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# Flax fibre and blended yarn characteristics

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**Abstract**
Stalks of flax varieties collected from AICRP, MULLARP Scheme, University of Agricultural Sciences, Dharwad were retted in water, chemical and enzymatic retting methods for extraction of fibre. The extracted fibres were assessed for quantitative and qualitative parameters *viz*., fibre yield, fibre length, microscopic appearance and fibre solubility in different chemicals. The extracted fibre was scoured and bleached and blended with cotton in three proportions *viz*., 40:60, 30:70 and 20:80 on ring frame to obtain blended yarns with cent percent flax and cotton for comparison. The blended yarns were assessed for yarn count, twist, yarn evenness, hairiness percentage and yarn strength. The results of the study revealed that, urea retting method yielded higher percentage of fibres, enzyme retted fibres gave longer length of the fibre, whereas water retted fibre yielded higher strength fibre. The 30:70and 20:80 flax /cotton blended yarn showed better yarn properties *viz*., yarn count, twist, yarn evenness, hairiness percentage and yarn strength compared to 40:60 flax /cotton blended yarn. Cent percent cotton and flax yarn showed better strength and lowest hairiness percentage compared to blended yarns.

**Keywords:** Retting methods, fibre yield, fibre length, yarn strength, evenness, hairiness percentage

## Introduction
Natural plant fibres have been successful due to their positive impact on our ecological balance. Various plant fibres can be used for number of textile and technical applications as environmental awareness is most important concern nowadays. Fibres are extracted either from the outer part of the plant stem i.e., the Bast (*viz*., Jute, Kenaf, Flax, Ramie, Hemp etc.), Leaf (*viz*., Sisal, Pineapple), Fruit(Coconut) or Seeds (Cotton).(Rastogi, 2009) [7].
Flax is an annual herbaceous plant, with one dominant typical stem that branches at the top and grows to a height of 1 to 3 feet. The taller and straight flax varieties developed for fibre production are used by the textile industry is as speciality fibres to create a distinctive fabric with unique characteristics.
The main constituent of flax fibres are cellulose, hemicelluloses, lignin and pectin. A small percentage of wax, oil and structural water are also found. Flax fibre is a biodegradable natural composite material which exhibits good specific mechanical properties. These fibres have a long history of being utilized in clothing by the textile apparel industry due to their comfort level. Cellulose is the major component in flax fibre and ranges from 70-80 per cent.
The term blending is used by the manufacturers to describe specifically the sequence of processes required for mixing of at least two components which differ by at least one parameter which characterises the component fibres. Fibre blending consists of orientations of different in the yarn structure in such a way that the content of each component remains same at every point of the yarn throughout its length (Samanta, 2014) [8]. Thus, in order to know the enhancement of yarn properties due to blending, this study is taken to know the effect of blend proportion on properties of flax /cotton blended yarn.

## Material and Methods
Flax stalks were collected from the MULLaRP Scheme, MARS, University of Agricultural Sciences, Dharwad for the research work. The fibres were extracted through different retting methods *viz*., water, chemical and enzyme. The fibres were extracted manually and tested for physical properties and the details of the fibre properties are presented in Table 1
Flax fibres were blended together with cotton in three different proportion *viz*., 40:60, 30:70 and 20:80 flax /cotton and spun on ring frame spinning machine *i.e* Zincer 351, Model No. C3 with rotor speed of 10000 rpm at Department of Spinning section, DKTE's Textile and Engineering Institute, Ichalkaranji, Maharashtra. The yarn properties were measured under standard conditions.

Yarn count, Yarn twist, Count Strength Product (CSP), yarn eveneness, hairiness percentage and strength of the yarns were tested. Yarn unevenness, hairiness and imperfections were evaluated using Uster evenness tester and the yarn strength and elongation percentage was determined by ASTM procedure (ASTM: 2256T, 1964) using Instron Tensile Tester.

## Result and Discussion

### Fibre properties

The length of the flax fibre ranges from 25.6 to 27.4 cm with fibre yield of 60 to 90 g/kg stalk. The fibre fineness varies from 1.7 to 1.39 dtex where as bundle strength of flax fibre was 14.34 to 15.84 g/tex.

**Table 1:** Flax Fibre properties

| S. No | Parameters | Flax |
|---|---|---|
| 1 | Fibre yield (g/kg stalk) | 60-90 |
| 2 | Fibre length (cm) | 25.6 to 27.4 |
| 3 | Fibre fineness (dtex) | 1.7-1.39 |
| 4 | Fibre bundle strength (g/tex) | 14.34 to15.84 |

**Physical properties of Cotton and Cotton/Flax blended yarn:** Yarn count (Ne), yarn twist (tpi) and Count Strength Product (CSP) of pure Cotton, Flax and Cotton/Flax blended yarns. It is observed from Table 2 that, the pure Flax yarn can be spun to 16.8 Ne count with 9.98 tpi and 2654.6 CSP. The Cotton yarn was spun to 20 Ne count with 17.04 Tpi and 2659.39 CSP.

Among the Cotton/Flax blended yarn, the Cotton/Flax blended fibres of 70/30 proportion could be spun to 13.75 Ne yarn count, 60/40 Cotton/Flax to 12.47 Ne count and 80/20 Cotton/Flax to 11.99 Ne count (Table 2). This reveals that, increase in flax content in blend, there was decrease in yarn count *i.e* decrease in fineness of the yarn because higher the count, finer the yarn.

Twist is usually expressed as the number of turns per unit length. Twist of yarn determines the strength, hand and feel of woven product. With the increase in the twist, the yarn strength increases till it reaches maximum and then further increase leads to decrease (Booth, 1996) [1]. It is observed that, turns per inch in 60/40 Cotton/Flax blended yarn was higher (23.45 Tpi) followed by in 70/30 Cotton/Flax blended yarn (20.57 Tpi), 80/20 Cotton/Flax blended yarn (18.62 Tpi). Among the blended yarns the CSP was highest in 70/30 Cotton/Flax blended yarn (1699.98) followed by 80/20 Cotton/Flax blended yarn (1635.59) and 60/40 Cotton/Flax blended yarn (1532.83). Variation in count of blended yarns and cotton may also be responsible for difference in CSP. However, there is no significant difference in CSP among cent per cent Cotton and Flax yarn. Higher the CSP, better is the yarn suitable for spinning. Cent per cent cotton and flax fabrics were spun on ring frame.

This may be due to the homogeneity of cotton, which increases cohesiveness and provide better compactness of yarn. However, blending other fibre reduce cohesiveness and compactness. Variation in count of blended yarns and cotton may also be responsible for difference in CSP.

**Table 2:** Physical properties of Cotton, Flax and Cotton/Flax blended yarns

| Sl. No | Yarns | Yarn count (Ne) | Yarn twist (Tpi) | Count strength product (CSP) |
|---|---|---|---|---|
| 1 | Cotton | 20.00[a] | 17.04d | 2659.39*a |
| 2 | Flax | 16.80[b] | 9.98e | 2654.60a |
| 3 | 60:40 (C/F blend) | 12.47[d] | 23.45*a | 1532.83bc |
| 4 | 70:30 (C/F blend) | 13.75c | 20.57b | 1699.98b |
| 5 | 80:20 (C/F blend) | 11.99d | 18.62c | 1635.59bc |
| | Mean | 15.50 | 17.93 | 2036 |
| | SEM ± | 0.290 | 0.310 | 48.884 |
| | CD@5% | 0.873 | 0.929 | 146.555 |
| | CV % | 4.18 | 3.86 | 5.37 |

### Yarn evenness and hairiness of Cotton and Cotton/Flax blended yarn

Yarn evenness is defined as the variation in weight per unit length of the yarn or as variation in its thickness (Saville, 2004) [9]. The yarn evenness is assessed in terms of thick places/km (+50%), thin places/km (-50%), neps/km (+200%) and unevenness percentage ratio. The total of all these factors gives total imperfection of the yarn.

Yarn evenness and hairiness (%) of Cotton and Cotton/Flax blended yarn are presented in Table 3. It is observed from table that, the unevenness(%), thin(-50%), and thick (+ 50%) places, Neps (+200%) and total imperfections was found to be highest in cent per cent Flax yarn (24.63%, 1909.4% and 1412%, 3006.6% and 6328.0 respectively) followed by in Cotton/Flax (60/40) blended yarn (21.81%, 552.4%, 1056.6%, 1615.0% and 3224respectively), 70/30 blended yarn (20.10%, 288.2%, 681%, 675.4% and 1644.6 respectively) and Cotton/Flax (80/20) blended yarn (19.12%, 193.3%, 726.4%, 1114.4% and 2034 respectively). However, selected pure Cotton yarn showed better evenness properties. Among the blended yarn, 80/20 Cotton/Flax is found to be better compared to 60/40 and 70/30 Cotton/Flax yarns in terms of unevenness percentage. This indicates that, increase in the flax content in the yarn, there is increase in yarn uneveneness (%), thin places, thick places, neps (%) and total imperfections. According to John (2006) flax fibres impart unique hand feel properties to the yarn and fabric due to the increasing percentage of thick places, thin places and neps in flax yarns. However, yarn evenness (CV%) and yarn elongation significantly affect the final yarn quality. On the other hand, the yarn evenness is mainly affected by spinning system (Bouchraiet *et al.*, 2016) [2].

Yarn hairiness is a measure of the amount of fibres protruding from the structure of the yarn**.** Among all the yarns it is observed that, the highest percentage of hairiness was observed in 80/20 Cotton/Flax blended yarn (8.72%) followed by 70/30 Cotton/Flax blended yarn (8.51%) and 60/40 Cotton/Flax blended yarn (7.5%). Among the pure Cotton and Flax yarn, Flax yarn had lower hairiness (2.42%) percentage compared to pure Cotton yarn (7.02%). But among cotton, flax and blended yarn the yarn hairiness was high in 80/20 and less in cent per cent Flax yarn.

According to Oner *et al.*, 2018 [6], most important fibre parameters that affects hairiness after yarn count is the amount of trash. However, trash content of the fibres has less effect on the yarn hairiness according to the results of the study. Hence, increase in the flax content, there was decrease in the hairiness percentage of yarns.

**Table 3:** Yarn evenness properties of Cotton, Flax and Cotton/Flax blended yarns

| Sl. No. | Yarns | Yarn Evenenss (%) | | | | | Yarn hairiness % |
|---|---|---|---|---|---|---|---|
| | | Unevenness % | Thin places/km (-50%) | Thick places/km (+ 50%) | Neps/km (+ 200%) | Total Imperfection | |
| 1 | Cotton (100%) | 11.22*a | 0.00*a | 22.8a | 17.0*a | 39.8a | 7.02b |
| 2 | Flax (100%) | 24.634e | 1909.4e | 1412d | 3006.6e | 6328.0d | 2.42*a |
| 3 | 60:40 (C/F blend) | 21.812d | 552.4d | 1056.6c | 1615.0d | 3224.0c | 7.50c |
| 4 | 70:30 (C/F blend) | 20.104c | 288.2c | 681b | 675.4b | 1644.6b | 8.51d |
| 5 | 80:20 (C/F blend) | 19.122b | 193.2b | 726.4b | 1114.4c | 2034.0b | 8.72d |
| | Mean | 19.378 | 588.64 | 779.76 | 1285.68 | 2564.08 | 6.83 |
| | S.Em.± | 0.394 | 111.769 | 35.290 | 102.363 | 235.337 | 0.078 |
| | C.D. (5%) | 1.161 | 329.717 | 104.104 | 301.970 | 694.244 | 0.229 |
| | C.V. (%) | 0.240 | 1.250 | 0.610 | 0.817 | 0.828 | 0.343 |

*-Significant at 5% level of significance; CD-Critical difference; CV-Coefficient of variation

**Single yarn strength (G/Tex) and elongation (%) of Cotton and Cotton/Flax blended yarn**

Single yarn strength is expressed by the 'Length of yarn in km' at which yarn will break on its own weight (Booth, 1996) [1]. It is found from Table 4 that, 80/20 cotton/ flax blended yarn showed highest single yarn strength (569.0 g/tex) followed by 70/30 cotton/ flax blended yarn (454.7 g/tex). Cent per cent cotton yarn showed highest single yarn strength (444.7 g/tex) and lowest was observed in flax (245.7 g/tex).These results are on par with the study conducted by Dhanalaxmi and Vastrad (2013) [3]. This may be due to the fact that, natural bast fibres are lignocellulosic in nature and offers good strength. However, higher per cent of Bast fibre decreased the strength due to lack of cohesiveness. Blending of dissimilar fibres result in a relative drop in strength which is maximum in higher proportion.

**Table 4:** Single Yarn strength (g/tex) and elongation (%) of Cotton, Flax and Cotton/Flax blended yarns

| Sl. No | Yarns | Single Yarn strength (g/tex) | Elongation (%) |
|---|---|---|---|
| 1 | Cotton | 444.7b | 4.9b |
| 2 | Flax | 245.7d | 2.4d |
| 3 | 60:40 (C/F blend) | 334.7c | 3.4c |
| 4 | 70:30 (C/F blend) | 454.7b | 3.7c |
| 5 | 80:20 (C/F blend) | 569.0*a | 5.7*a |
| | Mean | 409.73 | 4.02 |
| | S.Em.± | 8.582 | 0.202 |
| | C.D.@ 5% | 27.988 | 0.659 |
| | C.V. (%) | 3.63 | 5.38 |

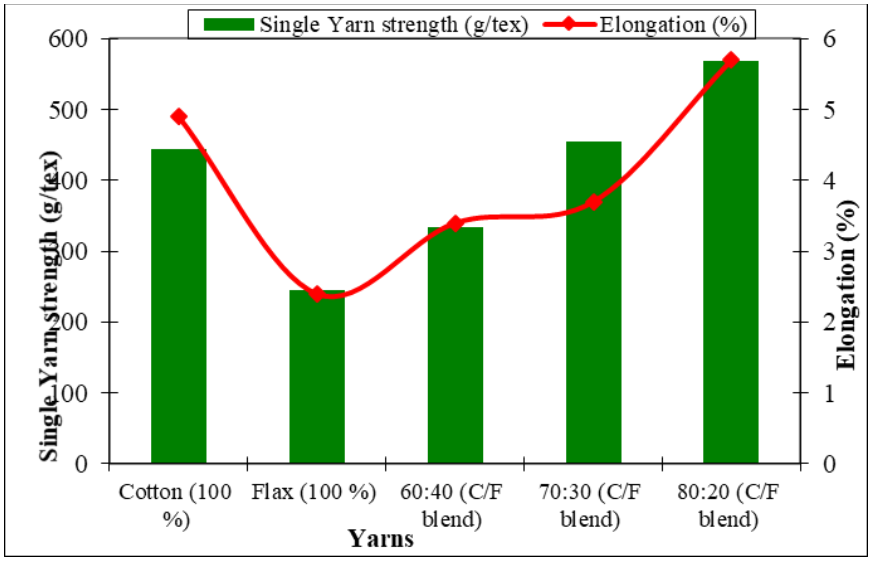


**Fig 1:** Show the single yarn strength and elongation

It reveals from the study that, irrespective of flax varieties, urea retting method yielded higher percentage of fibres, whereas longer length of the fibres were obtained by enzyme retting method compared to urea and water retting methods. The pure cotton fibre can be spun up to 20 s count compare to pure flax and blended yarn. The percentage of flax fibre

influences on the yarn properties *i.e* eveneness, strength and elongation percentage. Thus, increase in flax content increased the unevenness (%) in the blended yarn. Among all the blended yarns, the highest percentage of hairiness, single yarn strength and elongation (%) was observed in 80/20 Cotton/Flax blended yarn followed by 70/30 Cotton/Flax blended yarn.

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