

Hafsa Jamshaid<sup>1</sup>,  
Bilal Zahid<sup>2</sup>,  
Abdul Waqar Rajput<sup>3,\*</sup>,  
Sajid Hussain<sup>4</sup>,  
Uzair Hussain<sup>1</sup>

# Performance Evaluation of Upholstery Fabric Developed from Recycled Fibres

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<sup>1</sup> National Textile University,  
Faculty of Engineering & Technology,  
Protective Textile Group,  
Faisalabad, Pakistan

<sup>2</sup> NED University of Engineering and Technology,  
Karachi – 75270, Sindh, Pakistan

<sup>3</sup> BZU College of Textile Engineering,  
Technical Textile Research Group,  
Multan, Pakistan,  
\* e-mail: waqar.rajput@bzu.edu.pk

<sup>4</sup> Technical University of Liberec,  
Department of Clothing,  
Czech Republic

## Abstract

*The aim of this work was to investigate the properties of upholstery fabric produced from recycled hard waste of coloured fabric clippings. Mélange yarns were formed with the combination of red, green, black and yellow in different ratios. Five yarn samples of 5 Nec linear density were produced from each blend ratio using the rotor spinning technique. These yarns were used to develop fabric samples in a satin weave. These yarn and fabric samples were investigated for different quality parameters, especially the abrasion resistance, pilling resistance, absorbency and light fastness of the fabrics as per standard test methods. The abrasion test is important for the durability and longer-lasting performance of upholstery fabric. From the analysis of test results, it is concluded that all the serviceability properties are in a good range, and these fabrics can be used for waiting room area upholstery fabric*

**Key words:** *mélange yarn, recycle waste, upholstery, abrasion resistance.*

## Introduction

Textile is a basic need of human beings, but it affects the environment a lot. The textile industry, starting from fibre to the production of garments, is considered to be among one of the sectors which generates waste and pollution [1-2]. The world is greatly concerned about the significance for the environment because environmental problems are arising day by day on a global level. Therefore, there is a need for appropriate ways to protect the environment. Due to the continuously increasing world population, the consumption of fibre is increasing. Other factors like cheap-fast-fashion and high quality of life multiply this consumption [3]. A noticeable amount of waste is created and disposed of during the processing of textiles. Different techniques are used to preserve the environment, recycling being one of them, which is a process where the collection of disposable waste material is made, which is converted into new products after processing [4]. Textile waste can be categorised as pre-consumer and post-consumer. Cotton/Polyester (PC) yarn has been widely used in the manufacturing of various types of fabric and apparel due to its special physical and aesthetic properties. Sarkar et.al developed rotor spun yarn by changing the speed of different rollers and studied their quality [5].

Mélange yarn is widely used for fabric production. The blending of different colour fibres is done and multiple shades of mélange yarns are produced. The blend ratio of coloured fibres is altered to create unique spun mélange yarns. Mélange yarn is used for apparel and home

furnishing products due to its unique effect [6-7]. Suchibrata et.al investigated the effect of blending methodologies for mélange yarn in a blow room and at the draw frame stage separately on yarn quality [8]. Similarly another researcher studied the impact of cotton fibre dyeing parameters on yarn properties [9]. An article which is serviceable is capable of performing useful service, but its serviceability ceases when it can no longer do so. An article's usefulness is defined by requirements subject to end users. Multiple factors affect the serviceability of a product. Pilling performance and resistance to abrasion are most important mechanical properties for consideration regarding evaluation of fabrics. The resistance of a fabric to the force of friction is known as abrasion resistance. In general, pilling is a fabric defect observed as small fibre balls or a group consisting of intervened fibres that are attached to the fabric surface by one or more fibres [10-12]. Pamuk & Çeken conducted research on seven different automobile seat covers by subjecting them to 10000 rubs for abrasion. These fabrics were woven velour, flat woven, circular knitted pile, circular knitted flat, warp knit double bar raschel (DNBR), warp knit flat, and warp knit pol. The lowest abrasion resistance was shown by circular knitted flat, flat woven and warp knitted flat fabrics, whereas warp knit double bar raschel had the maximum value of abrasion resistance [13]. Mecit et.al investigated the application of recyclable products in the automobile industry. They produced two different fabrics with changed specifications and raw materials, virgin fibre and recycled fibres, and tested them accordingly for the specific requirements of

the automobile industry. They observed certain differences for fabric and yarns in terms of test results. The seam strength, breaking strength and tear strength of virgin cotton were higher than for recycled fibres; however, the values of recycled fibres were in the customer satisfaction range [14].

From the literature it can be observed that the development of mélange yarn from fabric clipping waste and of a new product have not been studied. Thus, the aim of this work was to develop mélange yarns on a rotor spinning machine from hard waste. The development of a new textile product i.e upholstery fabric from developed mélange yarns and investigation of its durability were also the purpose of the present work.

## Materials and methods

### Recycling of textile fibres

For the development of mélange yarn, fabric clippings of the respective colours of blends of cotton and polyester were taken from local knitted garment producing factories. Fabric sorting was done for different colours. The recycling of fabric clippings of different colours into fibres was done with the help of a waste open roller recycling machine. The clippings were processed on a six taker in an opener machine to convert them into fibre. The fibre reclaimed in this manner was nearly 21 mm in length (2.5% span length), which was tested by a Spinlab Fibro graph 530.

### Spinning of mélange yarn

Due to the sorting of the different colour fabric, mélange yarn was developed without doing flock dyeing. The recycling of coloured fabric clippings eliminates the dyeing cost for the preparation of mélange yarn. Mélange yarns were formed with the combination of red, green black and yellow in different ratios. All the fibre was passed through a Scutcher, Toyoda, where the blow room opening beater speed was 900 r.p.m and that of the shell roller – 9 r.p.m. After this, it is passed through a card CM 808, Howa, where the take-in speed was maintained at 900 r.p.m, the cyclinder speed at 350 r.p.m; the flat speed at 4.5 inch, and the delivery rate at 60 meter/mm. Afterwards, yarn was produced on a Schlafhorst SE 9 rotor spinning machine at an opening roller speed of 300 r.p.m and rotor speed of 35000 r.p.m.



Figure 1. Recycling waste procedure.

### Testing of yarn

The yarn testing was performed on a Lea Strength Tester as per ASTM D2256. For this test first a lea of yarn was made on a warping reel after the lea preparation; a weighing scale was used to determine the weight, and the yarn count was calculated. A lea strength tester was used to determine the yarn strength, which is a vertically installed machine with fixed and moveable jaws. After placement of the lea in the jaws, the machine is turned ON, and the movable jaw starts the application of force till the point lea breaks. The value shown on the machine is noted down, and after multiplying it with the count of yarn, CLSP is calculated. The lea strength of the yarn is an indicator of the suitability of the yarn for a specific application. This is a standard and defined method for the calculation of yarn strength.

### Weaving of recycled fabric

Later on these yarns were used to develop fabric on a sample rapier loom (CCI Tech Inc). A total of 5 samples were developed with specifications of 118 x 118/92 x 76 (where the linear density is in Tex and the

yarn density in cm), and 4 end satin with a thickness of  $1.5 \pm 0.2$  mm.

### Testing and performance evaluation of recycled fabrics

The abrasion Resistance test was done on a Martindale abrasion tester as per the ASTM 4966 standard. (12 KPa) Each sample was tested 3 times. The upholstery fabric's durability was determined by abrasion data, which can steer the consumer towards the type of upholstery material most suited for its intended use. This back and forth rubbing motion is similar to the application of rubbing in normal use as well as the friction caused by someone while sitting on the upholstery fabric for extended times. Test was continued, till set of yarn starts to break, it gives an indication of actual abrasion resistance of samples.

In addition to abrasion resistance, upholstery fabric that is heavily used, due to rubbing, touching and fuzziness of fibre developed, leads to the creation of pills. The rating of fabric pilling was determined in accordance with ASTM D4970-02 (3 KPa) on a Nu-Martindale tester.

Table 1. Yarn blend ratio %.

Sample No.	Blend ratio %
1	Red (80%) + Green (20%)
2	Red (70%) + Black (30%)
3	Red (80%) + Black (20%)
4	Red (50%) + Yellow (50%)
5	Green (80%) + Yellow (20%)

Table 2. CLSP of yarn samples developed.

Sr. No	CLSP
Sample 1	1224
Sample 2	1280
Sample 3	1240
Sample 4	1250
Sample 5	1270



Figure 2. Yarn sample.

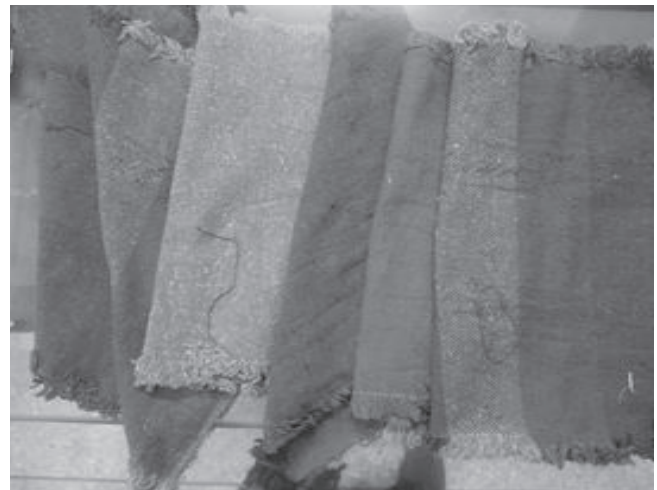


Figure 3. Fabric samples.

In addition to the above, weather resistance was tested i.e fastness to light, also done as per Standard AATCC 16-1998. Color fastness is the resistance of the colour to fading or bleeding by these agencies. The samples were exposed to an intense artificial light from a Xenon lamp light source for the light fastness test. The projected light was passed through a set of filters, glass filters, in order to simulate natural daylight.

The water Absorbency rate was also determined as per Standard AATCC-79-200 to measure the samples propensity to take up water, as upholstery fabric should be less water absorbent to avoid stains. The AATCC 79-2000 test method describes absorbency as an important factor that determines the suitability of a fabric for a particular use and is defined as the propensity of a material to take in and retain a liquid, usually water, in the pores and interstices of the material. The absorbency or wettability of yarns or fabrics can be determined by using this method. A drop of water is made to fall on the sample from a fixed height; measurement of the time required for the droplet to disappear is made, and five readings are taken to attain an average value. Absorbency is inversely proportional to the time for the water droplet to disappear. The longer the time, the less absorbency will be, and vice versa.

## Results and discussion

Average results of the CLSP of all yarn samples are given in *Table 2*.

### Abrasion test:

In the abrasion resistance testing, all samples showed no thread breakage up

to 35.000 cycles at standard testing conditions. The higher the number of Martindale cycles, the better the indicator of durability and long-lasting performance. According to the guidelines, an average of 3000 double rubs equals one year of usage [15]. According to the Association for Contract textiles (ACT), general purpose upholstery fabric should withstand 20.000 cycles and for heavy application – 40.000 cycles. The fabrics developed can be used for high traffic areas like waiting rooms.

### Pilling test

The pilling performance of all samples was tested. The degree of fabric pilling was observed against photographic standards. The pilling rating of all samples are in the range of 3. As per ACT guidelines upholstery fabric should be 3 or more.

### Color fastness test

A colour-fastness test was done to check the ability of the fabric to retain its colour when exposed to different environmental factors. All the samples are in the range of 5-6, which is considered as high fastness to light.

They range from 1 (very low colour fastness) to 8 (very high fastness), so that each higher-numbered reference is approximately twice as fast as the preceding one.

### Absorbency

The absorbency of textiles in AATC TM 79 may be related to the AATCC Test Method (TM) 195 Liquid Moisture Management Properties of Textile Fabrics Wetting Times. The indices are graded according to AATCC Test Method 195-2009 and converted from a number val-

ue to a grade on a five-grade scale [16]. The absorbency of all samples are in the range of 30+2 seconds, which is considered as a slow wetting time as per indices graded by Hu et.al. Because of their extremely low water absorption, these samples will resist water-borne stains. And due to the blend of cotton and polyester, the samples do not accumulate static though friction during use nor attract much dirt or dust, and hence resist staining.

## Conclusions

This study was devoted to investigating the recycling of fabric waste for the development of a new product. It is known that recycled material properties are lower than those of virgin materials. Therefore, recycling could not gain much attention for clothing production in practice. However, in general, this can be used for home furnishing applications. It is concluded from this research that yarns developed from waste can be used in upholstery applications as they have good abrasion and pilling performance, which are major requirements for this type of fabric. Along with this they have good colorfastness and absorbency properties. This study was limited to thard waste, therefore further research using soft waste and hard waste are planned for investigation at a later date.

## References

1. Ütebay B, Çelik P, Çay A. Effects of Cotton Textile Waste Properties on Recycled Fibre Quality. *Journal of Cleaner Production* 2019; 222: 29-35.
2. Liu W, Liu S, Liu T, Liu T, Zhang J, Liu H. Eco-Friendly Post-Consumer Cotton



Waste Recycling for Regenerated Cellulose Fibers. *Carbohydrate Polymers* 2019; 206: 141-8.

3. Lou C-W, Lin J-H, Su K-H. Recycling Polyester and Polypropylene Nonwoven Selvages to Produce Functional Sound Absorption Composites. *Textile Research Journal* 2005; 75(5): 390-4.
4. Vadicherla T, Saravanan D. Thermal Comfort Properties of Single Jersey Fabrics made from Recycled Polyester and Cotton Blended Yarns. *Indian Journal of Fibre & Textile Research (IJFTR)* 2017; 42(3): 318-324.
5. Khan MKR, Sarker RC, Rahman H. The Influence of Some Process Parameters on Rotor Spun Yarn Quality Produced from Recycled Cotton Spinning Wastes. *Int J Text Sci.* 2015; 4: 9-19.
6. Petruyte S. Analysis of Structural Effects Formation in Fancy Yarn. *Indian Journal of Fibre & Textile Research* 2007; 32(1).
7. Moghassem A. Study on the Dyed Cotton Fibers Damage in Spinning Processes and its Effect on the Cotton Mélange Yarn Properties. *Research Journal of Textile and Apparel* 2008; 12, 1: 71-78. DOI:10.1108/RJTA-12-01-2008-B009.
8. Ray S, Ghosh A, Banerjee D. Effect of Blending Methodologies on Cotton Mélange Yarn Quality. *FIBRES & TEXTILES in Eastern Europe* 2018; 26, 5(131): 41-46. DOI: 10.5604/01.3001.0012.2529.
9. Memon H, Ali Khoso N, Memon S. Effect of dyeing parameters on physical properties of fibers and yarns. *International Journal of Applied Sciences and Engineering Research* 2015; 4(4): 401-7.
10. Akaydin M, Can Y. Pilling Performance and Abrasion Characteristics of Selected Basic Weft Knitted Fabrics. *FIBRES & TEXTILES in Eastern Europe* 2010, 18, 2(79): 51-54.
11. Bilisik K, Yolacan G. Abrasion Properties of Upholstery Flocked Fabrics. *Textile Research Journal* 2009; 79(17): 1625-32.
12. Choudhary A, Payal B. To Study the Serviceability Properties of the Upholstery Fabrics. *Trends in Textile & Fashion Design* 2018; 2 (2): 160-165. DOI:10.32474/LTTFD.2018.02.000133.
13. Pamuk G, Çeken F. Comparative Study of the Abrasion Resistance of Automobile Seat Covers. *FIBRES & TEXTILES in Eastern Europe* 2008, 16, 4 (69): 57-61.
14. Mecit D, Berber RO, Boyaci B. A study on the application of recycled fabrics as automotive seat upholstery. *Industria Textila* 2015; 66(5): 278.
15. Hu J, Li Y, Yeung K-W, Wong AS, Xu W. Moisture Management Tester: A Method to Characterize Fabric Liquid Moisture Management Properties. *Textile Research Journal* 2005; 75(1): 57-62.
16. Willbanks A, Oxford N, Miller D. *Textiles for residential and commercial interiors*, Bloomsbury Publishing; 2014.

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