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Study of Physical Properties of Fibers Produced from Recycled Cotton Fiber and Blend of Recycled and Virgin Cotton Fibers

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***Abstract*: The recycled fibres market are growing in day by day. The main problem associated with the production of recycled yarn is the quality of the yarn obtained. The fibres are collected from knitted industry cotton waste and sorted according to the color of the waste. This research focus on use of different blending of recycled fibers with virgin cotton fibers to improve the quality of recycled fibre, there by increased use of the yarn in various sectors. Result showed that the lower value of short fiber content percent in 70:30 blend ratio of recycled fiber with virgin cotton showed a higher value of breaking strength and higher staple length of the fibre which have good spinnability and good yarn quality compared with other samples.**

***Keywords*: Blend ratio, recycled fiber, staple length, short fiber, virgin cotton.**

1. Introduction

Due to improvements in quality of life, population growth, and the effects of fast, inexpensive fashion, the world's use of fibre is always rising. Due to this, a substantial amount of textile waste is produced, and the majority of textile waste is disposed of. According to reports, 10% of the trash generated from clothes in Europe is recycled, 8% is used again, and the remaining 57% landfilled or 25% is disposed of in burned [1]. Cotton fiber are consumed more than polyester fiber. In one of the studies, recycled cotton and polyester fibers are mixed to produce staple yarn [2]. One of the researchers have Investigated and compared the mechanical characteristics of yarns and fabrics made from virgin and recycled cotton and polyester fibres and results showed that the yarns made from recycled materials showed superior characteristics in terms of unevenness, yarn flaws, and yarn quality index value [3]. Chemical recycling of PET was discussed [4]. Study of PET Material Properties at Various Recycling Ratios and Recycling Generations [5]. Effect of cotton waste and spinning parameter on the quality of rotor yarn was studied [6]. Production of medium Count Yarns using Friction Spinning from Recycled Fibres are discussed [7]. With fibre proportions of 20/80, 25/75, 30/70, 35/65, 40/60, 45/55, and 50/50, the qualities of recycled fibre and virgin cotton spun on open-end with 4.5 Ne were examined. Design-Expert software was used to analyse the outcomes and use central composite design to maximise the proportion. The 40/60 ratio yielded the best results, and utilising this ratio, 10 Ne yarn was created and utilised to make denim fabrics.[8]. Recycled polypropylene is strengthened in Turkey with waste silk and cotton, creating a composite with better mechanical and physical qualities [9]. Polyester recovered fibres are increasingly in demand from manufacturers of upholstery and automotive needle punch fabrics, and can be produced using traditional recycling techniques [10]. Clothes, drapes/curtains, towels, sheets, and blankets, clean rags, and sewing scraps, as well as tablecloths, can all be recovered from post-consumer waste. belts portable storage socks and shoes together [11].

2. Material and Methods

A. Material and Methods

Fabric cutting waste are collected from knitted garment manufactures and sorted according to its colors and then these fibers are placed in a single shedding process. Color fibers are taken for this study. This 100% recycled fibers are identified as Sample C. Sample A is obtained by blending of 70% recycled fibers and 30% virgin cotton fibres and Sample B is obtained by blending of 80% recycled fibers and 20% virgin cotton

Table 1
The physical properties of cotton fibers

Sample	Breaking Strength (g/Tex)	2.5% Span Length (mm)	Uniformity Ratio	Fiber Fineness (micronaire)	Short fiber content in percent
Sample A (70:30)	24.32	23.3	42.49	4.45	25.4
Sample B (80:20)	22.1	21.2	45.25	4.2	35
Sample C (100% Recycled Fiber)	23.55	22.5	42.22	3.73	31.2

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fibres. The physical properties of fibers are given in Table 1.

All the samples are tested in Universal span length tester from Pioneer textile testing Coimbatore.

3. Results and Discussion

A. Staple Length

As per SITRA Norms, classification of cotton based on 2.5% Span length are given in the Table 2.

Table 2
classification of cotton based on 2.5% span length

S.No.	Class	2.5% Span length (mm)
1	Extra-long staple	35.0 and above
2	Long Staple	32.0 – 34.5
3	Medium long staple	28.0 – 31.5
4	Medium staple	25.0 – 27.5

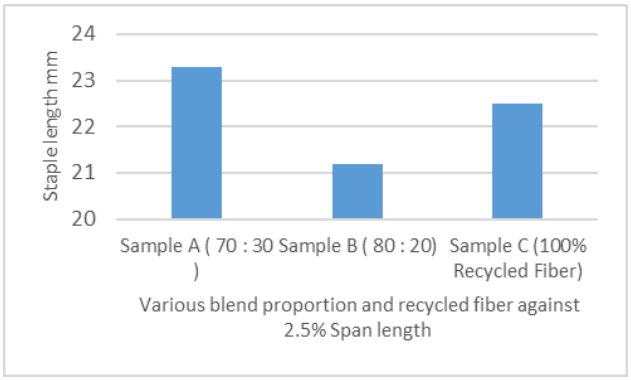

Fig. 1. Various blend proportion and recycled fiber against 2.5% Span length

When the staple length increases, strength of fiber increases. In Ring spinning it requires a minimum of 26mm staple length for spinning. From the above Figure 1, all the samples A, B and C have the staple length of 23.3mm, 22.1mm and 22.5mm respectively. Hence this samples are not suitable for ring spinning. Hence this can be used in open end spinning. Also in the Sample A, the fibre length is more than the 100% recycled fiber due to presence of 30% virgin cotton fiber.

B. Fiber Strength

As per SITRA norms, the Tenacity of cotton fibers obtained at 3mm gauge length is HVI are rated and given Table 3.

Table 3
Classification of cotton based on 2.5% Span length

HVI fibre Strength(g/tex)	Rating	HVI fibre Strength(g/tex)
31 and above	Very high	31 and above
29-30	High	29-30
26-28	Average	26-28
23-25	Low	23-25
20-22	Very low	20-22

Sample A and Sample C single fiber breaking strength falls between 23-25 g/tex, whereas the Sample B have very low breaking strength. This is due to the presence of less percentage of short fiber content in sample A followed by Sample C and sample B.

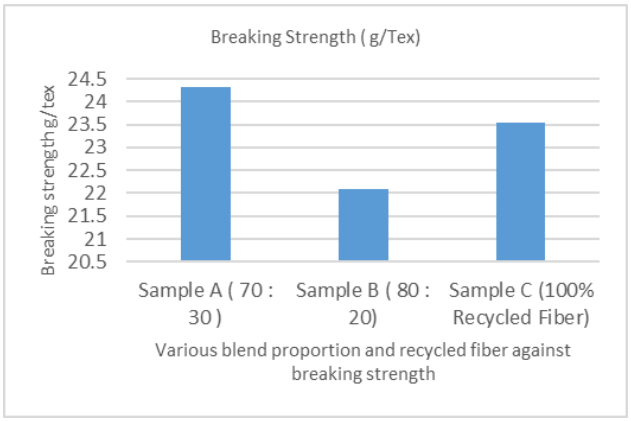

Fig. 2. Various blend proportion and recycled fiber against breaking strength

C. Micronaire Value

SITRA Norm for Microgram per inch are given in Table 4.

Table 4
Microgram per inch rating

Micronaire (µg/inch)	Rating
3	Fine
4	Average
5	Courser

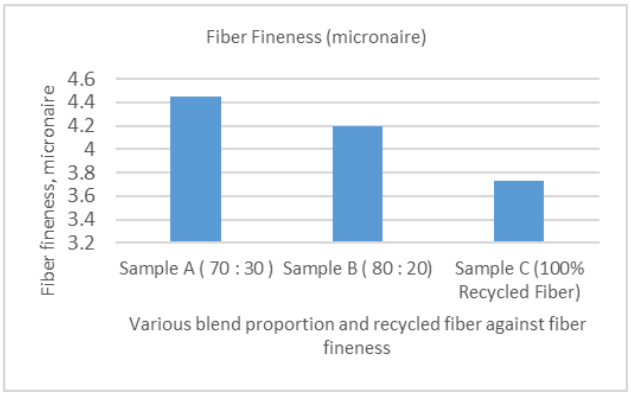

Fig. 3. Various blend proportion and recycled fiber against fiber fineness

Figure 3 shows that the micronaire value of Sample C is 3.73, which referred to its fine rating, due to presence of low micronaire value this will create a problem like lapping formation during spinning process. Both Sample A and B have the micronaire value of 4.4 and 4.2 respectively, having average rating.

D. Uniformity Ratio

Uniformity ratio is the measure of the length variability of the cotton. The rating for uniformity ratio as per SITRA norms is given in Table 5.

Table 5
Uniformity ratio and its rating

Uniformity Ratio %	Rating
50	Good
45	Average
43	Poor

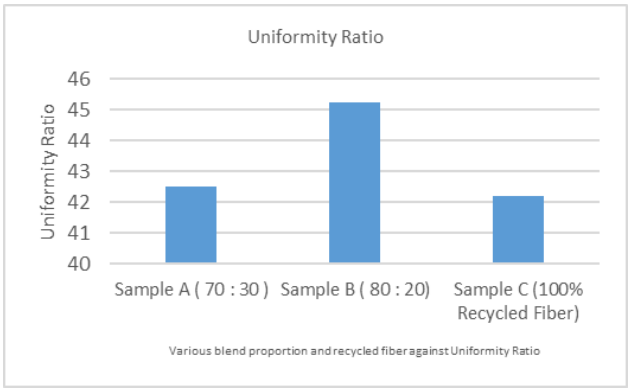

Fig. 4. Various blend proportion and recycled fiber against uniformity ratio

From the figure 4, Sample B have good uniformity ratio followed by sample A and C. This is due to the origin of the fiber sample.

E. Short Fiber Content

It is the percentage of short fiber content in the sample. From the figure 5, the sample A contain less percentage of short fibers, which confirms that it has good spinnability compared with other samples.

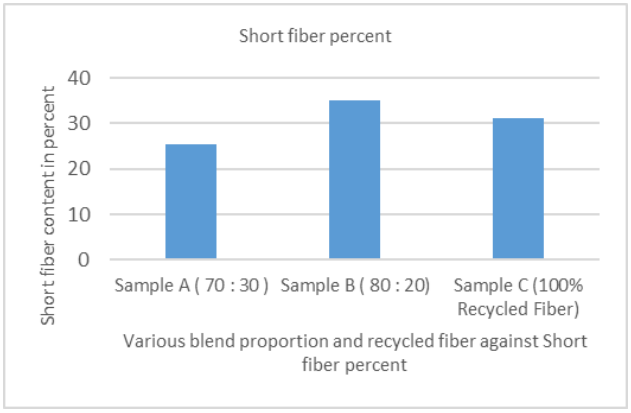

Fig. 5. Various blend proportion and recycled fiber against short fiber percent

4. Conclusion

Every year, a sizable volume of textile waste is dumped in landfills. That is a serious resource waster for society and raises challenges in the areas of economy and the environment. This paper discussed about the effective use of the hard waste from knitting manufacture, there by recycled and used the same in rotor spinning machines. Sample A recycled and virgin blend ration of 70:30 gives the best result in the fiber properties compared with 80:20 and with 100% recycled colored fibers. Another advantage is that the yarn produced from these recycled fibers does not require dyeing operation, which saves plenty of water and the environment.

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