cover, baby coat, tie and top was 100% while it was 87.5% for baby frock. This may be due to rough texture and low lustre of fabric.

Table 6: Respondents opinion for suitability of the fabric for the prepared diversified products

Types of fabrics	Diversified Products	Suitability (%)	Costing Appx. Rs.)
		Yes	
EET	Waist coat	100	200.00
EET	Tie	90	400.00
EET	Stole	90	600.00
EVRT	Waist coat	100	1700.00
AT	Skirt	100	580.00

SEM analysis

Scanning electron micrographs of fabric surface reveals that blanched treatment of eri silk removed the entire gum from the fabric surface which enhances the individualization of fabric entity (Fig 1a). In case of viscose (1b) and acrylic (1c) fabrics a clean and smooth surface appearance was observed.

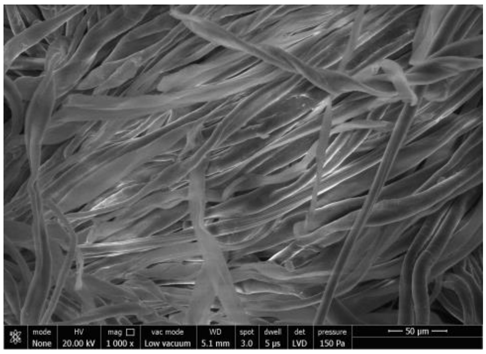

Fig 1a. In case of viscose

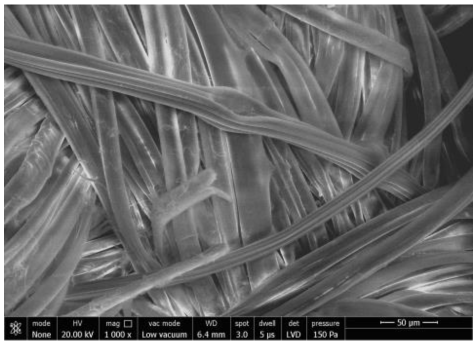

Fig 1b. In case of acrylic

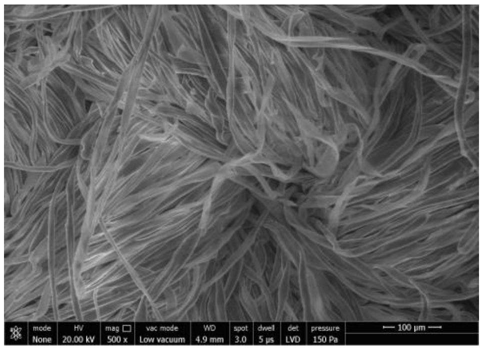

Fig 1c. Fabrics a clean and smooth surface appearance was observed.

Conclusion

From the above observation it is concluded that among the various test samples, Eri x acrylic union fabric showed better result in respect of tensile strength, abrasion resistance, drape coefficient (%) and pilling, which is much desirable for the fashion fabrics. As we know that Eri silk has vast potential in both domestic and international markets emerging as 'The fabrics of next millennium". The raw material cost, fabrics production as well as stitching charges were taken in to consideration for price calculation. The price of different product shows that the article could be conveniently be sold in the market as fahion garment with much high value addition. The finding of this study may also be useful to industries for manufacturing of fashionable apparel using eri union fabric.

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