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ECO-FRIENDLY FIBER FOR THE 21ST CENTURY- LYOCELL AND ITS BLENDS

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Abstract

Today's apparel fabrics are expected to meet all the requirements related to comfort, health-care, handle, ease of care properties as well as performance. Fashion forecasting is an important ongoing activity as it is very dynamic. The forecast for the 21st century is a blend of natural and man-made fibers. The objectives of the study were to compare Lyocell/Tencel and its blends, an eco-friendly regenerated fiber. The yarns procured used were of 2/30s and 2/40s count in parallel and twisted construction. Yarn count, twist per inch, unevenness %, hairiness, RKM, elongation % and CSP were evaluated to check the yarn performance. All the values obtained were as per industrial requirements. In all, 24 different yarns were tested. It was found that the yarn twist, count, elongation%, RKM, unevenness% and CSP of the yarn showed no significant difference. It was found that the blend of 35/35/30-E/C/P showed very good results followed by 65/35-E/C irrespective of the yarn count and yarn composition.

Keywords: *Lyocell, Tencel, blends, eco-friendly fiber, yarn properties*

INTRODUCTION:

We are all exposed to textiles right from the time we are born (wrapped in a cloth) to the time we say good bye to our near and dear ones-"The Cradle To Grave", concept- that Birla Cellulose group very aptly puts in.

Natural fibers have wonderful properties but are limited and are not able to suffice the growing global demand. This led to the invention of synthetic fibers, i.e. both manmade and regenerated fibers. In the case of manmade fibers, the raw material and the manufacturing process caused damage to our environment and also to human health. It then became

imperative for man to concentrate on the regenerated fibers-i.e. to invent fibers from natural resources using eco-friendly process and sustainable material.

This paper deals with the third generation Viscose fiber -Tencel/Lyocell

Lyocell is the generic name given to a new group of fibers, which are produced from a vegetable source sold under the trade names such as: Tencel, Lenzing Lyocell, Lyocell etc. Like Viscose, Lyocell is made from wood pulp. It is the first new generic fiber in decades. Because of its unique combination of characteristics; Courtaulds fibers requested a new generic classification for this fiber which was granted by Federal Trade Commission granted in 1996.It was initially produced only in Europe and United States but today is manufactured in India also .Lyocell is the solvent spun 100% regenerated cellulose fiber manufactured from wood pulp. The spun is made up of fibrils. It is an eco-friendly fiber. It is seen as the fiber for the 21st century. Today it is necessary to look for products from natures which are environment-friendly, with excellent properties and help us to move to more value added and sustainable solutions

Environment Friendly Fiber - Lyocell and Its Blends

Lyocell is a man-made regenerated fiber, made from the wood pulp of eucalyptus trees, which are harvested by sustainable tree plantations process. The fiber is produced in an advanced, bleach free process, in which 99.8% of all solvents and chemicals used are recovered and recycled. The process uses energy and water economically and has a minimal impact on the environment.

- But it is expensive and so less viable in the market for various end uses.
- Since it is a sustainable and environment friendly fiber, as a textile scientist a small step was taken to make it available for the greater population and not only for the niche market.

Aim of the study:

- To develop blends of Lyocell in different composition
- To evaluate various yarn parameters of the blends

Methodology of the Study:

Yarn Development and evaluation:

- Yarns were developed with the following specifications: 100% Lyocell (L), Cotton(C) yarns
- Total 4 different blend composition ie: 65/35% L/C, 50/50% L/C, 35/65% L/C, and 35/35/30% L/C/PET (Polyester)
- 2 different yarn types (twisted and parallel) of each
- 2 different yarn count (2/30s and 2/40s) of all the above

In all 24 different varieties of yarns were developed. Various yarn properties, such as unevenness %, hairiness, RKM, elongation, count, strength and twist per inch were evaluated.

Results and Discussion:

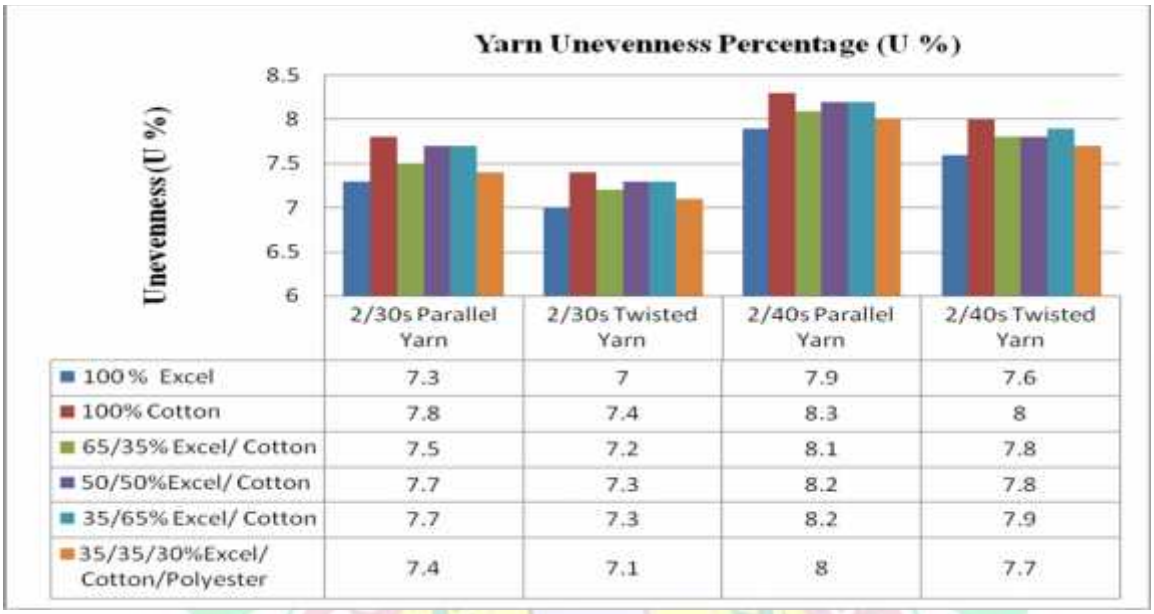
The key to the abbreviation and the operational definitions used in the study are given below in table no.1 and 2 respectively.

TABLE NO.1: ABBREVIATIONS USED IN THE STUDY

Sr. No.	Abbreviations	Full Form
1.	GSM	Gram Per Square Meter
2.	RKM	Rupture in kilometres
3.	CSP	Yarn Count x Strength= Product
4.	H%	Hairiness %
5.	U%	Unevenness %

Yarn Test Results of Lyocell Yarn and Its Various Blends

1. Yarn Unevenness Percentage (U %):



	2/30s Parallel Yarn	2/30s Twisted Yarn	2/40s Parallel Yarn	2/40s Twisted Yarn
100 % Excel	7.3	7	7.9	7.6
100% Cotton	7.8	7.4	8.3	8
65/35% Excel/ Cotton	7.5	7.2	8.1	7.8
50/50%Excel/ Cotton	7.7	7.3	8.2	7.8
35/65% Excel/ Cotton	7.7	7.3	8.2	7.9
35/35/30%Excel/ Cotton/Polyester	7.4	7.1	8	7.7

FIGURE 1: YARN UNEVENNESS PERCENTAGE (U %) OF LYOCELL YARN AND ITS VARIOUS BLENDS

Some of the research reviews related to yarn unevenness stated are as follows:

The findings of this research are in line with Sharma *et al*. (1987) who stated that the yarn unevenness decreases with incorporation of twist.

Sheikh (1994) mentioned that yarn irregularity was a measure of cross-sectional variation in the yarn and closely associated with imperfections in the yarn. Lord *et al.* (1998) stated that quality of a textile yarn is judged by its evenness. The lack of evenness is caused by mechanical defects in the machine used to make the yarn

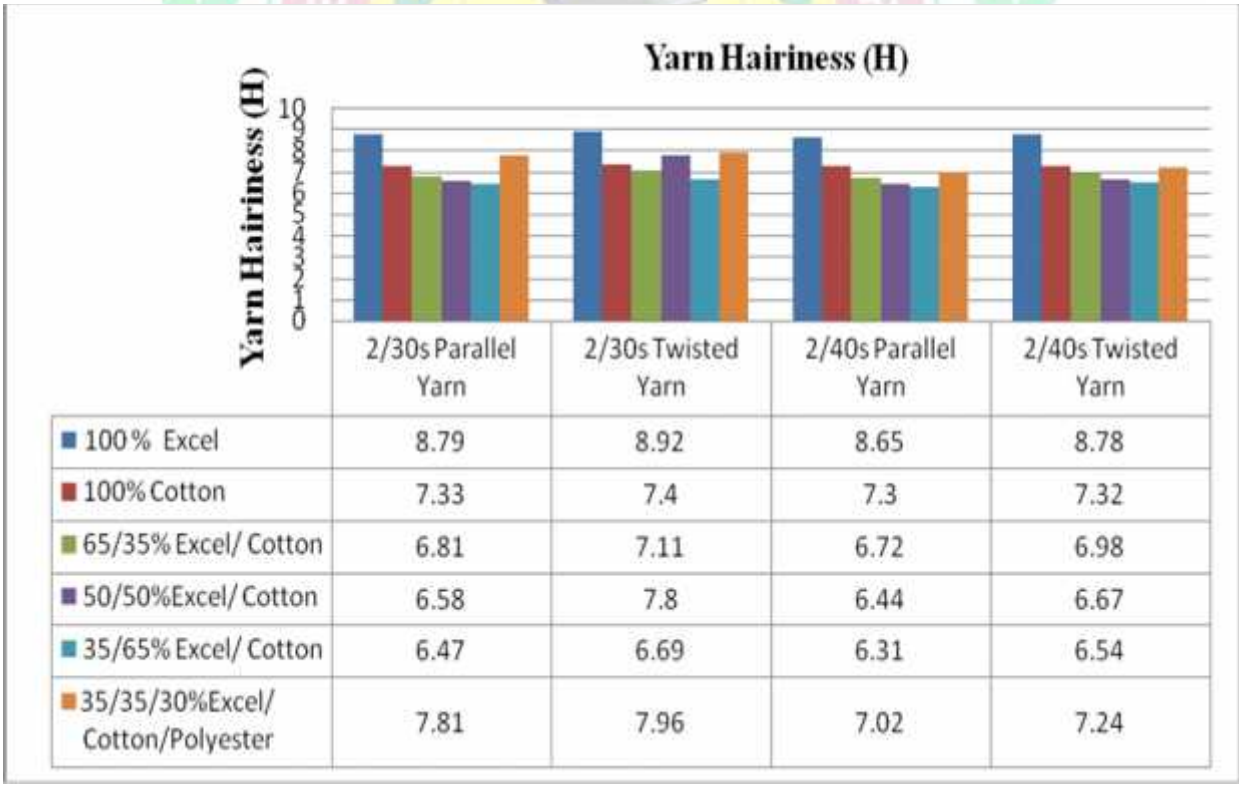
As observed in Figure 1:

- Amongst 100% Lyocell and 100% Cotton, Lyocell shows lower yarn unevenness percentage as compared to Cotton. This may be due to the fact that since Lyocell/Tencel yarn is a man-made regenerated cellulosic fiber, it is more even as its evenness can be controlled by the shape of the spinneret during the manufacturing process and Cotton is a natural cellulosic fiber with high amount of thick and thin places, as well as neps and therefore more uneven.
- Amongst the blends of Lyocell/ Cotton; 65/35 %- Lyocell/ Cotton shows least unevenness percentage followed by 50/50%- Lyocell/ Cotton and 35/65% Lyocell/ Cotton. This shows that as the percentage of Lyocell fiber decreases the yarn

unevenness percentage increase which indicates that the Lyocell fiber contributes to the evenness of the blended yarns.

- 35/35/30%-Lyocell/ Cotton/Polyester shows lower unevenness percentage. This may be due to the fact that, this yarn consist of, other than 35 % of Cotton fiber, 65% of - Lyocell and Polyester fibers together, both of which are man-made fibers due to which the yarn evenness may have further increased.
- 2/40s yarn shows higher unevenness percentage as compared to 2/30s yarn.
- Twisted yarns give the least unevenness percentage as compared to parallel yarns, thus showing that twist contributes towards the yarn evenness.
- To sum it all amongst the blends 35/35/30 %-E/C/P- 2/30s–twisted yarn shows the least amount of yarn unevenness percentage and therefore proves to be an excellent yarn for knitting.

2. Yarn Hairiness (H %**) :**



	2/30s Parallel Yarn	2/30s Twisted Yarn	2/40s Parallel Yarn	2/40s Twisted Yarn
100 % Excel	8.79	8.92	8.65	8.78
100% Cotton	7.33	7.4	7.3	7.32
65/35% Excel/ Cotton	6.81	7.11	6.72	6.98
50/50%Excel/ Cotton	6.58	7.8	6.44	6.67
35/65% Excel/ Cotton	6.47	6.69	6.31	6.54
35/35/30%Excel/ Cotton/Polyester	7.81	7.96	7.02	7.24

FIGURE 2: YARN HAIRINESS (H %) OF LYOCELL YARN AND ITS VARIOUS BLENDS

As per the studies conducted by Kaushick, et.al. (1992)– Hairiness of two-ply yarn are lower than that of single and double-rove spun yarn. These findings are contradictory to the

present studies as observed in Figure 2. This may be due to the fact that, in this study Lyocell fibres which are present in all the blends have an inherent tendency to fibrillate and form small protruding fibrils on the surface of the fibers. These fibrils maybe becoming more prominent as the fibers are twisted together as compared to when they are parallel.

As per details in Figure 2:

- It is seen that amongst 100% Lyocell and 100% Cotton, Lyocell shows higher yarn hairiness as compared to100% Cotton. This may be due to the fact that Lyocell although a man-made regenerated fiber tends to fibrillate and shows fine hair on its surface.
- Amongst the blends of Lyocell/ Cotton, 35/65 %- Lyocell/ Cotton shows the least yarn hairiness followed by 50/50%- Lyocell/ Cotton and 65/35% Lyocell/ Cotton. This shows that as the percentage of Lyocell fiber increases, yarn hairiness also increases.
- 35/35/30%-Lyocell/ Cotton/Polyester when compared to 100% Lyocell and Cotton yarns, it shows higher yarn hairiness than 100% Cotton. This may be due to the fact that other than 35% Cotton fibers, 35/35/30% -Lyocell / Cotton / Polyester yarn also consists of 65% of -Lyocell and Polyester fibers, both of which are synthetic fibers. Along with Lyocell fiber, Polyester staple fibers are also known to contribute to the yarn hairiness.
- 2/30s yarn shows the higher yarn hairiness as compared to 2/40s yarn. This shows that as the fineness of the yarn increases, the hairiness decreases. Also as the proportion of Lyocell decreases, the yarn hairiness decreases.
- When parallel and twisted yarns are compared it is seen that twisted yarn gives higher yarn hairiness as compared to parallel yarn. This finding shows that when twist is incorporated in the yarn, the fibrils stand out in a more pronounced way.
- This shows that in Lyocell and its blends, twist contributes in increasing the yarn hairiness.
- To conclude it all amongst the blends, 35/35/30 %-E/C/P-2/40s–parallel yarn shows the least amount of yarn hairiness and therefore proves to be an excellent yarn for knitting.
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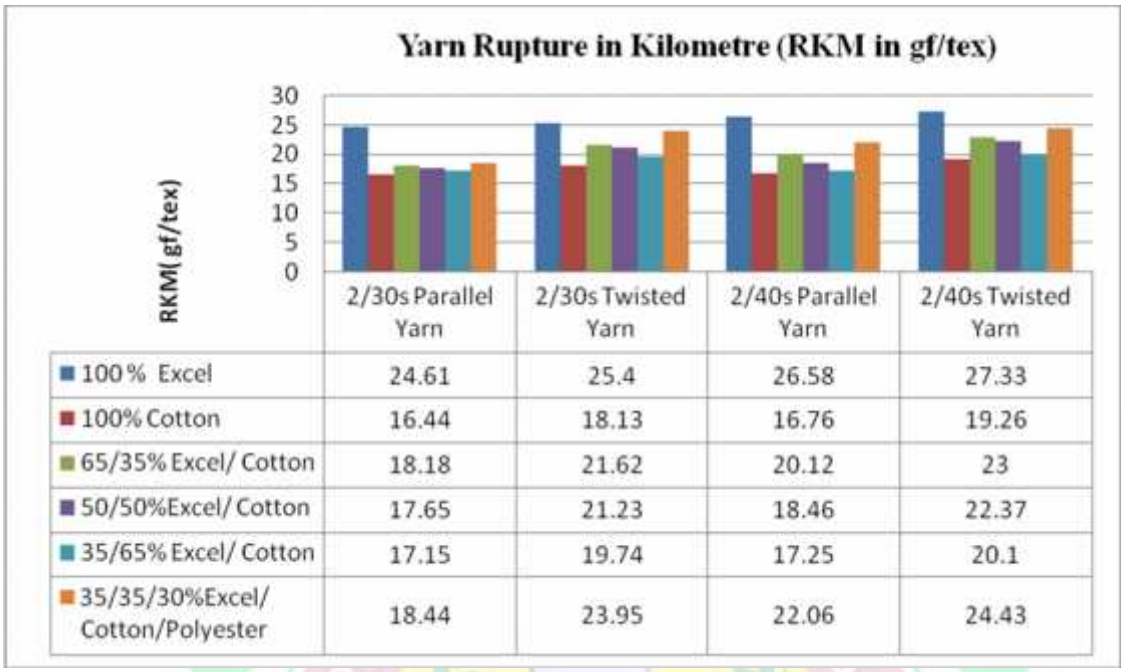
3. Yarn Rupture in Kilometre (RKM in gf/tex):



	2/30s Parallel Yarn	2/30s Twisted Yarn	2/40s Parallel Yarn	2/40s Twisted Yarn
100 % Excel	24.61	25.4	26.58	27.33
100% Cotton	16.44	18.13	16.76	19.26
65/35% Excel/ Cotton	18.18	21.62	20.12	23
50/50%Excel/ Cotton	17.65	21.23	18.46	22.37
35/65% Excel/ Cotton	17.15	19.74	17.25	20.1
35/35/30%Excel/ Cotton/Polyester	18.44	23.95	22.06	24.43

FIGURE 3: YARN RUPTURE IN KILOMETRE (RKM IN GF/TEX)) OF LYOCELL AND ITS VARIOUS BLENDS

Sharma,et.al. (1987) stated that strength parameters and elongation increases with twist level. From very coarse to fine counts, the yarn strength increases.

Arora (2002) observed that high twist and high fibril cohesion increase the stability of spun yarn, giving longer yarn breakage time. Twist increases the strength of the yarn by creating lateral forces which prevent the fibers in the yarn from slipping over one another.

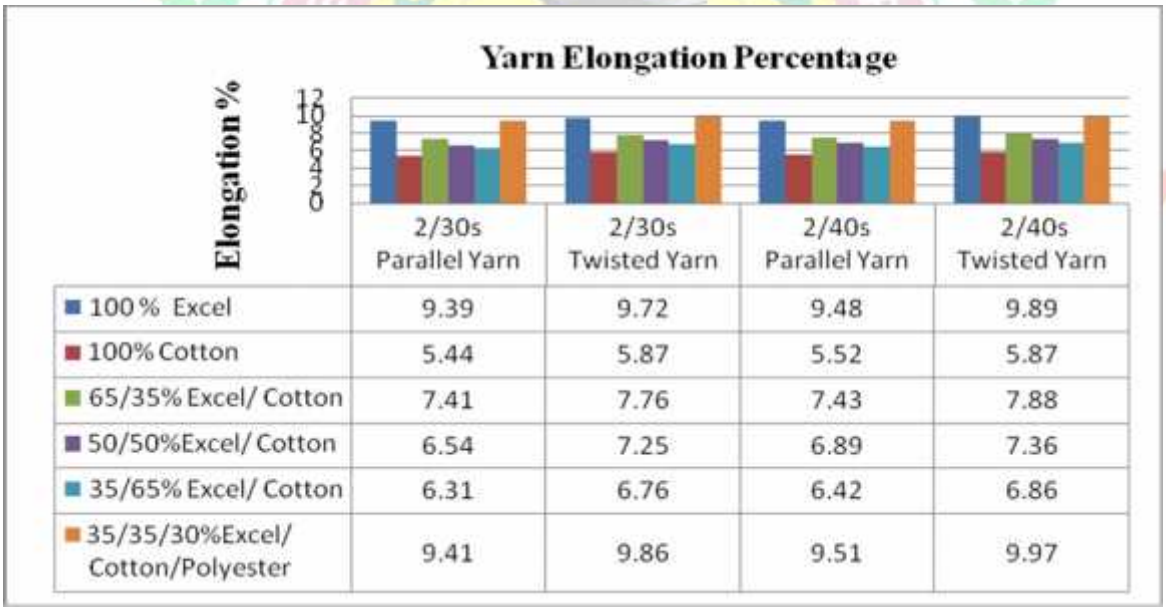
RKM – It is expressed as the length of yarn in Kilometres at which the yarn will break of its own weight which is measured either in centi-Newton (cN) or gram force per tex (gf/tex).

Details as seen in Figure 3:

- It is seen that amongst 100% Lyocell and 100% Cotton, Lyocell gives higher RKM as compared to100% Cotton .This may be due to the fact that, Lyocell yarn being a man-made regenerated cellulosic fiber, is stronger as compared to Cotton which is a natural cellulosic fiber with high amount of total imperfection.
- Amongst the blends of Lyocell/ Cotton, 65/35 %- Lyocell/ Cotton gives highest RKM followed by 50/50%- Lyocell/ Cotton and 35/65% Lyocell/ Cotton. This shows that as the percentage of Lyocell fiber decreases the RKM of the yarn decreases which also indicates that the Lyocell fiber contributes to the high RKM value of blended yarns.

- 35/35/30%-Lyocell/Cotton/Polyester when compared to 100% Lyocell and Cotton yarn gives higher RKM value than 100% Cotton and lower than 100% Lyocell. This may be due to the fact that 35/35/30% -Lyocell/Cotton /Polyester yarn consists of 65% of Lyocell and Polyester fibers, which are man-made in nature thus contributing to higher RKM value of the yarn.
- 2/40s yarn gives higher RKM value as compared to 2/30s yarn, which shows that, the fineness of the yarn contributes towards higher value of the RKM of the yarn.
- Overall when parallel and twisted yarns are compared it is seen that twisted yarn gives higher RKM value as compared to parallel. This may be due to the fact that when the twist is inserted the RKM of the yarn increases.
- Finally we can say that amongst the blends 35/35/30 %-E/C/P -2/40s twisted shows the highest RKM value therefore proves to be an excellent yarn for knitting.

4. Yarn Elongation Percentage:



	2/30s Parallel Yarn	2/30s Twisted Yarn	2/40s Parallel Yarn	2/40s Twisted Yarn
100 % Excel	9.39	9.72	9.48	9.89
100% Cotton	5.44	5.87	5.52	5.87
65/35% Excel/ Cotton	7.41	7.76	7.43	7.88
50/50%Excel/ Cotton	6.54	7.25	6.89	7.36
35/65% Excel/ Cotton	6.31	6.76	6.42	6.86
35/35/30%Excel/ Cotton/Polyester	9.41	9.86	9.51	9.97

FIGURE 4: YARN ELONGATION PERCENTAGE OF LYOCELL YARN AND ITS VARIOUS BLENDS

It is the percentage of length up to which the yarn can be extended before the occurrence of yarn breakage.

Chellamani (1996) stated that yarn elongation is generally influenced by (i) fiber length (ii) fiber strength (iii) fiber elongation and (iv) short fiber content in the feed material.

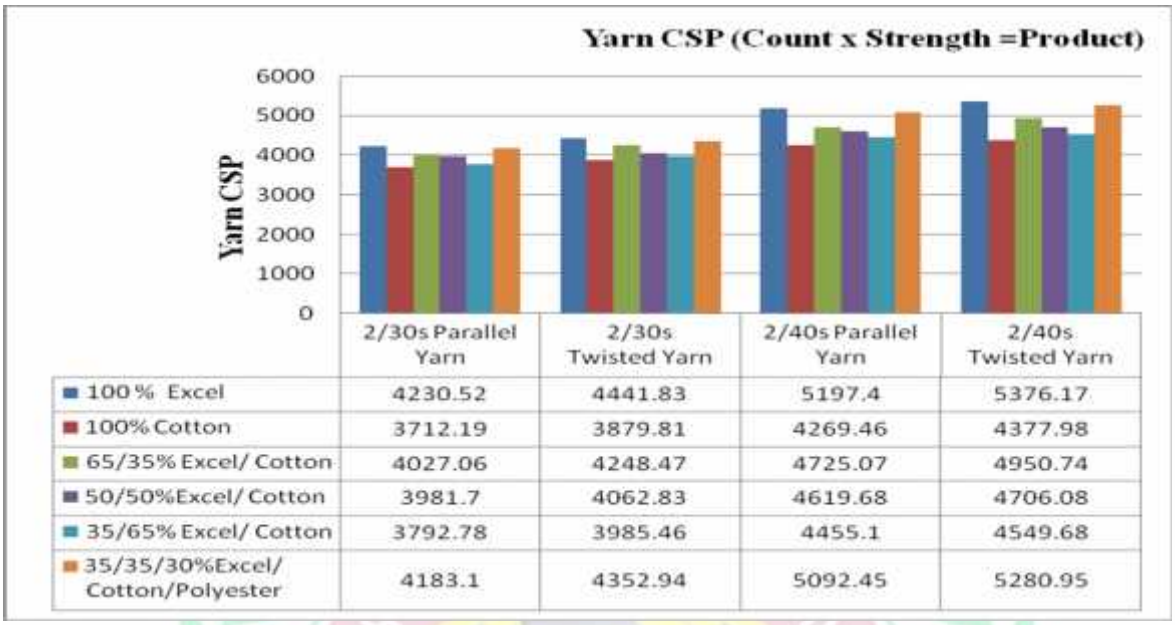
The findings of this study are in line with Sharma and Dedhia (2004 and 2005) research who

found that 2/40s - (60/40) - Lyocell/Cotton blend had good strength and elongation%.

As per details in Figure 4:

- It is seen that amongst 100% Lyocell and 100% Cotton, Lyocell shows higher yarn elongation percentage as compared to100% Cotton. This may be due to the fact that Lyocell fiber as it is a man-made regenerated cellulosic fiber has higher elongation percentage as compared to Cotton fiber which is a natural cellulosic fiber with lower elongation percentage
- Amongst the blends of Lyocell/ Cotton, 65/35 %- Lyocell/ Cotton shows highest yarn elongation percentage followed by 50/50%- Lyocell/ Cotton and 35/65% Lyocell/ Cotton. This shows that as the percentage of Lyocell fiber decreases the elongation percentage of the yarn decreases which indicates that the Lyocell fiber contributes to the high elongation percentage of the yarn.
- 35/35/30%-Lyocell/Cotton/Polyester when compared to 100% Lyocell and Cotton yarn shows higher elongation percentage than 100% Cotton and Lyocell as well as other blends. This shows that Polyester fibers also contribute to the yarn elongation percentage.
- 2/40s yarn shows higher yarn elongation percentage as compared to 2/30s yarn. This shows that, as the yarn count becomes finer, the yarn elongation percentage increases.
- Overall when parallel and twisted yarns are compared it is seen that twisted yarn shows higher elongation percentage as compared to parallel, thus showing that twist contributes towards yarn elongation percentage.
- In conclusion we can say that 35/35/30 %-E/C/P -2/40s- twisted yarn shows the highest yarn elongation percentage and therefore proves to be a good yarn for knitting.

5. Yarn CSP (Count x Strength =Product):



	2/30s Parallel Yarn	2/30s Twisted Yarn	2/40s Parallel Yarn	2/40s Twisted Yarn
100 % Excel	4230.52	4441.83	5197.4	5376.17
100% Cotton	3712.19	3879.81	4269.46	4377.98
65/35% Excel/ Cotton	4027.06	4248.47	4725.07	4950.74
50/50%Excel/ Cotton	3981.7	4062.83	4619.68	4706.08
35/65% Excel/ Cotton	3792.78	3985.46	4455.1	4549.68
35/35/30%Excel/ Cotton/Polyester	4183.1	4352.94	5092.45	5280.95

FIGURE 5: YARN CSP OF LYOCELL YARN AND ITS VARIOUS BLENDS

The strength of the yarn is measured based on the count and strength of the yarn. CSP is a product of lea count and strength. It is seen that higher the CSP better the yarn strength.

In a study conducted by Babar,et.al. (2001) the results showed that the physical parameters of fiber affected the yarn strength, finer the fiber stronger is the yarn. Similar observations were forwarded by Grover and Hamby (1966) who stated that finer fibers give greater yarn strength than coarser fibers. Likewise Bargeron and Shaw (1985) claimed that fiber fineness might result in improved yarn strength. Sheikh (1991) described that the fiber properties such as length, uniformity of length, fineness, fiber strength and elongation along with spinning conditions contribute to yarn strength. These observations were in conformity with findings of the present study.

Details as seen in Figure 5:

- It is seen that amongst 100% Lyocell and 100% Cotton, Lyocell shows higher yarn CSP as compared to100% Cotton. This may be due to the fact that Lyocell, which is a man-made regenerated cellulosic fiber, has higher molecular orientation as compared to Cotton fibers, that has more number of amorphous regions in the molecular structure.
- Amongst the blends of Lyocell/ Cotton, 65/35 %- Lyocell/ Cotton shows the highest yarn CSP followed by 50/50%- Lyocell/ Cotton and 35/65% Lyocell/ Cotton. This

shows that as the percentage of Lyocell fiber increases, the yarn CSP increases which indicates that the Lyocell fiber contributes towards the increase in yarn CSP.

- 35/35/30%-Lyocell/ Cotton/Polyester when compared to 100% Lyocell and Cotton yarn, shows higher yarn CSP than 100% Cotton and lower than 100% Lyocell. This may be due to the fact that other than 35% of Cotton fibers, 35/35/30% -E/C/P consists of 65% of Lyocell and Polyester fibers, both of which are man-made fibers, along with Lyocell fiber, Polyester staple fibers also to contribute to the yarn CSP.
- 2/40s yarn shows higher yarn CSP as compared to 2/30s yarn. This shows that as the yarn count becomes finer, the yarn CSP increases. This may be due to the fact that finer yarns are aligned more as compared to the coarser yarns, due which the orientation of finer yarns becomes better and hence contributes to the higher CSP of the yarn.
- When parallel and twisted yarns are compared it is seen that twisted yarn gives higher yarn CSP as compared to parallel, thus showing that twist contributes towards the CSP of the yarn.
- To conclude it all 35/35/30 %-E/C/P- 2/40s- twisted yarn shows the highest yarn CSP and therefore proves to be an excellent yarn for knitting.

Different yarns from the above study can be selected depending on the parameters required various end-uses These yarns can be used for production knitted apparels for menswear, women's wear, kids wear, sweater, tops etc

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