QUALITY CHARACTERISTICS OF VISCOSE RAYON AND ERI SILK UNION FABRICS

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1. INTRODUCTION

The textile industry is not only one of the oldest but also continues to be one of the main stay of the world economy. The evolution of the textile industry has brought about big changes in the function of fabric engineering. They which have become complex as well as intricate and incorporate some of the most advanced techniques, nanotechnology, smart textiles and digital printing. Today in the Indian scenario, textile industry contributes up to 9 per cent of its Gross Domestic Production and provides employment to over 35 million people which accounts to 35 per cent of the country's export earnings (www.thenews.com)

Being consumers every one has aspiration for aesthetic and quality fabrics forever. Today in the textile industry, a wide range of fibres are known, be it man made *viz.,* acrylic, Viscose, aramid, teflon so on or natural *viz.,* nettle, milk weed fibre, spider silk and so on. Of the various fibres, Viscose Rayon, the regenerated cellulosic fibre is unique in itself and has better sheen and softness to that of silk. Viscose Rayon which, is stronger than wool with good heat conductivity and absorbancy, a natural polymer made from wood pulp and cotton linters, Rayon which, is then treated with sodium hydroxide and carbon disulfide to form the viscous like liquid. Finally excruded through spinneret to make Viscose Rayon.

Viscose was first created by French scientist and industrialist Hilaire de Chardonnet (1838-1924), inventor of first-artificial textile fibre the artificial silk, which is also known as regenerated cellulosic fibre. The process of manufacturing Viscose Rayon was then patented by cross and his partners in 1891 (www.birlaviscose.com).Viscose was first used for coating fabrics which was quite successful. Further development lead to production of Viscose Rayon being spun into thread for embroidery and trimming which is attributed to its sheen and softness. Viscose is used for lining and furnishing fabrics, providing the staple for towels and tablecloth. It is also used for production of high tenacity yarn for tyres. Yet other uses included the manufacturing of sponges and absorbent cloths.

This artificial silk is blend friendly fibre and can be blended with polyester, nylon, silk, acrylic, cotton and lycra. It has brilliant luster and high moisture regain capacity. Its drape, thermal protection and smoothness of Viscose Rayon are on par with cotton (www.birlaviscose.com). Viscose Rayon is the most versatile fibre since the fabrics made from it are warm or cool, dull or bright, plain or complex. The processing of Viscose Rayon is not enormously costly as silk which not only adds comfort to the fabric but also enhances its attractiveness and appeal by way of offering excellent scope for the designs. The fibres have unique qualities that make it most suitable for fashionable yet comfortable fabrics.

Looking into aesthetics of the textile fibres the first name that strikes our mind is silk. Silk, the glorious gift of nature is an intimate natural fibre which is also popular with splendor, sibilant with lustre and spectacular in vision. Ever since, its discovery in 2500 BC, silk is surrounded by interesting history and has had an adventurous course of evolution. Inspite of inventions of numerous man made fibres and discovery of other natural fibres, silk has unique position in textile industry and in the society, keeping high the flag of naturalism and proclaiming herself to be the 'Queen of Textiles' (Koshy, 2001 – Silk Production and Export Management).

Chirping into the history of silk, it is believed that Fo Xi the first Chinese Emperor, taught the Chinese people to cultivate mulberry trees and to rear silk worms, although the lady Shilling Ti, Chief wife of Huang Ti, is named as the 'Lady of Silk Worms'. She observed the effect of hot tea on a cocoon, which accidentally dropped from a mulberry tree into her cup, is credited with the discovery of silk (Koshy, 2001 – Silk Production and Export Management).

Sericulture is also a very important agrobased industry. It is a labour intensive industry in all its phases - cultivation of silkworm, food plants, silkworm rearing, silk reeling and other post cocoon processes such as twisting of yarn, dyeing, weaving, printing and finishing. It provides employment to approximately 60 lakh persons (www.texmin.nic.in). There are many advantages in sericulture viz., high employment potential, provides vibrancy to village economics, low gestation, high returns, women friendly occupation, eco-friendly activity and so on (www.texmin.nic.in).

Silk has high value but low volume product accounting for only 0.2 per cent of worlds total textile production (www.texmin.nic.in). Silk production is regarded as an important tool for economic development of a country as it is a labour intensive and high income generating industry that churns out value added products of economic importance.

Geographically speaking, Asia is the main producer of silk in the world and produces over 90 per cent of the total global output. Though there are over 40 countries on the world map of silk, bulk of it is produced in China and India, followed by Japan, Brazil and Korea. China is the leading producer of silk with the annual production of 1, 02,560 metric tones (MT) which account to about 81.7 per cent. India ranks second in respect to world silk production of 17,305 metric tones (MT) which accounts to about 13.14 per cent in 2005-06 (www.texmin.nic.in).

India is the only country, which produces all the four major types of silk, which are of a great commercial importance. These silks are obtained from different species of silkworms, which inturn feed on a number of food plants. The four major types of silk are *viz*., mulberry, tasar, muga and Eri. Except mulberry, other varieties of silks are generally termed as non-mulberry silks.

There are various synonymous for non-mulberry silk like wild silk and vanya silks. Among the wild silks, Eri silk accounts to 78.4 per cent and its contribution to the total raw silk production in the country is 7.26 per cent next to mulberry silk. Ericulture is mainly concentrated to North Eastern region of India. The states of Assam, Nagaland, Meghalaya and Manipur account nearly 98 per cent of Eri silk production. The border areas of Assam and Meghalaya is considered to be the ‘Home of Eri’. Now, there is a vast scope for development of Ericulture in the non-traditional states like Andhra Pradesh, Karnataka, Tamil Nadu, Gujarat, Rajasthan, Punjab and Uttar Pradesh and have taken interest to promote Ericulture in the country (Itagi *et al*., 2006). Today the production of Eri silk has reached up to 1,310 metric tones (MT) (2002-03).

Eri silkworm is multivoltine in character and is reared indoors. It is generally hardy and not susceptible to diseases. It belongs to the family Saturnidae and species *ricini*. The most widely domesticated Eri silk worm is *Samia cinthia ricini*.

The advent of Ericulture in India is lost in the antiquity but, the fact remains that Assam was the original home of Eri silk from time immemorial. In the historical records Eri was identified as Assam silk and only British people called it as “PALMA CHRISTI” silk.

The earliest available reference to Ericulture in India has been documented in 1779 according to which vast quantity of Eri silk was produced in the country in the areas of Ghorghat within the undivided Bengal. Those days East India Company played a mega role in stepping up its production. Several experiments were conducted on Eri silk, so also innumerable colours were developed and sent the samples to England for trial weaving.

The industry of Ericulture consists of feeding of the Eri silk worm and reeling of silk. Eri worms are polyphagous and feed on several varieties of food plants like Castor (*Ricinus communis*), Kesseru (*Hetropana fragrance*), Tapioca (*Manihot utilissima*) and Payam (*Evodia flaxifolia*). Out of which castor is the main food crop of these silk worms.

As mentioned earlier castor is one of the main host plants of Eri worms, where castor in Assam is known as ‘Eranda’ or ‘Endi’, which is derived from a Sanskrit world. The silk worm too is, therefore known as Eri silk worm. Ericulture is mainly extended up to altitude of 5000 meters and lowest level of plains without any water logging in temperature varying from 55° to 98°F.

The Eri cocoons are usually white in colour, however, brick red colour cocoons are also available. The Eri silk cocoons cannot be reeled as they are made up of entangled layers, and are therefore spun like cotton into yarn. Eri silk is often referred as Ahimsa silk and the fabric as ‘Fabric of Peace’ because the process does not involve the killing of silk moth, as it is open-mouthed cocoon (Sarkar, 1980 – Ericulture in India).

Eri silk is durable and strong with a typical texture. Eri silk is similar to cotton fibre and has unique asthetic appeal. It appears like wool mixed with cotton and softness of silk. Each Eri cocoon weighs about 1 to 5 g with the shell weight of 0.2 to 0.7 g where the staple length of the fibre is about 57.00 mm. The denier (d) of the filament is 2.2 to 2.5 d with tenacity of 3 to 3.5 g/d. Eri silk has elongation per cent up to 20-22. It has excellent thermal properties, which can be a substitute for wool. The moisture retention capacity is learnt to be 11 per cent. Eri silk is highly crystalline than any other non-mulberry silks (Sreenivasa *et al.,* 2005).

The yarn produced from Eri silk is normally used for production of traditional materials mainly for domestic use. As it possesses excellent thermal property, closer to wool, it is mainly utilized for manufacture of shawls, jackets and blankets. It offers tremendous blending possibilities with other fibres like wool, cotton and polyester.

The survival of textile industry depends primarily on the diversification of end products to meet the national as well as international demands. Diversification in the product can be brought about at various stages *viz.,* yarn, fabric, design, fashion and style. Blends or union fabrics can be created with variegated novelty effect that caters to the fashion world today. Union fabrics are those, which are created with warp of one kind of fibre and the weft of the other. Weaving of such fabrics have opened a new era with limitless possibilities in the field of textile, in turn in the fashion world.

Thus considering the properties of Eri silk and the cost of Viscose Rayon an attempt is made in the present study to interweave Viscose Rayon with different counts of Eri silk and explore its properties so that even a common person can enjoy the unique richness of silk with excellent softness of Viscose Rayon. This study is an effort to merge the richness of silk with the brilliancy of Viscose Rayon that offers cost effective, yet attractive fabric in various combinations.

Hence, the present study on 'Quality Characteristics of Viscose Rayon and Eri Silk Union Fabrics' is taken up with the following objectives :

1. To explore the possibilities of weaving union fabrics from Viscose Rayon with Eri silk
2. To assess the mechanical and functional properties of the union fabrics
3. To evaluate the tactile properties of the union fabrics
4. To study the economic feasibility of the union fabrics

2. REVIEW OF LITERATURE

The present chapter deals with the relevant research articles, pertaining to the present investigation on "Quality characteristics of Viscose Rayon and Eri silk Union Fabric" and is presented under the following subheadings:

2.1 Yarn production

2.2 Blended yarn and fabrics/union fabrics

2.3 Physical properties

2.3.1 Mechanical properties

2.3.2 Functional properties

2.1 YARN PRODUCTION

Eri the group of non-mulberry silk is spun like cotton as the cocoons are open mouthed and therefore cannot be reeled. Other varieties of silk, mulberry and non-mulberry silks can be spun from the pierced cocoon where the moth is allowed to emerge by piercing the cocoons. The spun silk yarn is more bulky and less lustrous. It is invariably coarser and the evenness is comparatively lower than reeled silk because it is spun from short fibers. The popular spun silk count are 2/40s, 2/60s, 2/80s, 2/120s, 2/140s and 2/210s.

Bhalerao (1997) in his study on "Eri silk staple yarn production" reported that Eri silk is the second largest variety in the total production of silk and claimed that it is the only silk meant for spun yarn. He mentioned that Eri silk has a wide scope in the field of hand spinning where takli, an ancient hand spinning device is very simple to operate and is cheap when compared other spinning appliances. He also reported that there are other improved spinning equipments like NR Das spinning wheel, Trivedi spinning wheel and Chowdhury spinning wheels, which are popular for Eri spinning with the output greater than that of takli.

"Eri silk spinning technology" a paper presented by Mishra (2000), highlighted on various technologies used in spinning of Eri silk. The author here made comparison on performance of popular Eri spinning devices viz., muel spinning (takli), flyer spindle (pedal operated) and ring spindle (power operated) CSTRI. Comparison was made on yarn yield and the yarn counts obtained from different devices. It was revealed that power operated ring spindle a model invented by CSTRI had greater yarn yield of 120 g with count up to 30s.

Findings reported by Kariyappa *et al.* (2003) in his study on "CSTRI motorized-cum-pedal operated spinning machine" claimed that, the motor-cum-pedal operated spinning machine developed newly by the Central Silk Technological Research Institute, Central Silk Board, Bangalore has come as a boon to the Ericultrists which ensure both better quality and productivity of Eri silk yarn. The production level of yarn by this machine is higher than that of traditional devices *i.e.*, 200-250 g/8 hour with count range from 15s to 50s. It ensures regular and uniform twist to the yarn. It is further stated that this machine can be used to spin even the waste/pierced cocoons of mulberry, tasar, muga and Eri.

Rabindranath and Das (2003) studied on "Eri spinning on Ambar Charaka an experience TAGS" (Tamulpur Anchalik Gramdhar Sangh) in Assam have modified the Amber Charaka to suit Eri spinning for better productivity and ease of operation. The entire process of spinning is done manually and hence does not require power. The experienced spinners can earn an average of Rs.15-20 a day. The quality of yarn produced on TAGS method exhibited better tensile strength compared to yarn produced with other traditional devices. It is possible to spin yarn with the required counts as TAGS

Somashekar (2003) worked on "Recent advances in Eri silk spinning, weaving and future prospects" and described that the Eri silk cocoons cannot be reeled as they are made of entangled layers and hence spun into yarn. After degumming, the cocoons were mechanically processed on the machines working on Japanese and Italian technologies. The Japanese technology maintained the length of the fibres, while the Italian technology brought uniformity in the length by cutting the fibres. Both the technologies use woollen system of machineries modified suitably for silk processing. The counts of Eri spun silk ranged from 2/20s to 2/120s when spun on both type machines.

Kariyappa *et al.* (2005) in their study on “Fancy spun silk yarn” reported that mulberry and Eri spun silk yarns of metric counts 28s, 40s and 60s were used to produce fancy yarns viz., chenille, feather yarn, flag, boucle and slub yarn. The authors also mentioned fancy yarns can be used to produce various textiles materials viz., sweaters, upholstery, knitted fabric with leno weave, sarees and so on, thus opening a new way in the development of wide varieties of fabric of commercial importance.

Kariyappa *et al.* (2005) performed a study on “Eri silk noil spinning and its characterization” to produce coarser Eri silk noil yarns. A comparative study of three different systems of Eri noil spinning viz., woolen system, cotton and open and system was made on productivity, quality and economic advantage. The results revealed that the productivity in case of open end system of spinning is higher when compared to other two systems of spinning with lower investment cost for the machine and equipment. The quality parameter of open end spun yarn was in between cotton and woolen systems. It is further understood open end system can produce upto 40s count of noil yarn which cannot be produced in other two systems. Hence, it may be concluded that Eri noil spinning from open end spinning has clear techno-economic advantage over other two systems of noil spinning.

The perusal of the study on “Large scale mill spinning of Eri cocoons a possibility” conducted by Kariyappa *et al.* (2006) included two methods of mill spinning of Eri cocoons viz., Japanese technology and Italian technology using both brick red Eri cocoons and white cocoons. Comparisons were made between the two technologies and the type of Eri cocoons for yarn yield. It was observed that the yield percentage of white Eri yarn in Italian technology was significantly higher than Japanese technology. The study also revealed that yield percentage of white Eri cocoons processed through different spinning processes is significantly higher as compared to brick red Eri cocoons. On the other hand, the cost of production per kg of spun yarn of any count from white Eri cocoons is lowest, followed by brick red Eri cocoons.

Kariyappa *et al.* (2006) carried out on experiment on “Studies on processing of Eri cocoon in mill spinning to produce quality spun silk yarn and its characterization”. In this study a comparative assessment was made between Eri silk mill spinning and mulberry mill spinning processes. Degumming loss, yarn yield and economics were measured and the results revealed that degumming loss and processing loss is less in Eri silk as compared to mulberry. It was further learnt that Eri yarn fetches cheaper than mulberry silk in a particular count with the better yarn yield.

2.2 BLENDED YARN AND FABRICS/UNION FABRICS

The term blend is used by the yarn manufacturer to describe specifically the sequence of processes required to convert two or more kinds of staple fibres into a single yarn composed of an intimate mixture of the component fibres. Today blended fabrics with different combination can be produced which are suitable for performance of specific function. Blending makes it possible to build in a combination of desirable properties. Not only are blends and union fabrics used for better serviceability of fabrics but are also used for improved appearance and hand. Blends of synthetic fibres such as polyester, nylon, Viscose, acrylic etc. with natural fibers like wool, cotton, silk etc. offer the most valuable possibilities for combining desirable physical properties. In blends of polyester or acrylic fibers with cotton or Viscose the synthetic component provides crease recovery, dimensional stability, tensile strength, abrasion, resistance and easy care properties, whilst the cellulosic fibers contributes moisture absorption, antistatic characteristics and reduced pilling (Shilpa *et al.*, 2007).

Linganur *et al.* (1988) conducted a study on “Feasibility of blending cotton with silk” and reported that silk and cotton were mixed in the proportion of 80:20, 60:40, 40:60 and 20:80, respectively. The bundle strength and yarn tenacity of blends on assessing revealed that the values increased with the increase in the silk component. From the economic point of view processing silk, silk/cotton blends on the cotton system worked out to be inexpensive without making modification on existing machinery setup.

Praveena and Vatsala (1992) carried out a study on “Blending of mulberry silk waste”. Polyester, Viscose Rayon on and acrylic fibres were blended with silk waste in the proportion of 50:50 and the fabrics were made. The results revealed that blended fabric of mulberry silk waste with polyester was found to be the best because of its durability, appearance and general properties. The second preference was given to Viscose, mulberry silk fabric followed by cent per cent silk waste fabric. The least preferred was the acryclic/mulberry silk blended fabric, which showed poor serviceability. It was also mentioned that polyester mulberry silk fabric provided economical as well as functional advantages over other test fabrics.

Eri and Muga silk wastes of 6.0 and 5.30 dinier, respectively were blended with polyester (3d) having a variable cut length (90-120 mm) normal tenacity of 5 g/dinear to study the desired properties of yarn and fabrics and to minimize the cost of the fabrics. Results of the study on “Silk blending for yarns and fabrics” revealed that the fabric surface was uneven because of silk waste being used. Among two blend proportions 60:40 silk/polyster blended fabrics possessed all desirable properties than 50:50 blend. Thus, it can be concluded that Eri and muga silk may be positively blended with polyester and such fabrics can be used as shirting, suiting, dress materials and made-ups (Kalitha *et al*., 1998).

A study on “Evaluation of comfort properties of polyester Viscose suiting fabrics” was conducted by Mukhopadhyay *et al.* (2002). Polyester Viscose blended yarns of four different blend proportions were used for constructing plain and 2/2 twill suiting fabrics. Results revealed that stiffness of the fabric increased with increase in polyester content resulting into decrease in smoothness, softness and fullness.

Chollakup *et al.* (2004) did study on “Eri silk as blended material with cotton for ring spinning” and reported that Eri silk can be easily spun with cotton. The blended slivers were spun by ring spinning technique at 50:50 ratio. It was examined that blends of silk and cotton fibers at 50:50 did not improve any physical properties of yarn when compared to each pure component.

An experiment on “Development and study of the properties of Eri silk and polyester blended yarn” was carried out by Sreenivasa *et al.* (2005). In this study, attempt was made to develop two varieties of Eri silk polyester blended yarn to diversify Eri silk. The Eri fibres were blended with polyester in 50:50 and 30:70 blend ratio. The results revealed that as the percentage of polyester increased, yarn exhibited high frictional properties. It was further judged from the results that both the blended yarns exhibited uniform twist factor. Thus it was concluded that 30:70, Eri silk polyester blended yarn showed better performance than that of 50:50 blend.

Itagi *et al.* (2006) did a study on “Development of Eri silk blended fabrics and study of their properties” and made an attempt to produce the fabrics using mulberry silk and cotton as warp with Eri silk/polyester blend yarn of 30:70 and 50:50 as weft. Cent per cent pure mulberry silk and 100 per cent pure cotton were considered as control. Comparison was made on the performance of the fabrics of 100 per cent pure mulberry silk and 100 per cent pure cotton with different blend ratios by conducting physical tests. The results revealed that strength of the fabric in warp and weft way was higher for mulberry silk/Eri polyester fabrics when compared with cotton/Eri polyester. It was also examined that all the fabrics exhibited high pilling property.

An investigation was carried out by Kariyappa *et al.* (2006) on “Studies on blending of Eri silk with wool fibers in spinning and its characterization”. In this study brick red Eri tops were blended with wool in various proportions starting from 100 per cent pure wool, 70:30 wool:Eri, 50:50 wool: Eri, 40:60 wool:Eri, 30:70 wool:Eri and per cent pure Eri, where comparison was made on yarn performance. The results of the investigation depicted that breaking force, tenacity, elongation percentage was higher in case of pure Eri silk than pure wool. Further, it was learnt that there was no significant difference among 60:40, 50:50 and 50:70 blends related to hairiness.

Shilpa *et al.* (2007) presented a paper on “Growing importance of cotton blends in apparel market” and stated that now-a-days, global competition on blending of cottons appear to be inevitable. The present paper dealt with growing importance of cotton blends in apparel market. Importance of blending was mentioned with the reason to produce fabrics with a better combination of performance characteristics on the product. The paper included different cotton blends with their properties such as cotton and linen, cotton and jute, cotton and ramie, cotton and wool, cotton and Viscose, cotton and tenacel etc. The authors mentioned that Viscose is most frequently blended with cotton and the principal advantage of blending this fibre is that it is most affordable in terms of cost. Blending of cotton with Viscose offers softness, moisture absorbance and superior comfort with all ideal characters for manufacture of innerwear, leisure wear, sports, wear etc.

2.3 PHYSICAL PROPERTIES

2.3.1 Mechanical properties

The mechanical properties of any woven fabric are features that provide basic texture, hand feel and dimensions to fabric. The mechanical properties are assessed to determine appearance, performance and serviceability of the fabric. The yarn count, cloth count, fabric mass, fabric thickness, dimensional stability, crease recovery, stiffness etc. are some of the mechanical properties.

Datta and Patel (1995) carried out a study on "Fabric feel, hand and appearance of some Indian suiting fabrics using Kawabata instruments". A total of 44 men's suiting fabrics were selected and were classified into summer and winter suiting wherein the summer suitings included polyester/Viscose blended fabrics, 100 per cent wool and polyester/wool blended fabrics and winter suiting fabrics consisted of 100 per cent wool and polyester/wool blended fabrics. The low stress mechanical and surface properties of above fabrics were measured by Kawabata system. The results revealed that all the Indian polyester/wool summer were found to be good whereas some of the polyester/Viscose summer suitings found to be poor in total hand value. High bending rigidity with large shear stiffness and low surface roughness were the typical features of Indian summer suitings. All polyester/wool and woolen winter suitings were found to be average to good in total hand value. However, the total hand value of winter suitings increased with the increase in wool content and a good winter suiting possessed low surface friction, low variability in surface roughness, low bending and shear stiffness.

Tarafder and Kauser (1996) performed a study on "Stiffness and crease recovery" on five different shirting materials viz., 100 per cent polyester, 64/36 polyester/cotton, 58/45 polyester cotton 45/55 polyester/Viscose and 100 per cent cotton to know the effect of sampling on drape and crease behaviour of the fabrics. A trend of decrease in drape quality was observed with increase in the polyster content and crease recovery of the fabrics depending on the material characteristics in terms of least or most prone to creasing.

Polyester Viscose blended yarns of four different blend proportions viz., 40:60, 48:52, 65:35 and 75:25 were used for constructing plain and 2/2 twill suiting fabrics to know the effect of blend proportion on the comfort properties of polyester of polyester-Viscose blended suiting fabrics using Kawabata evaluation system in a study on 'Evaluation of comfort properties of polyester-Viscose suiting fabrics" conducted by Mukhopadhyay *et al.* (2002). Results revealed that, with the increase in the polyester content in the fabric, stiffness increased while smoothness and softness decreased. Further it was understood that as the polyester content in the blend increased, the total hand value decreased in 2/2 twill fabrics, while no significant change was observed in plain weave fabrics.

Sreenivasa *et al.* (2005) carried out an investigation on "Development and study of the properties of Eri silk and polyester blended yarn". In this study an attempt was made to develop two varieties of Eri silk polyester blended yarn. Blended yarns of Eri with polyester were developed in proportion of 50:50 and 30:70 ratios. Comparisons were made on mechanical properties of the yarn. Results of the investigation explained that tenacity of 30:70 Eri silk : polyester yarn was better than that of 50:50 blend ratio and thus polyester contributed towards improvement in the mechanical properties.

A study entitled "A comparative study of some mechanical properties of Eri and cotton fabrics" was carried out by De and Mitra (2005) to evaluate mechanical properties of four different sets of Eri fabric and four sets of cotton, where each of which had different cover factor, thickness and twist per inch. Comparisons were made between the fabrics and found that tensile property and fabric assistance of Eri fabric is better than that of all the cotton fabrics.

An experiment on "Development of Eri silk blended fabrics and study of their properties" was conducted by Itagi *et al.* (2006).Different fabrics were produced using mulberry and cotton as warp with Eri silk/polyester blend yarn of 30:70 and 50:50 as weft 100 per cent pure silk and 100 per cent pure silk and 100 per cent pure cotton were considered as control. Comparison was made on the performance in mechanical properties of the fabrics of 100 per cent pure mulberry silk and 100 per cent pure cotton with different blend ratios. The study revealed that weft way flexural rigidity and bending modulus increased with the increase in the percentage of polyester of the blended yarn and the crease recovery angle in weft way improved with the increase in the percentage of polyester content in the blended yarn.

Sanapapamma and Naik (2007) performed a study on "Durability of Ahimsa silk shirtings". Four varieties of shirting material were produced viz., ahimsa silk x ahimsa (control sample) cotton x ahimsa silk, tericot x ahimsa silk and filature silk x ahimsa. These fabrics were assessed for the mechanical properties and revealed that coarser yarn and irregular surface of control sample possessed maximum thickness than other sample types. Among other woven fabrics cotton x Ahimsa silk was relatively thicker than other two fabric samples.

2.3.2 Functional properties

Cloth tensile strength, tear strength, abrasion, drapability, pilling etc are some of the functional properties that decide the durability and serviceability of any fabric. Below are some of the studies related to functional properties of the fabric and are presented under the following headings:

Tensile strength and elongation

Shailaja and Padye (1996) conducted a study on "Yarn take up and strength". The study was conducted to find out the yarn take up and tensile properties of the handloom sarees and the effect of crimp on tensile strength. Three each sarees of cotton warp and cotton weft, Rayon warp x cotton weft and silk warp x cotton weft were woven on a fly shuttle pit loom. It was observed that greater the number of threads per inch, larger was the crimp percentage and better the strength. However, strength of any fabric did not depend on crimp percentage alone. But the fibre content, type of yarn, twist factor, cloth cover and finish applied are responsible for the durability and serviceability of the cloth. In general there was a gradual decrease in the strength on laundering of the sample.

Linganur *et al.* (1988) conducted a study on "Feasibility of blending cotton with silk" and reported that silk and cotton were mixed in the proportion of 80:20, 60:40, 40:60 and 20:80, respectively. Breaking elongation was assessed and the results revealed that breaking elongation of yarns gradually decreased with the increase in cotton percentage of the blend, since the breaking elongation of cotton was lower compared to that of silk.

An experiment on "Eri silk as blended material with cotton for ring spinning" was conducted by Chollakup *et al.* (2004) and reported that Eri silk can be easily spun with cotton. The blended slivers were spun by ring spinning technique at 50:50 ratio. It was examined that blends of Eri silk and cotton fibers at 50:50 did not improve the elongation and evenness of yarn.

Sanapapamma and Naik (2007) in "Durability of ahimsa silk shirtings" observed that among the four varieties of shirting materials viz., ahimsa silk x ahimsa silk (control), cotton x ahimsa silk, tericot x ahimsa silk and filature silk x ahimsa silk. Of all the fabrics, tericot x ahimsa silk shirting material possessed greater tensile strength whereas elongation percentage in warp way was found to be greater in filature silk x ahimsa silk shirting material. It is also observed that all the samples possessed lesser elongation percentage in the weft way as compared to the warp.

Cloth abrasion

A study on "Bending properties of wet abraded woven fabrics" was conducted by Joshua (1994). It was inferred that moisture content in the abraded fabric enhanced the stiffness. Large amount of moisture in the fabric sample and the type of abradant used for abrasion altered the mode of fabric abrasion significantly. The difference between the wet abraded and damp abraded fabrics indicated that the presence of moisture favorably supported the abrasion resistance. The damp abraded test sample showed higher percentage of variation in bending properties than the weft when compared with unabraded fabrics.

A study entitled "A comparative study on some mechanical properties of Eri and cotton fabrics" was carried out by De and Mitra (2005). In the present study four different sets of fabrics, each of Eri silk and cotton with varied construction were used. It was found that percentage weight loss during abrasion is lower in case of Eri fabric.

Four varieties of shirting materials viz., ahimsa silk x ahimsa silk (control), cotton x ahimsa silk, tericot x ahimsa silk and filature silk x ahimsa silk were tested for resistance to abrasion with loss in thickness and mass of the above mentioned fabrics in the study "Durability of ahimsa silk shirtings". It is observed that on abrasion, loss in cloth thickness was remarkable in control sample as compared to other fabric samples which may be due to frictional abrasion that lead to fibre breakage and therefore consequent decrease in the mass of the fabric (Sanapapamma and Naik, 2007).

Cloth drapability

Collier (1991) carried out a study on "Measurement of fabric drape and its relation to fabric mechanical properties and subjective evaluation". The drape of seventeen fabric samples with different yarn content, constructional details and cloth weight were measured using a digital drape tester and the values were significantly correlated. Drape is correlated with mechanical properties, among which bending rigidity was found to be most closely associated with fabric drapes.

A study on "Stiffness and crease recovery" was conducted by Tarafder and Kauser (1996). From the selected five different shirting materials viz., cent per cent polyester, 64/36 polyester/cotton, 58/45 polyester/cotton, 45/55 polyester/Viscose and 100 per cent cotton a trend of decrease in drape quality of fabrics was observed with increase in the polyester content and crease recovery of the fabrics depended on the material characteristics in terms of least or most prone to creasing.

"A study of the drapability of P/V blended woven fabrics" was conducted by Tarafder *et al.* (1998). In the present study six different polyester/Viscose blended fabrics viz., 100:0, 80:20, 70:30, 65:35, 55:45 and 48:52 were assessed for drape behaviour. It was observed that 70:30 polyester/Viscose fabric had greater drape co-efficient *i.e.,* 59.70 per cent when compared to other five fabric samples. Minimum drape coefficient of 29.60 per cent was found to be with 48:52 polyester/Viscose blended fabric. It was also learnt that bending length both in warp and weft was greater with 70:30 polyester/Viscose blended fabric and minimum with 48:52 polyester/Viscose blended fabric.

De and Mitra (2005) carried an investigation on "A comparative study of some mechanical properties of Eri and cotton fabrics". In the present study four different set of Eri fabric and four of cotton were produced each with different cover factor, twist per inch and cover factor. Comparisons were made between different sets of fabric for drapability and the results reported that, Eri fabric with open construction was comparable with cotton whereas the fabric with dense construction became stiffer.

Five different shirting fabrics of 100 per cent silk, 100 per cent polyester, 100 per cent cotton, polyester/Viscose blend and polyester/cotton were assessed for drapability at three different stages *i.e.*, before washing (parent sample) after washing and scouring in the study "Effect of seaming on drapability of washed and scoured plain woven shirting fabrics".Comparision was made between three stages for the fabric parameters such as thickness, blending length, flexural rigidity, fabric weight with drape coefficient of each of the sample. The results revealed that fabric parameters and drape coefficient are correlated and the value of correlation coefficient was improved due to the washing and scouring treatment. It was further learnt that drape behaviour of 100 per cent polyester and polyester/Viscose fabrics were more uniform and 100 per cent silk fabric had less uniformity when subjected to washing and scouring treatments (Tarafder and Sarkar, 2006).

Pilling

Sanapapamma and Naik (2007) worked on "Durability of ahimsa silk shirtings". Four varieties of shirting material were produced viz., ahimsa silk x ahimsa silk (control), cotton x ahimsa silk, tricot x ahimsa silk and filature x ahimsa silk. The fabric samples were assessed for pilling and the test results revealed that all the fabric samples showed slight to moderate pilling owing to their fiber content and yarn type.

Thermal insulation value

A study on “Evaluation of comfort properties of polyester Viscose suiting fabrics” was conducted by Mukhopadhyay *et al.* (2002). Polyester Viscose blended yarns of four different blend proportions were used for constructing plain and 2/2 twill suiting fabrics. It was observed that thermal insulation and water vapour resistance increased with the increase in polyester content.

De and Mitra (2005) performed a study on “A comparative study of some mechanical properties of Eri and cotton fabrics. In this study, four different sets of Eri fabric and four of cotton were produced each with different cover factor, twist per inch and thickness. All the eight fabric were examined for thermal insulation value. The results reported that thermal insulation value of Eri fabric was better than that of cotton fabrics.

3. MATERIAL AND METHODS

The present investigation on "Quality Characteristics of Viscose Rayon and Eri silk union fabrics" was carried out at the Department of Textiles and Apparel Designing, College of Rural Home Science, University of Agricultural sciences, Dharwad during the years 2005-07.

The material methods and techniques followed in the study are presented under the following headings:

3.1 Selection of sample

3.1.1 Viscose Rayon

3.1.1.1 Twisting Viscose Rayon yarn

3.1.2 Eri silk

3.2 Assessment of physical properties of yarn

3.2.1 Linear density (Ne)

3.2.2 Yarn twist (tpi/ tpm)

3.2.3 Yarn tenacity (gf/den)

3.3 Weaving of Viscose Rayon and Eri silk union fabrics

3.3.1 Selection of weaving center

3.3.2 Constructional details of union fabrics

3.4 Laboratory tests

3.4.1 Assessment of mechanical properties

3.4.1.1 Cloth count (Numerical expression)

3.4.1.2 Cover factor (Numerical expression)

3.4.1.3 Mass per unit area (g)

3.4.1.4 Cloth thickness (mm)

3.4.1.5 Cloth stiffness (cm)

3.4.2 Assessment of functional properties

3.4.2.1 Cloth tensile strength (kgf) and elongation (%)

3.4.2.2 Cloth abrasion resistance (cycles)

3.4.2.3 Cloth drapability (%)

3.4.2.4 Cloth pilling (ratings)

3.4.2.5 Air permeability ($m^3/m^2/min$)

3.4.2.6 Thermal insulation value (tog)

3.5 Subjective evaluation of union fabrics

3.6 Variables included in the study

3.6.1 Independent variables

3.6.2 Dependent variables

3.6.3 Classification of Independent variables

3.7 Economic of Viscose Rayon and Eri silk union fabrics

3.8 Statistical analysis

3.9 Null hypothesis set for the study

3.1 SELECTION OF SAMPLE

3.1.1 Viscose Rayon

Gray Viscose Rayon yarn of 75 d was procured from Gowri Shankar Colour Works, Radha Krishana Silk House, Bangalore. The yarn purchased was in the cone form (Plate 1).

Criteria for selection of Viscose Rayon yarn.

- Viscose Rayon has better fibre qualities
- It is highly lustrous
- It is most suitable for production of blended and union fabrics
- It is available in sufficient quantity
- It is not enormously priced as that of silk

3.1.1.1 Twisting Viscose Rayon yarn

The Viscose Rayon yarn procured had very low twist of 9 tpi which was insufficient for warping, additional twist of 9 tpi was necessary and was therefore given at Laxmi Power Loom Unit, Doddaballapura, Bangalore. Thus the resultant yarn was suitable for warping (Plate 2).

3.1.2 Eri silk

Eri mill spun silk yarn of three different counts viz., 2/40s, 2/60s and 2/80s was procured form Central Silk Board, Bangalore. The yarn procured was from white Eri cocoons (Plate 3).

Criteria for selection of Eri Silk

- Eri silkworm (*Samia cinthia ricini*) is multivoltine.
- The mill spun Eri silk yarn yield from white Eri cocoons is greater than brick red.
- Eri silk has better fibre qualities
- It is most blend friendly

3.2 ASSESSMENT OF PHYSICAL PROPERTIES OF YARN

The woven fabrics were subjected to physical testing to determine the quality parameters which play a major role in evaluation of the quality of the fabric.

3.2.1 Linear density (Ne) BS-2060.1963

Linear density or yarn count is a numerical expression, which defines its fineness. Yarn Count or yarn number or linear density is described in metric system (Nm), Indirect yarn numbering system is the number of ‘unit length’ (cm) per ‘unit weight’ (kg)

$$\text{Count (Nm)} = \frac{\text{Length in meters}}{\text{Weight in grams}}$$

Number of specimen tested : 10 each warp and weft.

Name of the instrument : Electronic Balance.

Plate 1. Viscose Rayon and Eri silk Union Fabrics

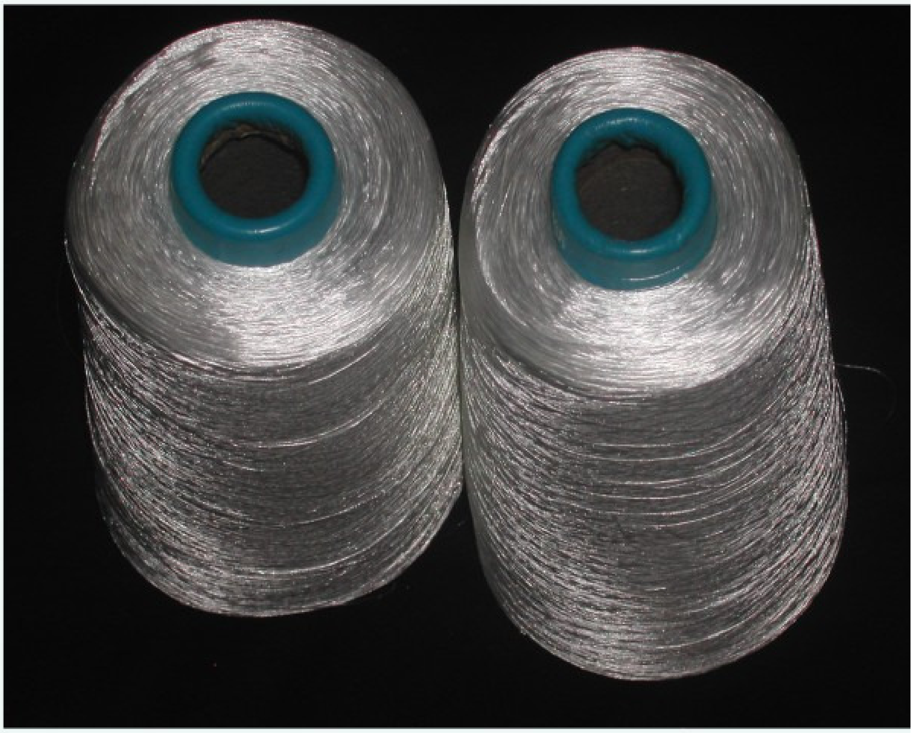

Plate 2. Cones of Viscose Rayon

Plate 2. Cones of Viscose Rayon

Plate 3. Eri silk hanks

Plate 3. Eri silk hanks

3.2.2 Yarn twist (tpi/tpm)

Twist is the spiral deposition of the components of the thread which is usually the result of relative rotation of the two ends. The direction of twist is indicated by the use of the letters S or Z. With the increase in twist the yarn strength gradually increases till it reaches maximum and then further increase leads to decrease. Yarn twist is expressed as twist per inch (tpi) or twist per meter (tpm)

Length of the specimen : 10 inch

Number of specimen tested : 15

Name of the instrument : Twist tester

3.2.3 Yarn tenacity (g/tex) and elongation (%)

The maximum load (force) suggested by specimen in a tensile test carried out to rapture is the breaking load or the tensile strength of the yarn. The breaking strength of the yarn determined is usually taken as an index of yarn quality and is expressed either in grams or pounds. The specimens were tested as directed in IS test method 1670-1991.

Length of the specimen : 51.0 cm

Load range : 0.900 kgs

Extension range : 20 cm

Speed : 15 cm/min

Gauge length : 200 mm

Number of specimen tested : 15

Name of the instrument : Instron Tensile Testing Machine

The value of reading for elongation at break was simultaneously recorded and expressed in terms of percentage.

3.3 WEAVING OF VISCOSE RAYON AND ERI SILK UNION FABRICS

Union fabrics are the fabrics where in the fibre content of warp is different form that of weft. Union fabrics create a variegated effect with distinguished features that are unique for specific end use. Thus, weaving union fabrics can serve as an ultimate material and cater to the present fashion world.

In the present study, an attempt is made to interweave Viscose Rayon with Eri silk to produce union fabrics.

3.3.1 Selection of Weaving Center

For the present study Laxmi Power Loom Unit, Doddaballapura (Bangalore) was the selected power loom weaving center of the state. The union fabrics of Viscose Rayon with Eri silk of different yarn count were woven on a semi-automatic power loom by the private weavers.

3.3.2 Constructional details of Viscose Rayon and Eri silk union fabrics

Constructional details of viscose Rayon and Eri silk union fabrics included general information about the constructional parameters of yarns and specific information of the fabrics pertaining to yarn type, twist direction, twist per inch, threads per inch, threads per inch, cloth cover and cover factor (Table 1).

3.4 LABORATORY TESTS

3.4.1 Assessment of mechanical properties

The mechanical properties of every woven fabric encompasses the features that provide basic texture, hand feel and dimensions to the fabric that inturn decides the functional properties of the woven fabric. In the present study the mechanical properties assessed for the union fabrics are as follows:

3.4.1.1 Cloth Count (Numerical expression)

Cloth count in woven textile material is the number of ends and picks per unit area, while the fabric is free from wrinkles.

The number of warp and weft yarns in one sq. inch of the fabric is counted at ten randomly selected places across the width and along the length of the test specimens. Further, mean values of ends and picks per inch are calculated.

Number of specimen tested : 10 each warp and weft

Method : Direct counting of threads per unit area, 1 inch

Instrument used : Magnifying counting device, the pick glass.

3.4.1.2 Cover factor (Numerical expression)

Cloth cover explains about the relationship between the count of the yarn and the fabric count. Cloth cover of any fabric is dependent on the cover factor of that material.

$$K = n / \sqrt{N}$$

where K= cover factor

n = Threads /inch

N = Count of yarn

Cover factor are calculated separately for warp and weft.

3.4.1.3 Mass per unit area (g)

The weight of a fabric can be described in two ways, as either the ‘weight per unit area’ or ‘weight per unit length’. In the fabric description, ‘weight per unit length’ is usually referred to as ‘weight per running yard’. The specimens were tested as per IS 1964:2001.

A sample size of 25 x 25 cm is cut and weighed on an electronic weighing balance to determine the weight per square meter (g). In addition, a sample size of 5x5 cm is cut where warp and weft threads are separated and weighed to calculate the percentage composition of warp and weft using the following formula.

Weight of 5x5 cm sample = a g

Weight of warp yarns = b g

Weight of weft yarns = c g

Percent of warp = 100 x b/ a

Percent of weft = 100 x c/ a

Number of specimens tested : 5

Instrument used : Electronic weighing balance

3.4.1.4 Cloth thickness (mm)

Thickness is the distance between the upper and lower surface of the material, measured under a specified pressure. The specimens were tested as directed in ASTM test method D: 1777-1975.

The average thickness of the material is determined by observing the linear distance that a movable plane is displaced from a parallel surface by the textile material while under a specified pressure.

The specimens taken were free from folds, wrinkles crushing or distortions, abnormal to test material.

Place the specimen on anvil of the test apparatus, bring the pressure foot into contact with the opposite side of the material, and record the thickness in mm.

Table 1. Constructional details of Viscose Rayon and Eri silk union fabrics

Sl. No.	Union fabrics	Direction	Fiber content	Yarn type	Twist direction	Yarn count	Threads per inch	Cover factor	Cloth cover	Weave type
1	Viscose rayon x Viscose rayon (control, (VR)	Warp	Viscose rayon	Single	Z	75d	101	12.65	17.12	Plain
		Weft	Viscose rayon	Single	Z	75d	83	9.98		
2	Viscose rayon x Eri silk of $2/40^S$ (VRE_1)	Warp	Viscose rayon	Single	Z	75d	101	12.78	21.25	Plain
		Weft	Eri silk	2 ply	S	$2/40^S$	51	15.60		
3	Viscose rayon x Eri silk of $2/60^S$ (VRE_2)	Warp	Viscose rayon	Single	Z	75d	101	12.28	19.96	Plain
		Weft	Eri silk	2 ply	S	$2/60^S$	58	13.99		
4	Viscose rayon x Eri silk of $2/80^S$ (VRE_3)	Warp	Viscose rayon	Single	Z	75d	101	12.18	20.09	Plain
		Weft	Eri silk	2 ply	S	$2/80^S$	72	13.80		

Shape of the anvil : Round

Area of the anvil : 1cm diameter

Shape of the presser foot : Round

Number of specimen tested : 15

Name of the instrument : Shirley's' thickness tester.

3.4.1.5 Cloth stiffness (cm)

Cloth stiffness is the resistance of the fabric to bending. Bending length is the length of the fabric that bends under its own weight to a definite extent. It equals half the length of rectangular strip of fabric that bends under its own weight to an angle of 41.5°. It is equal to the length of a rectangular strip of material that bends under its own weight to angle of 7.1°.The test sample were tested as directed in BS test methods: 3356-1961.

Place the test samples on the platform with the scale on top of it, length wise and the zero of scale coinciding with the leading edge of the test sample. Start pushing the sample along with the scale slowly and steadily when the leading edges project beyond the edges of the platform. An increasing part of the sample overhangs and starts bending on its own weight. When two inclined lines (of the inclined plane making an angle of 41.5° with the horizontal) of the tester coincide, record the length of the over hanging portion from the scale.

Four reading from each sample with each side up are taken

Size of the sample : 25x2.5 cm

Number of samples tested : One with four readings (both warp and weft- way)

Name of the instrument : Shirely's stiffness tester.

Further, the bending length was calculated by using formula.

Bending length=L/2 cm

Where L is the mean length of the over hanging portion in cm

3.4.2 Assessment of functional properties

Functional properties are the product of mechanical properties *i.e.* functional properties of any textile material is souly dependent on the mechanical prosperities, where mechanical properties inturn depend upon several other factors like type of yarn, fabric geometry etc. of the several functional properties durability of the fabric is of prime importance. Following are the functional properties assessed of the union fabrics:

3.4.2.1 Cloth tensile strength (kgf) and Elongation (%)

Tensile strength is the breaking strength of a sample *i.e.* ability of the material to withstand the rupture induced by external force. It is usually expressed in units of force per unit of cross sectional area of the sample. In the case of Rayon or silk it is expressed in grams per denier.

The specimens were tested as directed in IS test method 1969:1985

The method employed to determine the breaking load of the sample is by using the 'raveled strip test'. The specimen is 5cm wide piece of fabric prepared initially by cutting the material to a width of about 7cm and raveled the threads from both sides until the width attained 5 cm. The test length is 20cm in between the jaws and extra length was taken to grip within the jaws.

Size of the specimen : 20x5 cms

Number of specimen tested : 15

Test method : Raveled strip test

Load range : 200kgf

Speed : 300 mm/min

Name of the instrument : Instron tensile testing machine.

3.4.2.2 Cloth Abrasion Resistance (Cycles)

Abrasion is aspect of wear. "Wear" is the net result of a number of agencies which reduces the serviceability of an article. Abrasion is the rubbing away of the component fibers and yarns of the fabric. The specimens were abraded as directed under IS test method 12673:1989.

The specimen's were abraded until a hole was formed and number of cycles to create a hole was recorded.

Size of the specimen : 13.5 cm (diameter)

Number of specimen tested : 4

Type of abradant : Zero emery paper

Type of abrasion : Multidirectional

Determination of end point : Formation of hole

Name of the instrument : Martindale's abrasion tester

3.4.2.3 Cloth Drapability (%)

Drape is the ability of a fabric to assume a graceful appearance in use. It is the extent of which a fabric deforms when it is allowed hang under on its own weight to the extent.

Drape coefficient is the area covered by the shadow of the draped specimen expressed as percentage of the area of annular ring of the fabric.

A specimen is cut by means of circular template and is kept on supporting disc of the drapemteter. On switching the lamp, it gives the shadow of draped area, which is taken on a paper and is weighed. Similarly draped shadow area of the templet and supporting disc is also taken. Thus drape coefficient is calculated by using the formula:

$$F = \frac{W_S - W_d}{W_D - W_d} \times 100$$

where,

F=Drape co-efficient

W_s=Weight of the shadow

W_d=Weight of the supporting disc

W_D=Weight of the templet

Size of the specimen : 30 cm diameter

Name of the instrument : Eureka drape meter.

3.4.2.4 Cloth pilling (Rating)

Pilling is a fabric surface fault characterized by little 'pills'. Pills are balls or bunches of entangled fibers clinging to the cloth surface and giving the garment an unsightly appearance. This method covers the determination of resistance to the formation of pills and other related surface changes on textile fabric.

The specimens were tested as directed in IS test method: 10971-1984.

A fabric sample measuring 5x6 sq inch is sewn so as to fit firmly when placed around a rubber tube of 5 inch length, 1 ¼ inch outside and ⅛ inch thick, which is then rotated for 5 hours to complete 18,000 revolutions at the rate of 60 revolutions /min.

After tumbling, the extent of pilling is assessed visually by comparing with the arbitrary standards-1, 2,3,4, and 5.

Rating scale

1-No pilling

2-Slight pilling

3-Moderate pilling

4-Severe pilling

5-Very severe pilling

Size of the specimen : 12.5x12.5 sq inch

Name of the instrument : Heal's pilling tester

3.4.2.5 Air permeability ($m^3/m^2/min$)

Air permeability is defined as the volume of air measured in cubic centimeters passed per second through 1 cm^2 of the fabric at a pressure of 1 cm of water.

All the samples were tested as directed by IS test method 11056 : 1984. Air at standard atmosphere is drawn from the laboratory through the test specimen by means of a suction pump, the rate of flow being controlled by means of the by pass valve and series valve at the definite pressure. The rate of flow is adjusted until the required pressure drop a cross the fabric and is indicated on a drought gauge. The rate of flow of air is then recorded by rotameters from the instrument.

Area of specimen exposed	:	5 sq.cm
Pressure differential	:	10 mm
Number of specimens tested	:	5
Name of the instrument	:	Prolific air permeability tester

3.4.2.6 Thermal insulation value (tog)

Measurement of the 'warmth' of the fabric is known as thermal insulation value. It is very important to note that the warmth of a fabric is largely a function of airspace and its distribution in the structure and not, related to the thermal conductivity of the fibres used. The values of thermal insulation of a fabric are determined nominally in still air, whereas in practice the warmth value of a fabric is appreciated most in windy conditions.

The thermal insulation of fabric is expressed in tog units, where 1 tog corresponds to a heat transfer to 10 wm^{-2} (watt per meter square) per degree temperature difference. Higher the tog values, greater is the insulation (Basu, 2001 – Textile testing fibre, yarn and fabric).

All the samples were tested as directed in ASTM test method D: 1518-1985. The experiment was carried out at atmospheric condition of 65±2 per cent RH and 27±2°C temperature.

The instrument used for assessing thermal insulation of fabrics consists of a small chamber where it employees a hot plate on which the specimen is mounted. The temperature of the hot plate is maintained equal to human skin temperature by supplying continues power to the instrument. This hot plate is surrounded with a square strip known as guard plate whose temperature is slightly higher than the hot plate. An air gap is maintained between the hot plate and the specimen. The heat from the hot plate is absorbed by the fabric, there after decreasing the temperature of the hot plate, thus demanding for additional power supply. The power consumed Q_d to maintain the temperature of large hot plate is noted from the instrument. More the power consumed lesser is the thermal insulation of a fabric.

Size of the specimen	:	12 cm x 12 cm
Size of the hot plate	:	10 cm x 10 cm
Temperature of the hot plate	:	33°C
Temperature of the guard plate	:	33.5°C
Air gap between hot plate and the specimen	:	1 cm

Method employed	:	Guarded hot plate method
Duration of the test	:	30 min
Number of specimen tested	:	10
Name of the instrument	:	Kawabata thermolabo II

3.5 SUBJECTIVE EVALUATION OF UNION FABRICS

A panel of 25 textiles experts (respondents), comprising of faculty members and PG students of the Department of Textiles and Apparel Designing, College of Rural Home Science, UAS, Dharwad, faculty members of Central Silk Technological Research Institute, Central Silk Board (CSB), Bangalore carried out the visual assessment of union fabrics.

Criteria for selection of the respondents

- Selection was based on purposive sampling method where the respondents had knowledge about tactile properties of textile fabrics.

Appearance, handle and texture were the three tactile properties assessed. Further, the results were expressed in terms of percentages and average ranking whichever is appropriate.

3.6 VARIABLES INCLUDED IN THE STUDY

3.6.1 Independent variables

1. Yarn count (Ne)
2. Cloth count (Numerical expression)
3. Cover factor
4. Cloth weight (g)
5. Cloth thickness (mm)
6. Cloth bending length (cm)

3.6.2 Dependent variables

1. Cloth tensile strength (kgf) and elongation (%)
2. Cloth abrasion resistance (cycles)
3. Cloth drape coefficient (%)
4. Air permeability (m^3/ m^2/min)
5. Thermal insulation value (tog)

3.6.3 Classification of Independent variables

3.6.3.1 Age of the respondents

Based on the age, the judges were classified into three groups using the statistical formula $\bar{X} \pm 0.425$ SD.

3.6.3.2 Education of the respondents

The respondents were grouped on their education as stated by the them *i.e.* degree holders, post graduates and doctorates.

3.6.3.3 Occupation of the respondents

The respondents were classified broadly into employed and unemployed categories.

3.7 ECONOMICS OF VISCOSE RAYON AND ERI SILK UNION FABRICS

Variable cost of the union fabrics were calculated for cost comparison. Interest on working capital was calculated at the rate of 9 percent per annum and then apportioned to different materials considering the period of capital lacking in the form of raw material and finished products.

3.8 STATISTICAL ANALYSIS

The data were analyzed by using frequency tables. Percentages were calculated for subjective evaluation. The results obtained was subjected to statistical analysis by using One-way ANOVA technique.

Co-efficient of determination (R^2) was calculated to know the effect of mechanical properties on functional properties using the formula.

$$R^2 = \frac{\text{Sum of squares due to multiple regression}}{\text{Total sum of squares}}$$

To know the individual effect of all the independent variables on the dependent variables, multiple regression was carried out using the formula.

$$Y = a + b_1x_1 + b_2x_2 + \ldots\ldots\; b_nx_n + \ldots\ldots \in_{ij}$$

$i = 1\ldots\ldots n$ and $j = 1\ldots\ldots n$

Where $\in_{ij}$ are the errors independently normally distrubuted with mean 0 and common variante.

$x_1, x_2 \ldots\ldots\ldots x_n$ = Independent variable (regresión-coefficient)

Average ranking was used to determine the order of preference for union fabrics by the respondents where higher values indicated least preferred fabric.

3.9 NULL HYPOTHESIS SET FOR THE STUDY

- Eri silk as weft does not affect the physical properties of Viscose Rayon and Eri silk union fabrics
- Mechanical properties do not influence the functional properties of Viscose Rayon and Eri silk union fabrics

4. RESULTS

The results of the present study entitled "Quality characteristics of Viscose Rayon and Eri silk union fabrics" are presented under the following headings.

4.1 Weaving union fabrics

4.2 Physical testing

4.2.1 Physical properties of Viscose and Eri silk yarn

4.2.2 Mechanical properties of union fabrics

4.2.3 Functional properties of union fabrics

4.3 Subjective evaluation of union fabrics

4.4 Economic analysis of union fabrics

4.1 WEAVING UNION FABRICS

Weaving is one of the processes of fabric manufacturing where two sets of yarns *i.e.*, warp end and the filling yarn weft are interlaced at right angles to each other, according to a prearranged design. In the present study three different types of union fabrics were woven on a semi automatic power loom using Viscose Rayon as warp with three different yarn counts viz., 2/40s, 2/60s and 2/80s of Eri silk as weft. While the control sample was woven using Viscose Rayon as warp and weft. The production of union fabrics involved various processes like pre-loom, loom and post loom processes, which are separately dealt in this chapter (Plate 4).

4.1.1 Weaving Viscose Rayon with Eri silk of different yarn counts

Viscose Rayon x Viscose Rayon (control VR), Viscose Rayon x Eri Silk of 2/40s (VRE_1), Viscose Rayon x Eri Silk of 2/60s (VRE_2) and Viscose Rayon x Eri Silk of 2/80s (VRE_3) fabrics were woven on semi automatic power loom at Doddaballapur Bangalore by the private master weaver.

(i) Pre-loom process

Following pre-loom processes were followed :

(a) Warping

The yarn was then converted into warp where required number of thread were laid in parallel form under uniform tension to make the required width of cloth. Sectional warping was the technique adopted for warping. In this method the warp threads are drawn directly from separate spools arranged on a creel or spool rack on the warp beam. The main objective of this system of warping is to provide a quicker means of beaming the warp threads on the exact tension of the warp beam (Plate 5).

(b) Beaming

The process of winding the previously prepared warp in the form of a sheet, on to a beam is known as beaming. The beam is often provided with disc or flanges on both the ends to maintain the required width of warp to keep the selvedge ends in control. While winding the warp on to the beam, the individual threads are laid parallel to each other and are kept under uniform tension (Plate 6).

(c) Pirn winding

The Eri silk yarns of different counts were wound on to wooden pirns with the help of a power driven winding wheel provided on the left side of the power loom. Pirn winding is the process of transferring the weft yarn from cone onto the pirn (Plate 7 and Plate 8).

(ii) Loom process

(a) Loom particulars and weaving

Plate 4. Twisting Viscose Rayon

Plate 4. Twisting Viscose Rayon

Plate 5. Bobbin winding of Viscose Rayon

Plate 5. Bobbin winding of Viscose Rayon

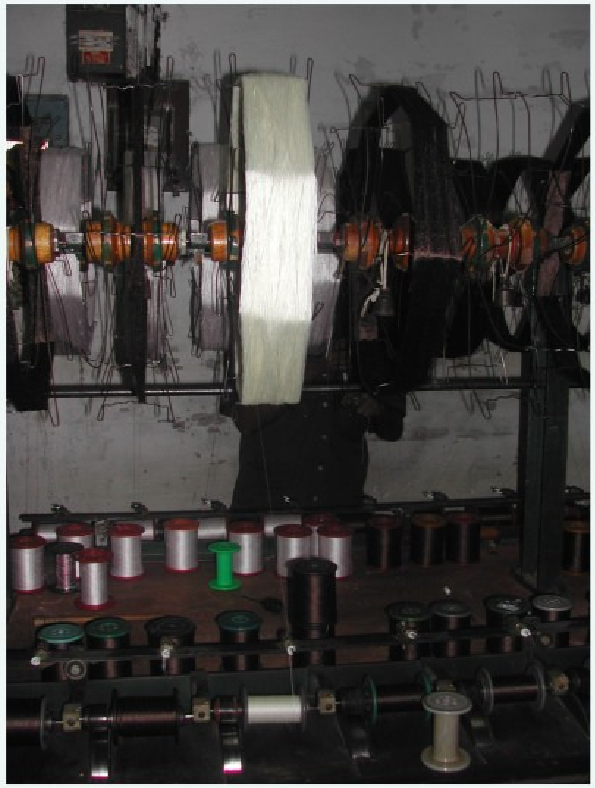

Plate 6. Bobbin winding of Eri silk

Plate 6. Bobbin winding of Eri silk

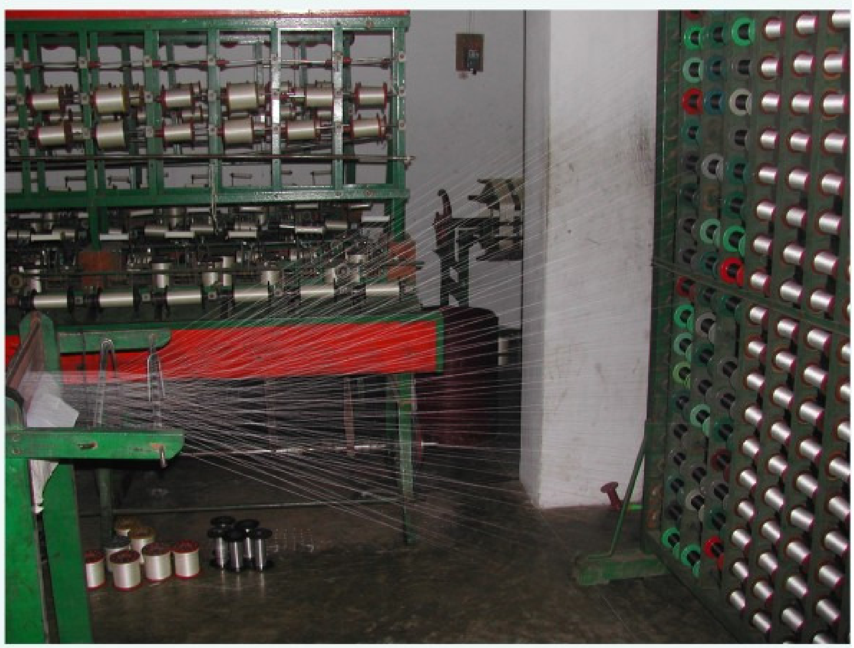

Plate 7. Sectional warping

Plate 7. Sectional warping

Plate 8. Beaming

Plate 8. Beaming

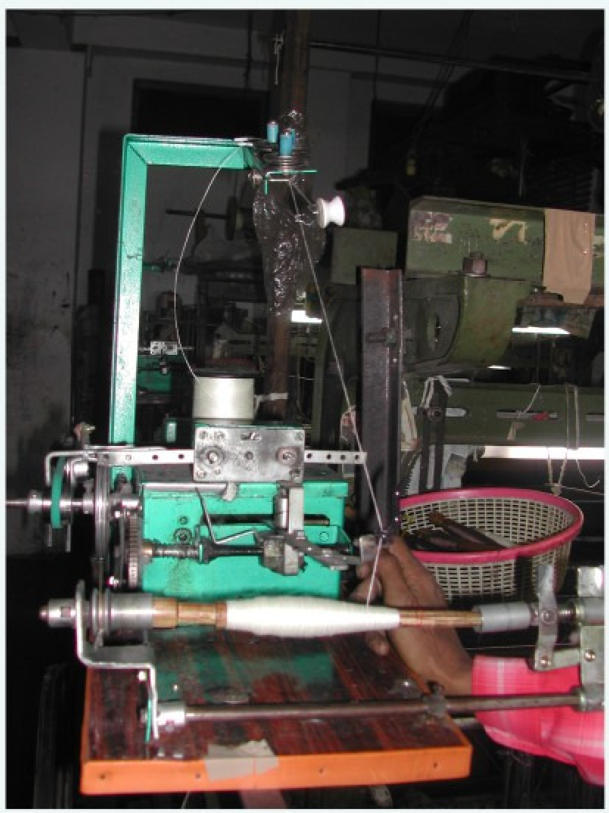

Plate 9. Power driven pirn winding

Plate 9. Power driven pirn winding

Plate 10. Weaving of union fabrics

Plate 10. Weaving of union fabrics

Plate 11. Splicing

Plate 11. Splicing

Table 2. Loom particulars of Viscose Rayon and Eri silk union fabrics

Sl. No.	Particulars	Union fabrics			
		VR (control)	VRE_1	VRE_2	VRE_3
1	Type of loom	Semi automatic power loom	Semi automatic power loom	Semi automatic power loom	Semi automatic power loom
2	Reed count	100	100	100	100
3	Reed width	52”	52”	52”	52”
4	Cloth width	44”	44”	44”	44”
5	Denting order	2 threads/ dent	2 threads/ dent	2 threads/ dent	2 threads/ dent

Note:
VR - Viscose rayon x Viscose rayon (control)
VRE_1 - Viscose rayon x Eri silk (2/40s)
VRE_2 - Viscose rayon x Eri silk (2/60s)
VRE_3 - Viscose rayon x Eri silk (2/80s)

Viscose Rayon x Viscose Rayon (control VR), Viscose Rayon x Eri Silk of 2/40s (VRE_1), Viscose Rayon x Eri Silk of 2/60s (VRE_2) and Viscose Rayon x Eri Silk of 2/80s (VRE_3), all the fabrics were woven on semi automatic power loom with reed count of 100, reed width of 52” cloth width of 45” and the denting order of 2 threads/dent (Table 2).

(b) Cutting and doffing

After weaving a known length of material, an extra length of approximately an inch was woven and separated from the cloth beam with the knife. This helped to prevent the slippage of yarns through the dents.

(iii) Post loom process

The woven fabrics were examined for flaws, then folded and packed neatly.

4.2 PHYSICAL TESTING

4.2.1 Physical properties of Viscose Rayon and Eri silk yarn

Table 3 indicates the physical properties of Viscose Rayon and Eri silk yarn. It is observed that Viscose Rayon was relatively finer (75d) among all the yarns with highest twist per inch (18) and elongation (35.1%). Eri silk of 2/40s was coarsest with highest yarn tenacity of 3.01 g/den.

4.2.2 Mechanical properties of union fabrics

4.2.2.1 Yarn count

Linear density or yarn count is a numerical expression which defines its fineness. The yarn count for both warp and weft was determined separately.

Table 4 gives an idea about the yarn count of Viscose Rayon – control sample and its union fabrics. Much variation was not found in the warp-way yarn count of all the samples.

On the other hand the weft-way yarn count of all the samples varied. The weft yarn count of control sample, Viscose Rayon x Viscose Rayon (VR) was finer (71s) than its union fabrics *i.e.*, Viscose Rayon x Eri silk of 2/40s (VRE_1 -10s), Viscose Rayon x Eri silk of 2/60s (VRE_2 -18s) and Viscose Rayon x Eri silk of 2/40s (VRE_3-26s).

The simple one way ANOVA test for all the samples presented in table indicated that the weft-way yarn count of all the union fabrics was significantly coarser compared to their corresponding warp-way count and there was a significant difference in weft-way count between the samples.

4.2.2.2 Cloth count (Numerical expression)

Cloth count is the number of ends and picks per unit area and is affected by the yarn count and compactness of the weave. From Table 5 it is learnt that, among all the fabrics, the control, Viscose Rayon x Viscose Rayon (VR) showed higher cloth density (101 x 83) and the least was observed in case of union fabric, Viscose Rayon x Eri silk of 2/40s (VRE_1) with ends per inch of 100 and picks per inch of 51. However, much variation was not found in the warp density of all the samples (VR-101, VRE_1-100, VRE_2-101, VRE_3-101).

Further, the statistical results revealed that there existed a significant difference in weft density among all the fabrics. The results also stated that there was significant difference in cloth count of control sample, Viscose Rayon x Viscose Rayon (VR- 100 x 83) as compared to union fabrics.

4.2.2.3 Cover factor (Numerical expression)

Cloth cover of the fabric depends on cover factor of warp as well as weft, which in turn is dependable on factors like yarn count, twist per inch, threads per inch etc. Table 6 depicted that the warp cover factor of all the fabric samples remained more or less same *viz.*, VR-12.65, VRE_1-12.78, VRE_2-12.28 ,VRE_3-12.18. On the other hand cover factor in weft-way showed a high difference among the test samples, where Viscose Rayon x Eri silk of 2/40s (VRE_1) exhibited highest weft-way cover factor of 15.60 followed by Viscose Rayon x Eri silk of 2/60s) (VRE_2 -13.99), Viscose Rayon x Eri silk of 2/80s (VRE_3-13.80). Least cover factor was showed by control sample, Viscose Rayon x Viscose Rayon (VR -9.980).

The simple one-way ANOVA presented in table indicated that, there was a significant difference in weft-way cover factor of the control sample, Viscose Rayon x Viscose Rayon (VR) and its union fabrics. However, there was no significant difference in cloth cover among the union fabrics.

4.2.2.4 Cloth weight (g)

Fabric mass per unit area is expressed either as grams per square meter or grams per linear meter. Some of the factors like type of fibre, yarn threads per unit area, type of weave employed etc. contribute to greater extent in determining the weight of the fabric. Table 7 narrates the cloth weight and percentage of warp and weft contributing to different sets of fabric. Viscose Rayon x Eri silk of 2/40s (VRE_1), exhibited highest cloth weight of 164.90 g. Weight per square meter of the control sample, Viscose Rayon x Viscose Rayon (VR-66.07 g) was lowest when compared to these union fabrics (VRE_1-164.9g, VRE_2-113.09g, VRE_3-109.70g). Further it is observed that percentage of weft is significantly higher than its corresponding warp for all the union fabrics except for control, Viscose Rayon x Viscose Rayon.

Moreover, statistical results exhibited significant decrease in cloth weight among the union fabrics.

Table 3. Physical properties of Viscose Rayon and Eri silk yarn

Sl. No.	Physical properties	Type of yarn			
		Viscose rayon	Eri silk		
1	Yarn count (Ne)	75d (71s)	2/40s	2/60s	2/80s
2	Average twist (tpi)	18	11	11	12
3	Average tenacity (g/den)	2.05	3.01	2.3	2.07
4	Elongation (%)	35.1	20.0	18.7	17.4

Table 4. Yarn count of Viscose Rayon and Eri silk union fabrics (Ne)

Sl. No.	Union fabrics	Direction		Yarn count (Ne)	
		Warp way	Weft way	Warp way	Weft way
1	Viscose rayon x Viscose rayon (control, VR)	Viscose rayon	Viscose rayon	75d (71s)	75d (71s)
2	Viscose rayon x Eri silk (VRE_1)	Viscose rayon	Eri silk	75d (71s)	2/40s
3	Viscose rayon x Eri silk (VRE_2)	Viscose rayon	Eri silk	75d (71s)	2/60s
4	Viscose rayon x Eri silk (VRE_3)	Viscose rayon	Eri silk	75d (71s)	2/80s

Variables	F value	Probability	SEd	CD	CV (%)
Warp	0.59	0.6310	0.074	0.574	0.165
Weft	14.29**	0.0003	8.492	18.50	1.567

** Significant at 1 per cent level of significance

Table 5. Cloth count of Viscose Rayon and Eri silk union fabrics (Numerical expression)

Sl. No.	Union fabrics	Direction	
		Warp way	Weft way
1	Viscose rayon x Viscose rayon (control, VR)	101	83
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	100	51
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	101	58
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	101	72

Variables	F value	Probability	SEd	CD	CV (%)
Warp	0.77	0.5273	0.949	2.011	1.488
Weft	187.15**	0.0000	1.503	3.275	3.596

** Significant at 1 per cent level of significance

Table 6. Cover factor of Viscose Rayon and Eri silk union fabrics (Numerical expression)

Sl. No.	Union fabrics	Cover factor	
		Warp	Weft
1	Viscose rayon x Viscose rayon (control, VR)	12.65	9.98
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	12.77	15.60
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	12.27	13.99
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	12.18	13.79

Variables	F value	Probability	SEd	CD	CV (%)
Warp	9.99*	0.0014	0.128	0.279	1.629
Weft	103.62**	0.0000	0.331	0.721	3.923

** Significant at 1 per cent level of significance
* Significant at 5 per cent level of significance

Table 7. Cloth weight of Viscose Rayon and Eri silk union fabrics (g/sq.mt.)

Sl. No.	Union fabrics	Total weight (g/sq.mt.)	Per cent warp	Per cent weft
1	Viscose rayon x Viscose rayon (control, VR)	66.07	57.22	45.18
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	164.90	26.64	74.12
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	113.09	30.98	68.60
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	109.70	36.46	66.23

Variables	F value	Probability	SEd	CD	CV (%)
Total weight (g/sq.mt.)	1322.16**	0.0000	1.573	3.426	2.192

** Significant at 1 per cent level of significance

4.2.2.5 Cloth thickness (mm)

It is always assumed that thicker the fabric longer is its life. Some of the fabric properties such as drapability, abrasion, thermal insulation value etc. are dependent on cloth thickness. Table 8 indicates the fabric thickness of Viscose Rayon and Eri silk union fabrics.

It is inferred from Table 8 that cloth thickness of Viscose Rayon x Eri silk of 2/40s (VRE_1) was noticeably high (0.42 m) as compared to other set of fabrics (VRE_2-0.31, VRE_3-0.27 mm and VR-0.18 mm). On the other hand control sample, Viscose Rayon x Viscose Rayon (VR, 0.18 mm) recorded least values of thickness.

The simple one way ANOVA depicted a significant decreasing trend in the cloth thickness among the union fabrics *i.e.*, VRE_{1}.0.42 mm, VRE_2-0.31 mm and VRE_3-0.27 mm.

4.2.2.6 Cloth stiffness (cm)

Stiffness is an important characteristic of a fabric. Stiffness is measured by bending length of the fabric. Bending length is the length of fabric that will bend under its own weight to a definite extent. Blending length determines the draping quality of a fabric. The factors that influence stiffness of a textile material are fiber content, yarn type, compactness of weave, cloth weight and thickness. Table 9 illustrated the bending length of samples. The warp and weft-way bending length of control sample, Viscose Rayon x Viscose Rayon (VR) was *i.e.,* 0.88 cm and 1.14 cm respectively. Among the union fabrics highest warp and weft bending length was observed in Viscose Rayon x Eri silk of 2/40s (VRE_1 - 1.56 cm) and 4.98 cm respectively. Whereas, lowest warp (1.06 cm) and weft-way (2.78) bending length was found in Viscose Rayon x Eri silk of 2/80s (VRE_3).

However, the statistical results revealed that there was significant difference in warp as well as weft-way cloth stiffness among all the samples.

4.2.3 Functional properties of union fabrics

4.2.3.1 Cloth tensile strength (kgf)

Tensile strength is the ability of the material to resist strain or rupture induced by external force. Table 10 narrates about tensile strength of the fabrics. Highest tensile strength in warp -way was observed in Viscose Rayon x Eri silk of 2/40s (VRE_1-62.18 kgf) followed by Viscose Rayon x Eri silk of 2/60s (VRE_2-61.58 kgf), Viscose Rayon x Eri silk of 2/80s (VRE_3-61.93 kgf), and the least was expressed by Viscose Rayon x Viscose Rayon (VR-58.31 kgf). Among the union fabrics Viscose Rayon x Eri silk of 2/40s (VRE_1) exhibited highest values of tensile strength in weft-way with 100.06 kgf. The least value of tensile strength was noticed for control sample Viscose Rayon x Viscose Rayon (VR- 48.89 kgf).

However, statistical results indicated significant difference in weft-way cloth tensile strength between Viscose Rayon and its union fabrics.

Influence of yarn count and cloth count on cloth tensile strength of Viscose Rayon and Eri silk union fabrics

Table 10a discloses the influence of yarn count and cloth count on tensile strength of the union fabrics. It indicated that there existed a weak and negative relationship both in warp and weft-way of yarn count and cloth count on cloth tensile strength, which inferred no relation between independent and dependent variable of the test samples i.e. yarn count and cloth count had no effect on cloth tensile strength of Viscose Rayon and Eri silk union fabrics.

4.2.3.2 Elongation (%)

Table 11 narrates the per cent elongation of the samples. The control sample, Viscose Rayon x Viscose Rayon (VR) showed highest elongation in warp-way (76.75%) whereas least elongation was observed for Viscose Rayon x Eri silk of 2/80s (VRE_3 - 44.69%). On the contrary, control sample VR exhibited highest elongation (37.67%) in the weft-way, where decreasing trend of elongation percentage was noticed among the union fabrics (VRE_1-21.40%, VRE_2-19.24%, VRE_3-18.24%).

The simple one-way ANOVA results revealed that there was a high degree of significance in the warp-way cloth elongation between all the samples. On the other hand,

Table 8. Cloth thickness of Viscose Rayon and Eri silk union fabrics (mm)

Sl. No.	Union fabrics	Cloth thickness (mm)
1	Viscose rayon x Viscose rayon (control, VR)	0.18
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	0.42
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	0.31
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	0.27

Variables	F value	Probability	SEd	CD	CV (%)
Cloth thickness (mm)	965.54**	0.0000	0.005	0.010	2.495

** Significant at 1 per cent level of significance

Table 9. Cloth stiffness of Viscose Rayon and Eri silk union fabrics (cm)

Sl. No.	Union fabrics	Bending length (cm)	
		Warp way	Weft way
1	Viscose rayon x Viscose rayon (control, VR)	0.88	1.14
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	1.56	4.98
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	1.22	2.84
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	1.06	2.78

Variables	F value	Probability	SEd	CD	CV (%)
Warp	15.18**	0.0001	0.105	0.222	14.053
Weft	300.49**	0.0000	0.128	0.272	6.920

** Significant at 1 per cent level of significance

Table 10. Cloth tensile strength of Viscose Rayon and Eri silk union fabrics (kg f)

Sl. No.	Union fabrics	Tensile strength (kg f)	
		Warp way	Weft way
1	Viscose rayon x Viscose rayon (control, VR)	58.31	48.89
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	62.18	100.06
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	61.58	65.83
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	61.93	56.88

Variables	F value	Probability	SEd	CD	CV (%)
Warp	12.69**	0.0005	0.677	1.474	1.761
Weft	66.64**	0.0000	4.001	8.718	9.384

** Significant at 1 per cent level of significance

Table 10a. Influence of yarn count and cloth count on cloth tensile strength of Viscose Rayon and Eri silk union fabrics

Source	Warp				Weft			
	Coefficient	**Standard error**	**t value**	**p value**	**Coefficient**	**Standard error**	**t value**	**p value**
X_1	-0.767	4.472	-0.171^{NS}	0.866	-0.102	0.358	-0.286^{NS}	0.779
X_2	-0.137	0.349	-0.393^{NS}	0.699	-1.016	0.659	-1.542^{NS}	0.142
R^2	0.011				0.539			

NS – Non-significant

X_1 – Yarn count
X_2 – Cloth count
R^2- Coefficient of determination

Table 11. Cloth elongation of Viscose Rayon and Eri silk union fabrics (%)

Sl. No.	Union fabrics	Elongation (%)	
		Warp way	Weft way
1	Viscose rayon x Viscose rayon (control, VR)	76.74	37.67
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	69.26	21.40
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	60.64	19.24
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	44.68	18.24

Variables	F value	Probability	SEd	CD	CV (%)
Warp	137.26**	0.0000	1.665	3.626	4.194
Weft	46.96**	0.0000	1.881	4.099	12.325

** Significant at 1 per cent level of significance

Table 11a. Influence of yarn count and cloth count on elongation Viscose Rayon and Eri silk union fabrics

Source	Warp				Weft			
	Coefficient	Standard error	t value	p value	Coefficient	Standard error	t value	p value
X_1	4.354	26.822	0.162^{NS}	0.873	0.554	0.071	7.751**	0.000
X_2	-0.307	2.093	-0.46^{NS}	0.885	-0.484	0.132	-3.675**	0.001
R^2	0.003				0.892			

** Significant at 1 per cent
NS – Non-significant

X_1 – Yarn count
X_2 – Cloth count
R^2- Coefficient of determination

there was no significant difference in weft-way cloth elongation among all the union fabrics. However, the weft-way elongation of the control sample VR, was highly significant when compared to its union fabrics.

Influence of yarn count and cloth count on cloth elongation percent of Viscose Rayon and Eri silk union fabrics

The influence of yarn count and cloth count on elongation presented in Table 11a clearly indicated that there was no relation between yarn count and cloth count on cloth elongation in warp-way of the test samples, since there existed no significant relation between independent and dependent variables. On the other hand there was a high influence of yarn count and cloth count on cloth elongation in the weft-way of the sample. It was noticed that yarn count and elongation are positively and significantly related in weft direction *i.e.,* increase in the yarn count resulted in to increase in elongation. However, in the weft-way, cloth count and elongation were negatively but significantly related which inferred that as the cloth count increased, cloth elongation of the samples decreased. Further, the influence of yarn counts and cloth count on cloth elongation in weft direction is explained by R^2 value 89 per cent.

4.2.3.3 Cloth abrasion resistance (cycles)

Abrasion resistance of a textile material is an important fabric property. Abrasion is an aspect of wear. It is the rubbing away of the component fibres and yarns of the fabric. The ability of a material to resist the action of abrasive forces is one of the major criteria to take into account for assessing the durability.

Table 12 reveals the cloth abrasion resistance of Viscose Rayon and Eri silk union fabrics. Among all the test samples, Viscose Rayon x Eri silk of 2/40s (VRE_1) exhibited higher resistance to abrasion (1180 cycles) followed by Viscose Rayon x Eri silk of 2/60s (VRE_2 -415 cycles), Viscose Rayon x Eri silk of 2/80s (VRE_3 -342 cycles) and Viscose Rayon x Viscose Rayon (VR-329 cycles).

The values of loss in thickness of Viscose Rayon x Eri silk of 2/80s (VRE_3) was found to be highest (5.07%) among all the test samples. The loss in mass of the test samples on abrasion, expressed in terms of percentage, was also higher in Viscose Rayon x Eri silk of 2/80s (VRE_1-5.08%) followed by Viscose Rayon x Eri silk of 2/60s (VRE_2 - 2.08%), Viscose Rayon x Eri silk of 2/40s (VRE_1 – 1.52%), Viscose Rayon x Viscose Rayon (VR – 1.09%).

The statistical results indicated that there was no significant difference in thickness loss on abrasion among the test samples. However, mass loss in union fabrics was significantly higher when compared to control sample.

Influence of yarn count and cloth thickness on loss in thickness of Viscose Rayon and Eri silk union fabrics

Table 12a revealed the influence of yarn count and cloth thickness on loss on thickness per cent of test samples. It was observed from the table that there is no relation between independent and dependent variables of the samples *i.e.*, the warp as well as weft yarn count did not show any significant effect on loss in thickness of the test samples.

Influence of yarn count and cloth thickness on loss in mass of Viscose Rayon and Eri silk union fabrics

Influence of yarn count and cloth thickness on loss in mass is presented in Table 12b. The results showed that there is relationship between independent and dependent variables of the test samples, where only weft-way yarn count values were significant at 5 per cent level. It is evident that both weft-way yarn count and cloth thickness negatively influenced the loss in mass on abrasion with significant relationship. Thus, increase in yarn count and cloth thickness resulted into decrease in loss in mass. On the other hand, warp-way yarn count and cloth thickness showed non-significant relationship with loss in mass on abrasion. Further the influence of yarn count and cloth thickness on loss in mass in weft direction is explained by R^2 26 per cent.

Table 12. Cloth abrasion resistance of Viscose Rayon and Eri silk union fabrics (cycles)

Sl. No.	**Union fabrics**	**No. of cycles**	**Loss in thickness (%)**	**Loss in mass (%)**
1	Viscose rayon x Viscose rayon (control, VR)	329	5.01	1.09
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	1180	3.25	1.52
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	415	4.87	2.08
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	342	5.07	5.08

Variables	F value	Probability	SEd	CD	CV (%)
Loss in thickness (%)	2.60	0.0881	0.912	1.934	30.573
Loss in mass (%)	35.31**	0.0000	0.389	0.826	23.314

** Significant at 1 per cent level of significance

Table 12a. Influence of yarn count and cloth thickness on loss in thickness Viscose Rayon and Eri silk union fabrics

Source	Warp				Weft			
	Coefficient	Standard error	t value	p value	Coefficient	Standard error	t value	p value
X_1	-2.142	3.372	-0.635^{NS}	0.534	5.679	0.033	1.732^{NS}	0.101
X_2	-4.178	4.195	-0.996^{NS}	0.333	9.632	8.648	1.114^{NS}	0.281
R^2	0.067				0.189			

NS – Non-significant

X_1 – Yarn count
X_2 – Cloth thickness
R^2- Coefficient of determination

Table 12b. Influence of yarn count and cloth thickness on loss in mass Viscose Rayon and Eri silk union fabrics

Source	Warp				Weft			
	Coefficient	Standard error	t value	p value	Coefficient	Standard error	t value	p value
X_1	-1.147	3.340	-0.343^{NS}	0.736	-7.15	0.030	-2.357*	0.031
X_2	-2.405	4.155	-0.579^{NS}	0.570	-19.054	7.999	-2.382*	0.029
R^2	0.023				0.259			

* Significant at 5 per cent
NS – Non-significant

X_1 – Yarn count
X_2 – Cloth thickness
R^2- Coefficient of determination

4.2.3.4 Cloth drapability (%)

Drape is an important property, which affects the aesthetics of fabrics. Drape of the fabric is generally referred to the way in which a fabric hangs down in folds. The drapability of a fabric depends on many factors such as weave, cover-factor, finish etc. Fabrics with different weaves but similar cover factor show difference in drapability. From Table 13 it is learnt that Viscose Rayon x Eri silk of 2/40s (VRE_1) exhibited highest drape coefficient value of 88.58per cent whereas least drape coefficient value was found for control sample., Viscose Rayon x Viscose Rayon (VR-64.21%) indicating its flexibility and pliability.

However, the statistical results depicted that cloth drape coefficient of control sample, Viscose Rayon x Viscose Rayon (VR) was significantly lower than its union fabrics.

Influence of cloth thickness and cloth stiffness and cover factor on drapability of Viscose Rayon and Eri silk union fabrics

Table 13a depicts the influence of cloth stiffness and cover factor on drapability of Viscose Rayon and Eri silk and its union fabrics. It is relevant from table that there existed a strong relation between independent and dependent variables, except cover factor in weft direction showed non-significant relation with drapability of the test samples. Further it is noticed that cloth stiffness in the warp-way negatively and significantly influenced the drapability of Viscose and its union fabrics. On the other hand, warp-way cover factor of the test samples positively and significantly influenced the drapability, which inferred that as the cover factor increased, the drapability also increased. It was also observed that weft-way cloth stiffness had positive and high significant relation with cloth drapability of Viscose and its union fabrics. Further, the influence of cloth stiffness and cover factor on drapability in warp direction is explained by R^2 value *i.e.*, 55 per cent.

4.2.3.5 Cloth pilling (ratings)

Cloth pilling is defined as bunches of entangled fibres that are held on the surface of the fabric. The pills are formed during wear and washing by entanglement of loose fibres which protrude from the fabric surface, thus giving an ugly appearance to the fabric.

Table 14 indicates resistance of samples for pilling. All the samples except Viscose Rayon x Eri silk of 2/60s (VRE_2) showed very severe pilling.

4.2.3.6 Cloth air permeability ($m^3/m^2/min$)

Air permeability can be defined as the rate of air flow under a differential pressure between the two fabric surface. Factors like weave, cloth count, cover factor, finishes applied etc. have an appreciable effect upon air permeability by causing a change in length of air flow paths through a fabric. Yarn twist is also important in that as twist increases, the circularity and density of yarn increases, reducing the yarn diameter and cover factor thus increasing the air permeability of a fabric.

Table 15 exhibited air permeability of Viscose Rayon and Eri silk union fabrics. Highest air permeability was illustrated by control sample., Viscose Rayon x Viscose Rayon (VR- 200.864 $m^3/m^2/min$) followed by Viscose Rayon x Eri silk of 2/60s (VRE_2-28.138-$m^3/m^2/min$), Viscose Rayon x Eri silk of 2/80s (VRE_3-27.303 $m^3/m^2/min$) and Viscose Rayon x Eri silk of 2/40s (VRE_{1}-15.998 $m^3/m^2/min$).

The simple one-way ANOVA technique presented in table indicated that air permeability of control sample, Viscose Rayon x Viscose Rayon (VR) was significantly higher than union fabrics. Further it was revealed that there existed no significant difference among the union fabrics.

4.2.3.7 Thermal insulation value (tog)

Thermal insulation property of a textile fabric can be defined as the effectiveness of fabric in maintaining the normal temperature of the human body under equilibrium conditions.

Table 16 depicts the thermal insulation value of the test samples. Of the all the samples Viscose Rayon x Eri silk of 2/40s (VRE_1), possessed highest values of thermal insulation (1.49 tog) followed by Viscose Rayon x Eri silk of 2/60s (VRE_2-1.46 tog), Viscose

Table 13. Cloth drape coefficient of Viscose Rayon and Eri silk union fabrics (%)

Sl. No.	Union fabrics	Drape coefficient (%)
1	Viscose rayon x Viscose rayon (control, VR)	64.21
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	88.58
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	87.72
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	83.23

Variables	F value	Probability	SEd	CD	CV (%)
Drape coefficient (%)	105.70**	0.0000	1.567	3.415	3.062

** Significant at 1 per cent level of significance

Table 13a. Influence of cloth stiffness and cover factor on drapability Viscose Rayon and Eri silk union fabrics

Source	Warp				Weft			
	Coefficient	**Standard error**	**t value**	**p value**	**Coefficient**	**Standard error**	**t value**	**p value**
X_1	-12.512	5.470	-2.284*	0.035	5.205	1.076	4.839**	0.000
X_2	24.998	5.731	4.362**	0.000	-1.484	1.646	-0.902^{NS}	0.380
R^2	0.554				0.829			

** Significant at 1 per cent,
* Significant at 5 per cent
NS – Non-significant

X_1 – Cloth stiffness
X_2 – Cover factor
R^2- Coefficient of determination

Table 14. Cloth pilling of Viscose Rayon and Eri silk union fabrics (ratings)

Sl. No.	Union fabrics	Pilling (ratings)
1	Viscose rayon x Viscose rayon (control, VR)	5
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	4
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	5
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	5

Rating scale

1-No pilling
2-Slight pilling
3-Moderate pilling
4-Severe pilling
5-Very severe pilling

Table 15. Cloth air permeability of Viscose Rayon and Eri silk union fabrics

Sl. No.	Union fabrics	Air permeability ($m^3/m^2/min$)
1	Viscose rayon x Viscose rayon (control, VR)	200.864
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	15.998
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	28.138
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	27.303

Variables	F value	Probability	SEd	CD	CV (%)
Drape coefficient (%)	1242.77**	0.0000	3.555	7.537	8.62

** Significant at 1 per cent level of significance

Table 16. Thermal insulation value of Viscose Rayon and Eri silk union fabrics (tog)

Sl. No.	Union fabrics	Thermal insulation value (tog)
1	Viscose rayon x Viscose rayon (control, VR)	1.17
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	1.49
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	1.46
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	1.37

Variables	F value	Probability	SEd	CD	CV (%)
Thermal insulation value (tog)	4.34*	0.0203	0.098	0.208	11.317

* Significant at 5 per cent level of significance

Table 16a. Influence of cover factor and air permeability on thermal insulation value Viscose Rayon and Eri silk union fabrics

Source	Warp				Weft			
	Coefficient	Standard error	t value	p value	Coefficient	Standard error	t value	p value
X_1	0.175	0.108	1.613^{NS}	0.125	-1.29	0.047	-0.146^{NS}	0.787
X_2	-1.80	0.000	-4.179**	0.001	1.93	0.001	-0.796^{NS}	0.153
R^2	0.510				0.437			

** Significant at 1 per cent
NS – Non-significant

X_1 – Cover factor
X_2 – Air permeability
R^2- Coefficient of determination

Rayon x Eri silk of 2/80s (VRE_3-1.37 tog). Least values of thermal insulation was observed in case of control sample, Viscose Rayon x Viscose Rayon (VR-1.17 tog).

However, statistical results indicated that thermal insulation value of union fabrics was significantly higher than control sample.

Influence of cover factor and air permeability on thermal insulation value of Viscose Rayon and Eri silk union fabrics

Table 16a illustrates the influence of cover factor and air permeability on thermal insulation value of Viscose Rayon and Eri silk union fabrics. The results depicted that there was no relation between independent and dependent variables of the test samples, since the values were found to be non significant, except in warp direction *i.e.*, air permeability in warp-way has negative influence on thermal insulation of the test samples and the values are significant at 5 per cent level. It reveals that as the air permeability increases, thermal insulation of the samples decreases. Further, the influence of cover factor and air permeability on thermal insulation value in warp direction is explained by R^2 value 44 per cent.

4.3 SUBJECTIVE EVALUATION OF UNION FABRICS

Subjective evaluation of union fabrics is an age old method of assessing fabric qualities like appearance, handle and texture. This type of evaluation involves extensive personal preferences. The quality of any fabric is largely dependent on fiber content, type of yarn fabric construction, finish, mechanical, functional properties and serviceability of the fabric. However, specification and judgment of the fabric characteristics is perfectly individual's decision and is judged by the experts (Plate 11).

4.3.1 General information of the respondents according to their age, gender, education and occupation

The general information of the textile experts who formed the respondents for assessing tactile properties of the union fabrics is presented in Table 17.

1. Age

Table 17 reveals the distribution of respondents according to their age. It was observed that majority of them belonged to middle age group (48%) followed by older (28%) and young (24%) age group (Fig. 1).

2. Gender

Majority of the respondents constituted of male 56 per cent and rest were female 44 per cent.

3. Education

Among the respondents majority of them were post graduates (48%) followed by degree holders (32%) and doctorates (20%) (Fig. 2).

4. Occupation

From Table 17 it is evident that 80 per cent of the respondents were employed and 20 per cent were unemployed (Fig. 3).

4.3.2 Respondents opinion on fabric appearance of Viscose Rayon and Eri silk union fabrics

Table 17a depicts the respondents opinion on fabric appearance of the samples. The appearance was judged mainly by four different categories viz., clear or fibrous fine or coarse, lustrous or dull and smooth or rough. Again each category was sub divided into two factors viz., slightly clear or slightly fibrous, moderately fine or slightly coarse, highly lustrous or semi dull and fairly smooth or slightly rough. It means that a total of sixteen factors were considered for assessing the appearance (Appendix I) of Viscose Rayon and Eri silk union fabrics.

Plate 12. Textile experts evaluating Viscose Rayon and Eri silk union fabrics

Plate 12. Textile experts evaluating Viscose Rayon and Eri silk union fabrics

Table 17. Distribution of respondents according to age, gender, education and occupation

Sl. No.	Variables	Number of respondents (%)
1	Age	
	Younger (<34 years)	06 (24)
	Middle (34-42 years)	12 (48)
	Older (>42 years)	07 (28)
2	Gender	
	Male	14 (56)
	Female	11 (44)
3	Education	
	Degree holders	8 (32)
	Post-graduates	12 (48)
	Doctorates	05 (20)
4.	Occupation	
	Employed	20 (80)
	Unemployed	05 (20)

Figures in parenthesis indicate percentages

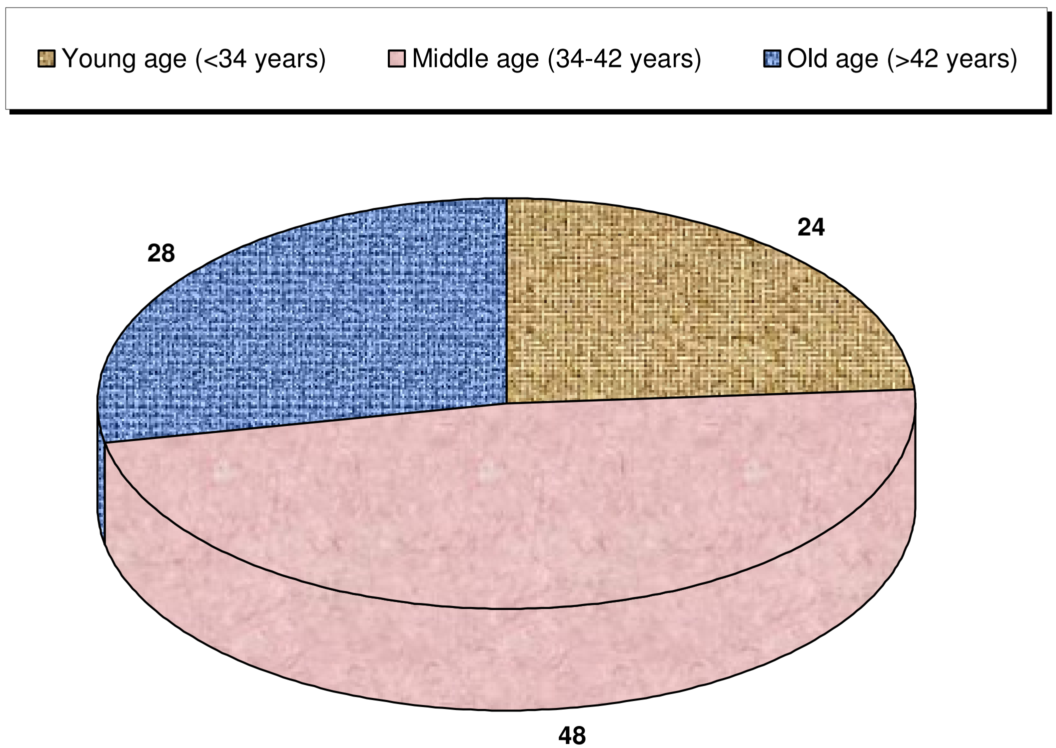

Fig. 1. Distribution of respondents according to age

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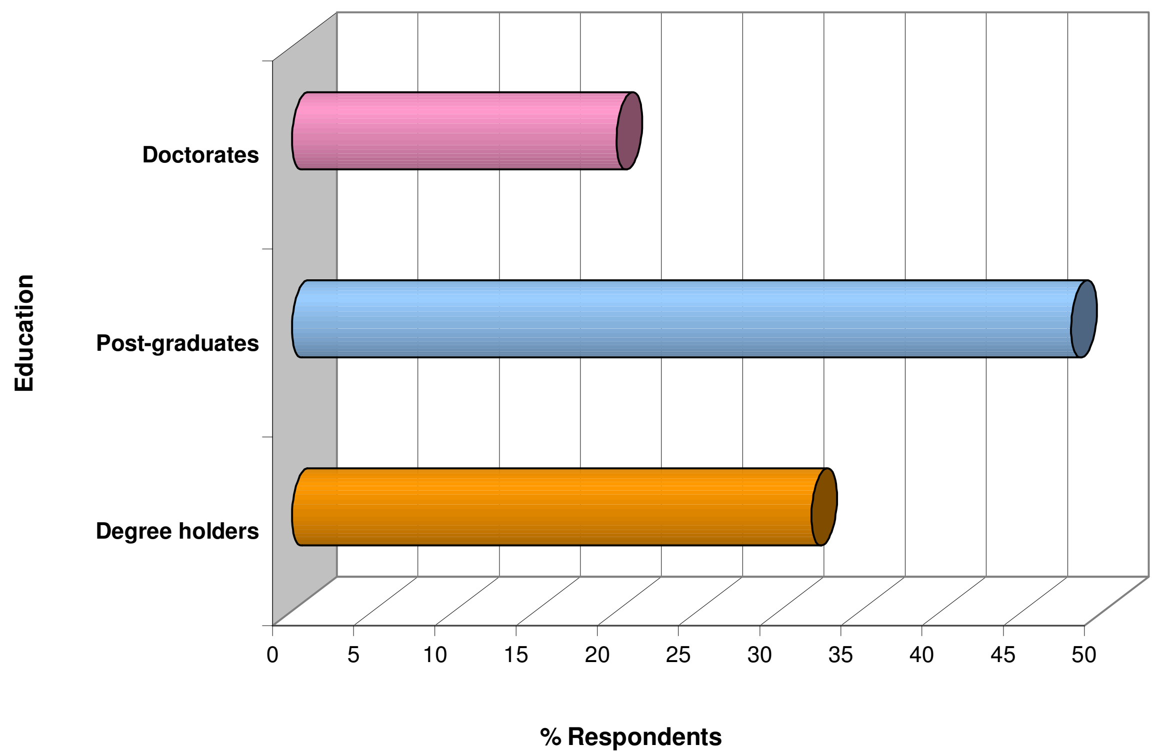

Fig. 2. Distribution of respondents according to education

Fig. 2. Distribution of respondents according to education

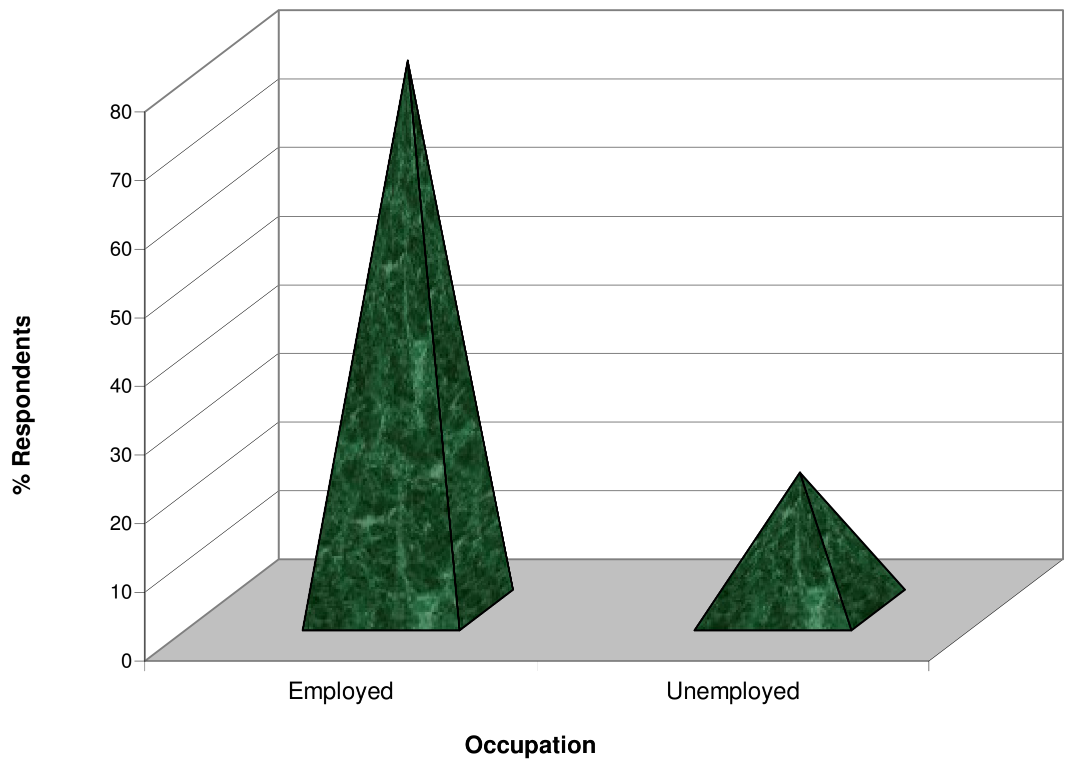

Fig. 3. Distribution of respondents according to occupation

Fig. 3. Distribution of respondents according to occupation

Table 17a. Respondents opinion on appearance of Viscose Rayon and Eri silk union fabrics

(n=25)

Sl. No.	Particulars	Union fabrics			
		VR (Control)	VRE_1	VRE_2	VRE_3
A	1. Clear	25 (100)	-	18 (72)	-
	2. Slight clear	-	-	07 (28)	23 (92)
	3. Slight fibrous	-	21 (84)	-	2 (8)
	4. Fibrous	-	04 (16)	-	-
B	1. Fine	25 (100)	-	16 (64)	10 (40)
	2. Moderately fine	-	-	09 (36)	15 (60)
	3. Slightly coarse	-	20 (80)	-	-
	4. Coarse	-	05 (20)	-	-
C.	1. Highly lustrous	25 (100)	-	-	-
	2. Lustrous	-	-	-	25 (100)
	3. Semi dull	-	-	25 (100)	-
	4. Dull	-	25 (100)	-	-
D.	1. Smooth	25 (100)	-	-	-
	2. Fairly smooth	-	-	18 (72)	19 (26)
	3. Slightly rough	-	05 (20)	07 (7.28)	06 (24)
	4. Rough	-	20 (80)	-	-

Figures in parentheses indicate percentage

Cent per cent respondents opined that, Viscose Rayon x Viscose Rayon (control, VR) was clear (100%), fine (100%), highly lustrous (100%) and smooth (100%). All most all the respondents expressed that among the union fabrics, Viscose Rayon x Eri silk of 2/40s (VRE_1) was duller (100%), slightly fibrous (84%) slightly coarser (80%) and rougher (80%) than Viscose Rayon x Eri silk of 2/60s and Viscose Rayon x Eri silk of 2/80s (VRE_3) fabrics.

4.3.3 Respondents opinion on fabric handle of Viscose Rayon and Eri silk union fabrics

The fabric handle was assessed by considering three main parameters viz., soft or crisp, flexible or stiff and compact or loose. Each of these parameters were again divided as farily soft or slightly crisp, stightly flexible or fairly stiff, moderately compact or slightly loose. A sum of twelve parameters were taken into account for assessing fabric handle of Viscose Rayon and Eri silk its union fabrics (Appendix I).

It is interesting to note that, all the respondents expressed control sample, Viscose Rayon x Viscose Rayon (VR) was flexible (100%) and compact (100%) to handle. It was also observed that 68 per cent of the respondents opined VR was soft to handle. On the other hand Viscose Rayon x Eri silk of 2/60s was fairly soft (76%), slightly flexible (80%) and compactly woven (100%). Further, cent per cent respondents inferred all the fabrics were compactly woven except Viscose Rayon x Eri silk of 2/80s (VRE_3) (Table 17b).

4.3.4 Respondents opinion on fabric texture of Viscose Rayon and Eri silk union fabrics

Table 17c illustrates the respondents opinion on fabric texture of Viscose Rayon and Eri silk its union fabrics. Texture of the fabrics was assessed by factors viz., close structure or open structure, light weight or heavy weight and even (flat) surface or uneven surface, which further was divided as moderately close structure or slightly open structure, moderately light weight or fairly heavy weight and slight even surface or slightly uneven surface (Appendix I).

All the respondents stated that (Table 17c) Viscose Rayon x Viscose Rayon (control, VR) had closed structure, was light weight with even surface. Among the union fabrics, Viscose Rayon x Eri silk of 2/40s (VRE_1) and Viscose Rayon x Eri silk (2/60s) (VRE_2) had close structure, (88% and 25% respectively) when compared to Viscose Rayon x Eri silk of 2/80s (VRE_3-64%) which had moderately closed structure. However, none of the samples had open structure.

Majority of the respondents opined that Viscose Rayon x Eri silk of 2/40s (VRE_1) was heavy in weight (100%) with slightly uneven surface (72%). Further the respondents stated Viscose Rayon x Eri silk of 2/60s (VRE_2) was the only fabric which had fairly heavy weight (92%) with even surface (52%).

4.3.5 Preference for Viscose Rayon and Eri silk union fabrics

Table 17d narrates the order of preference for Viscose Rayon and Eri silk union fabrics. The order of preferences expressed in terms of average ranking in which higher the values, lesser is the preference and vice versa. Most of the respondents preferred Viscose Rayon x Eri silk of 2/60s (VRE_2 – 1.88) followed by Viscose Rayon x Eri silk of 2/80s (VRE_3 – 2.24) and Viscose Rayon x Viscose Rayon (VR-2.8). Further Viscose Rayon x Eri silk of 2/40s (VRE_1 – 3.08) was least preferred union fabric.

4.4 ECONOMICS OF UNION FABRICS

Table 18 shows the cost of production of Viscose Rayon and Eri silk union fabrics. The cost included the cost of raw materials, wages for preparatory processes and weaving. Interest on variable cost was also taken into account. However, the selling price was calculated by adding 40 per cent profit on total cost of production. Table 18 describes the economics of Viscose Rayon and Eri silk union fabrics.

It is observed from the table that among the union fabrics the total cost of Viscose Rayon x Eri silk of (2/40s) (VRE_1) was accounted to be higher *i.e.* Rs.254.76. It is found that greater amount was incurred on the raw material (Rs.198.73) followed by weaving charges (Rs.20.00), preparatory processes (Rs.15) and interest on variable cost (Rs.21.03). From the calculated value of total cost and total returns, a profit of Rs.101.90 was earned. On the other

Table 17b. Respondents opinion on handle of Viscose Rayon and Eri silk union fabrics

(n=25)

Sl. No.	Particulars	Union fabrics			
		VR (Control)	VRE_1	VRE_2	VRE_3
A	1. Soft	08 (32)	-	-	-
	2. Fairly soft	17 (68)	-	19 (76)	-
	3. Slight crisp	-	-	06 (24)	25 (100)
	4. Crisp	-	25 (100)	-	-
B	1. Flexible	25 (100)	-	-	11 (44)
	2. Slight flexible	-	-	20 (80)	14 (56)
	3. Fairly stiff	-	24 (96)	05 (20)	-
	4. Stiff	-	1 (4)	-	-
C.	1. Compact	25 (100)	25 (100)	25 (100)	03 (12)
	2. Moderately compact	-	-	-	22 (88)
	3. Slightly loose	-	-	-	-
	4. Loose	-	-	-	-

Figures in parentheses indicate percentage

Table 17c. Respondents opinion on texture of Viscose Rayon and Eri silk union fabrics

(n=25)

Sl. No.	Particulars	Union fabrics			
		VR (Control)	VRE_1	VRE_2	VRE_3
A	1. Close structure	25 (100)	22 (86)	25 (100)	09 (36)
	2. Moderately close structure	-	03 (12)	-	16 (64)
	3. Slightly open structure	-	-	-	-
	4. Open structure	-	-	-	-
B	1. Light weight	25 (100)	-	-	-
	2. Moderately light weight	-	-	-	19 (76)
	3. Fairly heavy weight	-	-	23 (92)	06 (24)
	4. Heavy weight	-	25 (100)	02 (08)	-
C.	1. Even (flat) surface	25 (100)	-	13 (52)	-
	2. Slightly even (flat) surface	-	07 (28)	12 (48)	21 (84)
	3. Slightly uneven surface	-	18 (72)	-	04 (16)
	4. Uneven surface	-	-	-	-

Figures in parentheses indicates percentage

Table 17d. Respondents preference for Viscose Rayon and Eri silk union fabrics

(n=25)

Sl. No.	Union fabrics	Rank				Average ranking
		I	II	III	IV	
1	Viscose rayon x Viscose rayon (control) (VR)	03	02	09	11	2.8
2	Viscose rayon x Eri silk of 2/40s (VRE_1)	02	01	10	12	3.08
3	Viscose rayon x Eri silk of 2/60s (VRE_2)	14	07	03	01	1.88
4	Viscose rayon x Eri silk of 2/80s (VRE_3)	05	12	02	06	2.24

Table 18. Economics of Viscose Rayon and Eri silk fabrics (per meter)

(Rs./m)

Sl. No.	Particulars	Viscose rayon x Viscose rayon (control) (VR)	Union fabrics		
			Viscose rayon x Eri silk of 2/40s (VRE_1)	Viscose rayon x Eri silk of 2/60s (VRE_2)	Viscose rayon x Eri silk of 2/80s (VRE_3)
I	Variable cost				
a.	Raw material				
	Warp	10.93	11.62	11.52	11.60
	Weft	8.67	187.11	117.00	118.00
	Total	19.60	198.73	128.52	129.64
b	Preparatory processes	22.50	15.00	15.00	15.00
c	Weaving	20.00	20.00	20.00	20.00
d	Interest on variable cost	5.58	21.03	14.71	14.81
III	Total cost	67.60	254.76	178.24	179.45
IV	Selling price	94.64	356.66	249.54	251.23
V	Net returns	27.04	101.90	71.30	71.78

Note:

Cost of Viscose rayon/kg (warp) : Rs. 270.00
Cost of Eri silk (2/40s)/kg (weft) : Rs. 1350.00
Cost of Eri silk (2/60s)/kg (weft) : Rs. 1350.00
Cost of Eri silk (2/80s)/kg (weft) : Rs. 1650.00

hand the total cost of Viscose Rayon x Eri silk of 2/80s (VRE_3), Viscose Rayon x Eri silk of 2/60s (VRE_2) and control sample, Viscose Rayon x Viscose Rayon (VR) was Rs.179.45, 178.24 and 67.60 with net profit of Rs.71.78, 71.30 and 27.04 respectively.

On the whole the total cost of Viscose Rayon x Eri silk of 2/40s (VRE_1) was maximum (Rs.254.76) followed by Viscose Rayon x Eri silk of 2/80s (VRE_3), Viscose Rayon x Eri silk 2/60s (VRE_2) and control sample, Viscose Rayon x Viscose Rayon (VR) *i.e.* Rs.178.24, Rs.67.60 and Rs.67.60 respectively. In terms of net profit, VRE_1 earned a maximum profit of Rs.101.90 followed by VRE_3 (Rs.71.78), VRE_2 (Rs.71.30) and control sample (Rs.27.04).

5. DISCUSSION

Findings of the present investigation on "Quality characteristics of Viscose Rayon and Eri silk union fabrics" are presented under the following sub-headings.

5.1 Weaving of Viscose Rayon and Eri silk union fabrics

5.2 Physical testing

5.2.1 Mechanical properties

5.2.2 Functional properties

5.3 Subjective evaluation of Viscose Rayon and Eri silk union fabrics

5.4 Economics of Viscose Rayon and Eri silk union fabrics

5.1 WEAVING OF VISCOSE RAYON AND ERI SILK UNION FABRICS

In the present study Viscose Rayon as warp was interwoven with Eri silk of three different yarn counts *viz.*, 2/40s, 2/60s and 2/80s as weft on a semi automatic power loom.

5.2 PHYSICAL TESTING

5.2.1 Mechanical properties

5.2.1.1 Yarn count

Table 4 reveals that the warp-way yarn count 75d of all the union fabrics as well as control was same viz., Viscose Rayon x Viscose Rayon (control VR), Viscose Rayon x Eri Silk (VRE_1), Viscose Rayon x Eri Silk (VRE_2) and Viscose Rayon x Eri Silk (VRE_3), because of fibre content inherent fineness, regularity uniformness single yarn which was constant for all the fabrics.

The weft-way yarn count of all the fabric samples viz., VR_1, VRE_1, VRE_2 and VRE_3 varied with each other. Weft-way yarn count of control sample (VR) was relatively finer than all the union fabrics attributed to its fibre content, filamentous nature, greater twist per inch and single yarn structure. The weft-way yarn count of the union fabrics was coarser than control because Eri silk being spun, was characterized by short filaments which are joined end to end, thus giving uneven distribution of slubs and snars throughout the yarn length with 2 ply yarn structure.

5.2.1.2 Cloth count (Numerical expression)

From the Table 5, it is clear that the warp density of all the samples *i.e.* Viscose Rayon x Viscose Rayon (control VR), Viscose Rayon x Eri Silk of 2/40s (VRE_1), Viscose Rayon x Eri Silk of 2/60s (VRE_2) and Viscose Rayon x Eri Silk of 2/80s (VRE_3), did not very much. This may be due to employment of same reed count, fibre content type of yarn and yarn count for all the sets of fabric. The weft density of control and union fabrics varied with each other. It was observed that the weft density of control sample was higher than the union fabrics which may be because weft being Viscose Rayon was relatively finer than Eri silk. Thus VR the control sample was woven more compactly than its union fabrics.

5.2.1.3 Cover factor (Numerical expression)

It is inferred from the Table 6 that the warp-way cover factor of all the test samples more or less remained same, may be because Viscose Rayon yarn of 75d which was used as warp for all the sets of fabric. On the other hand, Viscose Rayon x Eri silk of 2/40s (VRE_1) exhibited highest cover factor in the weft direction attributed to coarser yarn count and 2 ply yarn structure.

5.2.1.3 Cloth weight (g/sq.mt.)

A perusal of Table 7 reveals that, the cloth weight per square meter of all the union fabrics was higher than control sample owing to the fiber content *i.e.* Eri being spun silk of 2/40s to 2/80s possessed slubs and snars formed during spinning probably might have contributed to certain per cent of weight with two ply yarns structure, were relatively coarser, heavier and possessed less number of picks per inch.

5.2.1.5 Cloth thickness (mm)

Table 8 reflects about the cloth thickness of Viscose and its union fabrics. It is observed that the cloth thickness of control sample was lowest compared to its union fabrics. It was also noticed that, though the control sample was compactly woven, was relatively thinner and finer than its union fabrics, which may be because of filamentous nature, greater twist per inch as well as finer yarn count uniform surface of Viscose Rayon yarn. Hence, giving rise to lower thickness of cloth. Viscose Rayon x Eri silk of 2/40s (VRE_3) possessed higher values of thickness which may be attributed to coarser yarn count and irregular yarn surface. These findings are on par with the results of Sanapapamma and Naik (2007).

5.2.1.6 Cloth stiffness (cm)

Table 9 indicates cloth bending length of test samples. In general, the values were greater in weft direction than warp for all the union fabrics. This may be because of coarseness and heaviness of Eri silk.

Among all the test samples Viscose Rayon x Eri silk of 2/40s (VRE_1) union fabric showed highest bending path, which inturn depicted its stiffness, may be due to coarser yarn, greater cloth weight and thickness. Least bending length was exhibited by control sample Viscose Rayon x Viscose Rayon (VR), attributed to least weight and thickness. Thus was found to be soft and pliable.

5.2.2 Functional properties

5.2.2.1 Cloth tensile strength (kgf)

There are various factors which contribute to the tensile strength of any textile material viz., fibre content, yarn count, yarn type, method of fabric construction, fabric sett etc. It is generally assumed that the breaking strength of the finer yarn is higher than coarser yarn but when individual strength is compared, coarser fibres would show higher value of strength.

It is observed from the Table 10 that, in general the warp tensile strength was lower than weft attributed to fibre content and coarse yarn of Eri silk, which is a spun silk. Warp tensile strength of Viscose Rayon x Eri silk of 2/40s (VRE_1) was highest may be because Eri as weft being coarser each constituent fibre share more load than finer yarn, thus increasing the breaking strength of the fabric. However, there was no significant difference observed between the warp tensile strength of the unions fabrics. Similar trend was observed in weft direction, where union fabrics exhibited greater tensile strength than control, which may be due to the combined effect of fibre content, coarse yarn (2/40s) with 2 ply yarn structure of Eri silk.

5.2.2.2 Cloth elongation (%)

The perusal of Table 11 revealed about elongation of test samples. In general the weft-way elongation was lower than warp-way due to fibre content of Eri silk which is considered to be more plastic than elastic. The very crystalline polymer system, Eri silk does not resist the polymer movement. On the contrary is possible in amorphous system. Hence, when silk is stretched additionally, the polymer, which are already in stretched state may not elongate further. Similar results were observed in the study conducted by Sanapappamma and Naik (2007).

On the other hand the weft-way elongation percentage of control sample, Viscose Rayon x Viscose Rayon (VR) was found to be highest which may be due to combined effect of single yarn structure and more amorphous region than Eri silk.

5.2.2.3 Cloth abrasion resistance (cycles)

Table 12 inferred the results of abrasion resistance of the test the samples. Abrasion resistance is the capacity of absorbing a textile material for absorbing the repeated energy impacts. Abrasion is just one aspect of wear and tear that in turn determine the durability of the cloth. The properties which play a greater role in influencing the cloth abrasion resistance are fibre content, yarn count and thickness to some extent.

Viscose Rayon x Eri silk of 2/40s (VRE_1) showed higher resistance to abrasion may be because of Eri silk, which was coarsest among all the union fabrics, in turn increased the thickness, resulting into better abrasion resistance. On the other hand the control sample Viscose Rayon x Viscose Rayon (VR) showed low resistance to abrasion attributed to its fine yarn count and low thickness value.

On abrasion, there existed loss in thickness, which was found to be more in union fabrics influenced by frictional abrasion in multi direction that resulted into breakage of fibres. Consequently, there was also loss in mass which may be because the fibrous substance in the form of dust is raised from the fabric surface during abrasion and gradually resulting into fuzz, nap, pill and finally leads to breakage of yarn.

5.2.2.4 Cloth drapability (%)

Drape of the fabric is related to the cloth stiffness and is influenced by various properties viz., weave, cloth count, cover factor, cloth thickness etc. Table 13 illustrates that, the control sample Viscose Rayon x Viscose Rayon (VR) showed least drape coefficient attributed to low bending length, low thickness, thus making it soft and pliable. However, highest drape coefficient value was observed in case of Viscose Rayon x Eri silk of 2/40s (VRE_1) which may be due to high bending length and thickness with greater weft-way cover factor. Thus it can be assumed that greater the stiffness, higher is the drape coefficient.

5.2.2.5 Cloth pilling (ratings)

It is evident from the Table 14 that all the samples exhibited very severe pilling. During pilling, under the influence of rubbing action loose staple fibres develop in to small spherical bundles anchored to the fabric by a few unbroken fibres. It is clear that all most all the union fabrics showed very severe pilling owing to their fiber content and staple length. These findings are on par with the results of Praveena and Vatsala (1992).

5.2.2.6 Air permeability ($m^3/m^2/min$)

A perusal of Table 15 reveals that the air permeability of control sample and Viscose Rayon x Viscose Rayon (VR) was highest, which may be due to high twist factor and low cover factor of the sample. It is assumed the as the yarn twist increases, the circularity and density of the yarn increases, reducing the yarn diameter and the cover factor, thus increasing the air permeability of a fabric (Basu, Textile Testing Fibre, Yarn and Fabric, 2001). Least value of air permeability was observed, in case of Viscose Rayon x Eri silk of 2/40s (VRE_1) which may be due to coarser yarn count, low twist factor, high cloth cover and thickness, hence reducing the amount of air flow through it.

5.2.2.7 Cloth thermal insulation value (tog)

Table 16 reveals the thermal insulation value of control and union fabrics. The thermal insulation of Viscose Rayon x Eri silk of 2/40s (VRE_1) was highest among all the test samples attributed to combined influence of coarser yarns, greater cover factor, higher values of thickness and lowest values of air permeability, thus increasing thermal insulation value of the sample. Control sample (VR) exhibited least value of thermal insulation value. This may be due to finer yarn, lower values of cover factor and thickness with highest air permeability.

Thus the null hypothesis, “Eri silk as weft does not affect the physical properties of Viscose Rayon and Eri silk union fabrics” and “the mechanical properties do not influence the functional properties of the Viscose Rayon and Eri silk union fabrics were rejected” which means that Eri silk as weft of three different yarns count did effect the physical properties and also that the mechanical properties did influence the functional properties of Viscose rayon and Eri silk union fabrics.

5.3 SUBJECTIVE EVALUATION OF VISCOSE RAYON AND ERI SILK UNION FABRICS

5.3.1 General information of respondents according to their age, education and occupation

From Table 17 it is noticed that majority of the respondents belonged to middle age group and were educated upto degree and post graduate. Further it is apparent from the table that 80 per cent of the respondents were employed in the field of textiles. This may be attributed to the purposive sampling system where the respondents had knowledge about tactile properties of textile fabrics.

5.3.2 Respondents opinion on fabric appearance of Viscose Rayon and Eri silk union fabrics

Table 17a revealed the respondents opinion on fabric appearance of union fabric. Cent per cent respondents expressed that Viscose Rayon x Viscose Rayon control (VR) was clear, fine, highly lustrous and smooth in appearance, which may be because of Viscose Rayon a major component of the fabric that has a unique properties of fineness, inherent luster, soft and smooth appearance.

Further, majority of the respondents opined that, Viscose Rayon x Eri silk of 2/40s (VRE_1) was slightly fibrous and slightly coarser with dull and rough appearance. This may be due to coarser yarn count and Eri silk being spun, gave an irregular yarn surface in turn resulted into slightly fibrous and coarser appearance of cloth as such.

5.3.3 Respondents opinion on fabric handle of Viscose Rayon and Eri silk union fabrics

The factors considered for fabric handle are presented in Table 17b. Greater per cent of respondents expressed that, Viscose Rayon x Eri silk of 2/40s (VRE_1) was crisp and slightly stiff to handle than other fabrics. This may be due to the reason that Eri silk being spun was coarsest which added to the stiffness making it hard to touch, thus made the fabric crisp and stiffer.

5.3.4 Respondents opinion on fabric texture of Viscose Rayon and Eri silkunion fabrics

The perusal of Table 17c reveals the respondents opinion on fabric texture of Viscose Rayon and its union fabrics. Majority of the respondents opined that union fabrics exhibited more weight than control sample. This may be attributed to Eri silk being spun with coarser yarns, which probably added stiffness and weight to the fabrics. However, all the samples except Viscose Rayon x Eri silk of 2/80s (VRE_3) attained closed structure may be due to high density of warp and weft yarns.

Further, majority of the respondents expressed that Viscose Rayon x Viscose Rayon (VR) had even surface attributed to evenness and fineness of Viscose Rayon yarn which was highly free from slubs and snars inturn resulted into even surface.

5.3.5 Preference for Viscose Rayon and Eri silk union fabrics

It is evident form Table 17d that, most of the respondents preferred Viscose Rayon x Eri silk of 2/60s (VRE_2). This may be due to hand and feel, even surface, texture and overall appearance that, enhanced the elegance, with aesthetic appeal and brightness. Moreover Eri silk of 2/60s was comparatively free from slubs and snars as compared to yarns of 2/40s and 2/80s, thus adding to its appearance.

5.4 ECONOMICS OF VISCOSE RAYON AND ERI SILK UNION FABRICS

A perusal of Table 18 indicates that, the total cost of production of Viscose Rayon x Eri silk of 2/40s (VRE_1) was maximum followed by Viscose Rayon x Eri silk of 2/80s (VRE_3), Viscose Rayon x Eri silk of 2/60s (VRE_2) and Viscose Rayon x Viscose Rayon (VR). The cost of production of union fabrics was more than control may be due to high price of raw material *i.e.* Eri silk of 2/40s than Viscose Rayon yarn. However, the net profit earned was more in VRE_1 compared to control sample.

6. SUMMARY AND CONCLUSIONS

The present research entitled "Quality characteristics of Viscose Rayon and Eri silk union fabrics" was carried out during the year 2005-07 with the objective to explore the possibilities of weaving union fabrics of Viscose Rayon with Eri silk, to assess the mechanical and functional properties of union fabrics, to evaluate the tactile properties of the union fabrics and to study the economic feasibility of the union fabrics.

Viscose Rayon as warp with Eri silk of three different counts viz., 2/40s, 2/60s and 2/80s as weft were interwoven on a semi-automatic power loom to produce union fabrics. These woven fabrics were then subjected for testing of mechanical and functional properties. A panel consisting of 25 textile experts assessed the woven fabrics for visual appearance, hand feel and texture. Average ranking method was applied to assess the experts preference for the union fabrics. Economic analysis was done for cost comparison of union fabrics.

The results of the present study is summarized as follows:

Physical testing of Viscose Rayon and Eri silk yarns

- Viscose Rayon yarn showed greater elongation (%)
- Eri silk registered greater tensile strength

Fabric information of union fabrics

- All the fabrics including control were woven on a semi automatic power loom with reed width of 52" and cloth width of 44".
- The reed count of Viscose Rayon and Eri silk union fabrics was 100 with the denting order of 2 threads/dent.
- Plain weave was employed to construct all the fabrics

Assessment of mechanical properties of Viscose Rayon and Eri silk union fabrics

- Viscose Rayon and Eri silk union fabrics were woven with finer yarn count.
- Among the union fabrics, Viscose Rayon x Eri silk of 2/40s (VRE_1) was interlaced with coarser weft yarn than VRE_2 and VRE_3.
- Control sample Viscose Rayon x Viscose Rayon (VR) was densely woven than its union fabrics. However, the warp density of all the fabrics remained same, whereas the weft density varied.
- All the samples possessed greater ends per inch than picks.
- Among all the test samples, Viscose Rayon x Eri silk of 2/40s (VRE_1) exhibited highest weft-way cover factor.
- All the union fabrics *viz.*, VRE_1, VRE_2 and VRE_3 were found to be heavier than control sample, VR.
- The cloth thickness of control sample Viscose Rayon x Viscose Rayon (VR) was lower than its union fabric.
- Among the union fabrics Viscose Rayon x Eri silk of 2/40s (VRE_1) exhibited highest bending path.

Assessment of functional properties of Viscose Rayon and Eri silk union fabrics

- Among the test samples Viscose Rayon x Eri silk of 2/40s (VRE_1) and Viscose Rayon x Viscose Rayon (VR) showed highest and least weft-way tensile strength respectively.
- In general the warp-way elongation was higher than weft-way. Among the test samples, Viscose Rayon x Viscose x Rayon (control, VR) showed highest warp-way elongation per cent.

- There existed a positive and non-significant relationship between yarn count and warp-way elongation, while cloth count showed negative and non-significant relation on warp-way elongation.
- Viscose Rayon x Viscose Rayon (control, VR) exhibited highest weft-way elongation per cent.
- The influence of weft-way yarn count on weft elongation (%) of the test samples was found to be positive with high significance. However, the influence of cloth count on elongation (%) in weft direction was highly significant but negatively related.
- The union fabric Viscose Rayon x Eri silk of 2/40s (VRE_1) sample exhibited higher resistance to abrasion than control sample, Viscose Rayon x Viscose Rayon (VR).
- On abrasion, the loss in thickness as well as loss in mass percentage was highest in union fabrics as compared to control sample.
- The influence of weft yarn count and cloth thickness on loss in mass was significantly and negatively related.
- The per cent drape coefficient was least in control sample, Viscose Rayon x Viscose Rayon (VR) which inturn expressed its soft and pliable texture than its union fabrics.
- All the samples, except Viscose Rayon x Eri silk of 2/48s (VRE_1) exhibited very severe pilling.
- Highest air permeability was recorded by control sample VR where as least was found with VRE_1.
- Of all the test samples, Viscose Rayon x Eri silk of 2/40s expressed highest thermal insulation value which inturn exhibited less air space in the fabric.
- Weft-way cover factor and air permeability negatively and significantly influenced the thermal insulation of the test samples.

Subjective evaluation of union fabrics

- Majority of the respondents belonged to middle age group who were either degree holders or post graduates followed by older age and young age who were either doctorates or post graduates respectively.
- Among the respondents, majority of them were men and employed since the respondents were the faculty members of Central Silk Board, Bangalore.

Opinion on appearance, handle, texture and preference for Viscose Rayon and Eri silk union fabrics

- Majority of the respondents opined that the control sample, Viscose Rayon x Viscose Rayon (VR) was clear, fine, highly lustrous and smooth in apeparnace than its union fabrics.
- Among the union fabrics, cent per cent of the respondents expressed that Viscose Rayon x Eri silk of 2/40s (VRE_1) was crisp, compact and fairly stiff to handle.
- The respondents stated that Viscose Rayon x Viscose Rayon (control, VR) was flexible compactly woven with fair softness to handle.
- Maximum per cent of the respondents expressed that Viscose Rayon x Eri silk of 2/40s (VRE_1) exhibited heavy weight, closed structure with slightly uneven surface.
- Most of the respondents preferred Viscose Rayon x Eri silk of 2/60s (VRE_2) followed by Viscose Rayon x Eri silk of 2/80s (VRE_3), Viscose Rayon x Viscose Rayon (control, VR) and the least preferred was Viscose Rayon x Eri silk of 2/40s (VRE_1) because of their appearance, construction, hand and feel and texture that enhanced the elegance.

Economics of Viscose Rayon and Eri silk union fabrics

- The total cost of Viscose Rayon x Eri silk of 2/40s (VRE_1) union fabric was maximum followed by Viscose Rayon x Eri silk of 2/80s (VRE_3), Viscose Rayon x Eri silk of 2/60s (VRE_2) and Viscose Rayon x Viscose Rayon (control, VR).
- In terms of net returns, Viscose Rayon x Eri silk of 2/40s (VRE_1) union fabric earned maximum profit.

IMPLICATIONS AND RECOMMENDATIONS

Eri silk has a vast potential of emerging as "A silk of the new millennium", providing excellent dimension of scope in design development and product diversification with special properties to produce abundant finished products.

Eri silk being a spun silk, can either be hand spun or mill spun has tremendous scope of utilization in handloom sector. The hand spun Eri yarn has unequal distribution of slubs and snars is an added advantage that gives a fancy appearance and texture to the end product.

In the present study the mill spun yarn had almost even surface which provided an unique elegance to the fabric. The special qualities of the cloths made from mill spun Eri, have not been exploited. There is an immense field for guaranteed Eri fabrics in India and that very special qualities of mill spun Eri will lead to greater demand both in India and abroad. Thus special properties of Eri silk could be utilized for production of diversified finished products to venture world market of craze for natural silk and mark it an export commodity.

Eri silk is not as lustrous as other silks. It can be either blended with polyester, Viscose *etc.* or union fabrics can be produced which not only provides luster but also is cost effective.

As Eri silk can be spun into wide range of counts from 10s to 210s, innumerable diversified end products can be produced. Considering the special quality of warmthness of Eri, coarser yarns of 10s, 20s, 35s, 40s could be suitable for the production of chadar, rugs, shawls, furnishing and upholstery commodities. On the other hand finer counts viz., 60s, 80s, 120s and higher counts can be effectively used for producing dress materials, shirtings, etc. thus can open new era with limitless possibilities in the field of fashion world.

The study provides the information on mechanical and functional properties of Viscose Rayon and Eri silk union fabrics. As Eri silk worms are multivoltine and domesticated which can be commercially reared like mulberry silk worms, provokes the Ericultrists and textile scientists to make future developmental activities in process and product control for fabric engineering. The study also provides information on tactile properties of Viscose Rayon and Eri silk union fabrics. Eri silk or Ahimsa silk is natural and a eco-friendly fibre, where user friendly and non-toxic dyes can be used to obtain wide range of shades.

Thus¸ the newly designed Viscose Rayon and Eri silk union fabrics are unique, a new venture for the textile industry and Ericulturists. Eri silk production can conveniently be under taken as a subsidiary occupation along with castor crop where castor is commercially cultivated for oil seeds and also a leisure time subsidiary activity by economically poor sections of the society. Thus, it is an income generating activity for spinners, weavers, dyers and printers for their livelihood security.

FUTURE DIMENSIONS OF WORK

The following future studies can be taken up

- Development of new functional polyester/acrylic/Eri silk union fabrics
- Production of fancy weaves using mulberry/tasar/muga/ Eri silk blended yarns
- To study the quality characteristics of Eri silk union fabrics with special finishes
- Colour fastness properties of Eri silk union fabrics dyed with acid and natural dyes
- Value addition of Eri silk union fabrics
- Development of non-woven fabrics using Eri silk noil fibres

REFERENCES

Basu, A., 2001, Textile testing fibre, yarn and fabric. The South Indian Textile Research Association, Coimbatore.

Bhalerao, S., 1997, Eri silk staple yarn production. *The Indian Tex. J.,* **107**(4): 106-108.

Chollakup, R., Lopez, L., Sinoimeri, A. and Drean, J., 2004, Eri silk as blended material with cotton for ring spinning. *Tex. Asia.,* **37**(7): 25-27.

Collier, B.J., 1991, Measurement of fabric drape and its relationship of fabric mechanical properties and subjective evaluation. *Tex. Dyer Pri.,* **25**(21): 32.

Datta, R.K. and Patel, N.C., 1995, Fabric feel, and appearance of some Indian suiting fabrics using Kawabata instrument. *ATIRA Comm. Tex.,* **29**(1): 22-35.

De Subir Kumar and Mitra Ashis, 2005, A comparative study on some mechanical properties of eri and cotton fabrics. *Man-made Tex. India.,* **48**(11): 430-434.

Itagi, M.R., Sreenivasa, Vijaykumar, H.L. and Nadiger, G.S., 2006, Development of Eri soil blended fabrics and study of their properties. *Man-made Textiles in India*, **49**(2): 47-50.

Joshua, O.U., 1994, Bending properties of wet abraded woven fabrics. *Indian J. Fibre Tex. Res.,* **19**(4): 229-239.

Kalitha, B., Gogoi, N. and Phukan, A., 1998, Silk blending for yarns and fabrics. *The Indian Tex. J.,* **108**(10): 72-73.

Kariyappa, Roy Subrata and Somashekar, T.H., 2005, Eri silk noil spinning and its characterization. *Indian Silk,* **44**(5): 15-18.

Kariyappa, Somashekar, T.H., Ramaswamy, G.N., Roy Subrata, Shasidar, C. and Pattanshetty, R.B., 2006, Studies on processing of eri cocoons in mill spinning to produce quality spun silk yarn and its characterization. *Man-made Tex. India*, **49**(9): 339-348.

Kariyappa, Somashekar, T.H., Roy Subrata and Ramaswamy, G.N., 2006, Large scale mill spinning of eri cocoons a possibility. *Indian Silk*, **45**(4): 19-23.

Kariyappa, Somashekar, T.H., Roy Subrata and Sastry Nanjunda, 2006, Studies on blending of eri silk with wool fibres in spinning and its characterization. *Man-made Tex. India,* **49**(5): 176-185.

Kariyappa, Umesha, M. and Somashekar, T.H., 2003, CSTRI motorized – cum – pedal operated spinning machine. *Indian Silk,* **42**(1): 37-40.

Kariyappa, Vasumathi, B.V., Ramaswamy, G.N., Shreekant, T., Roy Subrata and Somashekar, T.H., 2005, Fancy spun silk yarns. *Indian Silk,* **43**(11): 15-16.

Koshy, T.D., 2001, Silk production and export management, APH Publishing Corporation, New Delhi.

Linganur, B.K., Kaushal, K.S., Havanur, K.G. and Hadimani, V.V., 1998, Feasibility of blending cotton with silk. *The Indian Tex. J.,* **98**(6): 72-74.

Mishra, S.N., 2000, Eri silk spinning technology. *Indian Silk*, **43**(12): 20-23.

Mukhopadhyay, A., Sharma, I.C. and Sharma, M., 2002, Evaluation of comfort properties of polyester viscose suiting fabrics. *Indian J. Fibre Tex. Res.*, **27**: 7-76.

Praveena, M. and Vatsala, R., 1992, A study on blending of mulberry silk waste. *The Indian Tex. J.,* **103**(1): 92-94.

Rabindranath, U. and Das, P.K., 2003, Eri spinning on Ambar Charaka – An experience. *Indian Silk*, **41**(12):53-55.

Sanapapamma, K.J. and Naik, S.D., 2007, Durability of Ahimsa silk shirtings. *J. Tex. Assoc.,* **67**(5): 215-219.

Sarkar, D.C., 1980, Ericulture in India, Edn. 1., Central Silk Board, Bombay.

Shailaja, N. and Pandhye, 1996, Yarn take up and strength. *The Indian Tex. J.,* **107**(1): 50-52.

Shilpa, P., Charankar, Verma, V. and Gupta, M., 2007, Growing importance of cotton blends in apparel market. *J. Tex. Assoc.,* **67**(5): 201-210.

Somashekar, T.H., 2003, Recent advances in eri silk spinning weaving and future prospects. *Indian Silk*, **41**(11): 20-23.

Sreenivasa, Itagi, M.R., Vijaykumar, H.L. and Nadiger, G.S., 2005, Development and study of the properties of eri silk and polyester blended yarn. *Man-Made Tex. India,* **48**(1): 15-18.

Tarafder, N. and Kauser, A., 1996, Stiffness and crease recovery. *The Indian Tex. J.,* **116**(3): 34-39.

Tarafder, N. and Sarkar, K., 2006, Effect of seaming on drapability of washed and scured plain woven shirting fabric. *Man-Made Tex. India*, **49**(6): 205-210.

Tarafder, T., Sengupta, R. and Sau, T., 1998, A study on the drapability of P/V blended woven fabrics. *Man-Made Tex. India*, **41**(12): 517-521.

http://www.birlaviscose.com
http://www.texmin.nic.in
http://www.thenews.com

APPENDIX

VISUAL ANALYSIS - QUESTIONNAIRE

Name :

Age :

Gender :

Education :

Occupation :

A. FABRIC APPEARANCE

Sl. No	Particulars	Union fabrics			
		Sample A	Sample B	Sample C	Sample D
A	1. Clear				
	2. Slightly clear				
	3. Slightly fibrous				
	4. Fibrous				
B	1. Fine				
	2. Moderately fine				
	3. Slightly coarse				
	4. Coarse				
C	1. Highly lustrous				
	2. Lustrous				
	3. Semi dull				
	4. Dull				
D	1. Smooth				
	2. Fairly smooth				
	3. Slightly rough				
	4. Rough				

B. FABRIC HANDLE

Sl. No	Particulars	Union fabrics			
		Sample A	Sample B	Sample C	Sample D
A	1. Soft				
	2. Fairly soft				
	3. Slightly crisp				
	4. Crisp				
B	1. Flexible				
	2. Slightly flexible				
	3. Fairly stiff				
	4. Stiff				
C	1. Compact				
	2. Moderately compact				
	3. Slightly loose				
	4. Loose				

C. FABRIC TEXTURE

Sl. No	Particulars	Union fabrics			
		Sample A	Sample B	Sample C	Sample D
A	1. Close structure				
	2. Moderately close structure				
	3. Slightly open structure				
	4. Open structure				
B	1. Light weight				
	2. Moderately light weight				
	3. Fairly heavy weight				
	4. Heavy weight				
C	1. Even (flat) surface				
	2. Slightly even (flat) surface				
	3. Slightly uneven surface				
	4. Uneven surface				

D. PREFERENCE FOR UNION FABRICS

Sl. No.	Particulars	Union fabrics			
		Sample A	Sample B	Sample C	Sample D
1.	Rank I				
2.	Rank II				
3.	Rank III				
4.	Rank IV				

QUALITY CHARACTERISTICS OF VISCOSE RAYON AND ERI SILK UNION FABRICS

ANJALI A. KULKARNI 2007 Dr. GEETA MAHALE
MAJOR ADVISOR

ABSTRACT

The present study entitled "Quality Characteristics of Viscose Rayon and Eri Silk Union Fabrics" was carried out in 2005-07 at Dharwad with the objectives, to explore the possibilities of weaving union fabrics from Viscose Rayon with Eri silk, to assess the mechanical and functional properties of the union fabrics, to evaluate the tactile properties of union fabrics and to study the economic feasibility of the union fabrics. Viscose Rayon as warp with three different yarn counts *viz.*, 2/40s, 2/60s and 2/80s as weft were interwoven on a semi-automatic power loom to produce union fabrics. While the control sample was woven using Viscose Rayon as warp and weft. The experimental results revealed that, union fabrics woven with coarser yarn count had better cloth cover than control sample. Objective evaluation of the test samples inferred that Viscose Rayon x Eri silk of 2/40s (VRE_1) exhibited greater mass per unit area, cloth cover, thickness, bending length, weft-way tensile strength and thermal insulation value with least weft-way elongation percentage and air permeability. However, all union fabrics showed greater resistance to abrasion with severe pilling. The drape co-efficient was least in control sample, Viscose Rayon x Viscose Rayon (VR). In case of subjective evaluation, most of the respondents opined that all the union fabrics were slightly stiff to handle, heavy with slightly uneven surface in texture. In general, majority of the respondents preferred (VRE_2) whose cost of production was also found to be lower as compared to other union fabrics.