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Effect of scouring and bleaching on mechanical properties of excel and cotton fabrics

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Abstract
With the growing demand for more comfortable, healthier and environmentally friendly products, efforts in research and development activities in the textile industry have focused on the utilisation of renewable and biodegradable resources as well as environmentally sound manufacturing processes in textiles. In this respect, a new kind of regenerated fibres which are an alternative to conventional ones such as tencel, modal, bamboo are gaining significant importance among the fashion group due to their excellent fabric properties ultimately used in apparel and home textile. The recent development in the regenerated fibre is the excel manufactured from Birla Cellulose of the Aditya Birla group with improved fibre properties. The 2/40s count of excel and cotton yarns were used to develop plain woven fabric using power loom for comparative study to distinguish properties at every stages of wet processing. The plain woven excel and cotton fabrics were scoured and bleached and assessed for mechanical properties. It is revealed from the study that, the scoured excel and combined scoured and bleached cotton fabrics were improved the mechanical properties. Among the pure fabrics (excel and cotton), the excel fabric was found to be significantly greater in mechanical properties than the cotton fabric and the excel fabric became softer, stronger and flexible than cotton fabric. Hence, the excel fabric can be used for apparel purpose, babies clothing and women garments to add better drape and softness to the fabrics.

Keywords: Excel, cotton, scouring, bleaching, cloth count, cloth crease recovery and cloth stiffness

1. Introduction
The textile industry not only provides one of the necessities of life, but it also plays a very important role through its contribution to industrial output and employment opportunity which is particularly true in Asia. In recent years, the demand for regenerated cellulose is increased due to unique favorable characters with sustainable approach has experienced rapid growth in textile sector. Regenerated cellulosic are fibers derived from natural sources comprising organic polymers by chemical processing to both extract the fiber-forming polymer and to impart novel characteristics to the resulting fibers. With the growing demand for more comfortable, healthier and environmentally friendly products, efforts in research and development activities in the textile industry have focused on the utilisation of renewable and biodegradable resources as well as environmentally sound manufacturing processes in textiles. In this respect, a new kind of regenerated fibres, which are an alternative to conventional ones, and cotton have gained importance in apparel and home textile manufacturing. The most commonly known novel type of regenerated fibre is lyocell, which is produced from wood pulp by a viscose-like process but with a less hazardous environmental impact, as the compound (NMMO: N-methylmorpholine N-oxide) used in the lyocell manufacturing process for dissolving cellulose is organic and can be almost 99.5% recycled. Another commercial production process of regenerated cellulose known as “Excel”, was established by Birla Cellulose of the Aditya Birla group. The Excel is the latest regenerated cellulose fibre from Birla Cellulose of the Aditya Birla group. It is made from a highly refined eco-friendly and sophisticated process after a rigorous scientific Research and Development conducted at the Birla Research Institute. It is fully natural and organic; Excel, the third-generation cellulose fibre is the answer to fashion conscious consumers, who look for comfort and luxury of a natural fibre, with the engineered precision of a manmade fibre.
Pretreatments of cellulose based fabrics mainly concerned with the removal of natural as well as added impurities from the fabric and also need to be obtained a level necessary for good absorbency and whiteness by utilizing lowest chemical, energy and time as well as water by using several chemical processes. The dye uptake during dyeing of cotton textile or absorbency of others chemical agent during finishing will be uniform or to the maximum

extent possible if the fabric is pretreated well i.e. uniform in whiteness, absorbency, chemical composition and has low levels of impurities. Scouring and bleaching are the two stages of conventional pretreatments of woven fabrics (Hamza *et al.* 2015) [2].

The main purpose of scouring of fabrics is to remove natural as well as added impurities of essentially hydrophobic character as completely as possible and leave the fabric in a highly absorptive condition without undergoing chemical or physical damage significantly and also to make the goods suitable for removing the natural colouring matter of the cotton during the subsequent bleaching process (Shenai, 1991) [7]. Bleaching is the process of decolorization of raw textile material by removing inherent and or acquired colouring components from the fiber. It provides base whiteness to the textile material which could be further whitened with the help of optical brighteners or dyed, printed depending on the desired end use.

Cellulosic and regenerated cellulosic fibres possessed many impurities during manufacturing process from fibre to fabric stages which creates the problems for further dyeing and finishing process. Hence to reduce these problems, the pre-treatment process are introduced but the effect of these pre-treatments on physical properties of fabrics need to be analyse. Therefore, the present study was designed with an objective to study the effect of scouring and bleaching on mechanical properties of cotton and excel fabrics.

2. Material and Methods

2.1 Selection and procurement of excel fibre

Excel is the latest manmade cellulose fibre synthesized from the selection of wood pulp, a natural and renewable resource by the Birla Cellulose of the Aditya Birla Group. The excel fibre was procured from Birla cellulose unit, Kumarapatnam, Harihar.

2.1.1 Development of excel yarn

Required amount of Excel staple fibre subjected to ring frame spinning system to prepared the yarn of 2/40s count and the same count of cotton yarn was procured from Anjenaya Cotton Mills (ACM), Davangere, Karnataka.

2.1.2 Development of plain woven excel and cotton fabric

2/40s excel and cotton yarn were used for production of plain-woven fabric with following loom and fabric details at Department of Textile and Apparel Designing, College of Community Science, University of Agricultural Sciences, Dharwad and further the developed fabrics used for finishing (Plate 1).

Table 1: Loom details for excel and cotton fabric production

Type of loom	Reed no.	Weave type	Denting order	Loom width (inch)
Power loom	56	Plain weave (Rib weave)	2/dent	40

Loom details for excel and cotton fabric production

Loom is the device which is used to weave the fabrics. For production of cotton and excel fabrics power loom was used with the reed number of 56, denting order 2/dent woven with plain weave (Rib weave) and fabric width of 40inches at the Department of Textile and Apparel Designing, College of Community Science, University of Agricultural Sciences Dharwad during 2017-2020 (Table 1).

Table 2: Fabric details for production of excel and cotton fabric

Sl. No.	Fibre content	Yarn count	Yarn twist	Weave type	Cloth width (inch)
1.	Pure Excel	2/40s (2ply)	S	Plain (1×2)	40
2.	Pure Cotton	2/40s (2ply)	S	Plain (1×2)	40

Fabric details for production of excel and cotton fabric

Weaving is technique of interlacing two sets of yarns *i.e.*, warp and weft yarns at the right angle to each other. 2/40s, 2 ply, S twisted pure excel yarn was used for production of pure excel fabric. The fabric was interlaced with rib weave that is variation of plain weave using 1×2 rib structure with cloth density of 56 ends and 52 picks (Table 2).

2.2 Scouring (Excel)

The ultimate aim of scouring is to reduce the amount of impurities efficiently and to make the material formally and highly absorbent in a cost-effective manner so that there are no difficulties in the later processes of dyeing, printing and finishing. The following recipe was used to carry out the scouring of excel fabric.

Recipe

MLR : 1:30
Tween 20 : 2 gpl
Sodium hydroxide : 2%
Temperature : 40 to 60 °C
Time : 1 hours

2.3. Combined scouring and bleaching (Cotton)

The objective of scouring is to reduce the amount of impurities efficiently to obtain level and reproducible result in finishing operation and bleaching is done for whitening the fabric. The auxiliaries used to carry out the combined scouring and bleaching technique for cotton fabric. The following recipe was used to carry out the combined scouring and bleaching technique for cotton fabric.

Recipe

MLR : 1:30
Tween 80 : 2 gpl
Hydrogen Peroxide : 2%
Sequencing agent (EDTA) : 1 gpl
Temperature : 40 to 60 °C
Time : 1 hours

Assessment of mechanical properties of excel and cotton fabrics

Mechanical properties

The mechanical properties of any woven fabric are complex of yarn and weave structure, design, finish applied which provides basic texture, hand & feel and dimensions of the fabric in turn affect the functional properties. The following physical properties are used to define the static physical dimensions of strand fabrics: Fiber or filament: type, size, length. Yarn: diameter, twist, weight or size, count, fibre content for mixed yarns, ply. The excel and cotton were subjected to following mechanical properties which carried using standard test methods.

Sl. No.	Properties	Test methods
1.	Cloth count (Ne)	BS method 2862: 1957
2.	Cloth thickness (mm)	ASTM D177-1975
3.	Cloth weight (GSM)	IS 1964-2001
4.	Cloth stiffness (cm)	BS 3356-1961
5.	Cloth crease recovery (degree)	AATCC 66-1975

3. Results and Discussion

Table 3: Effect of scouring and bleaching on cloth count of excel and cotton fabrics

Sl. No.	Type of fabrics	Treatment	Cloth count (Ne)	
			Warp	Weft
1.	Cotton	Control	56	50
		Scoured and bleached	60	54
2.	Excel	Control	56	48
		Scoured	58	52

Variables	S.Em. ±	C.D. (1%)	C.D. (5%)	CV
Warp	0.43	1.67	1.24*	0.14
Weft	0.42	1.64	1.22*	0.11

3.1 Effect of scouring and bleaching on cloth count of excel and cotton fabrics

Cloth count of the woven textile material is the number of ends and picks per unit area which is influenced by the yarn count and compactness of the weave. It is also expressed as cloth density *i.e.*, alignment of yarns, which not only influence the yarn count but also the mechanical and functional properties of the ultimate cloth. The cloth count of woven fabrics also influenced by the pre-treatments and finishing treatments.

Irrespective of fabrics and pre-treatments, the warp density of cotton and excel fabrics was relatively greater than the weft and the cloth density was found to be significantly greater in all the scoured and bleached fabrics than control fabrics. Among the fabrics, the cloth count was found to be same in both fabrics *i.e.*, cotton (56) and excel (56) in warp direction. Where as in weft direction, a significantly greater cloth density was observed in cotton (50) then the excel (48) respectively.

On the other hand, the pretended cotton and excel fabrics exhibited greater cloth density in both warp and weft way. Among the scoured and bleached fabrics, the cloth count was found to be significantly greater in scoured and bleached cotton fabric in warp (60) and weft (54) then scoured excel fabrics *i.e.*, warp (58) and weft (52) respectively (Table 4). It may be because of removal of impurities during the pre-treatment process and maximum consolidation of threads takes place by forming compact structure of the fabrics which is resulting into increased in cloth count. The results are on par with the results of Prabaharan (2003) [5] who reported that, after number of wet processing treatments the cotton fabric was prone to shrink considerably resulting in high threads density.

Table 4: Effect of scoured and bleached on cloth thickness of excel and cotton fabrics

Sl. No.	Type of fabrics	Cloth thickness (mm)	
		Cotton	Excel
1.	Control	0.591	0.617*
2.	Scoured and bleached	0.592	0.520
	S.Em. ±	0.003	
	C.D. (1%)	0.013*	
	C.D. (5%)	0.010*	
	C.V	1.450	

3.2 Effect of scoured and bleached on cloth thickness of excel and cotton fabrics

The thickness of fabric is one of the most important factor determining on its warmthless, heaviness or stiffness in use. Fabric thickness depend upon fiber content, pre-treatments and finishing agents which effects the fibric properties *viz.*, cloth stiffness, crease recovery angle, drapability and fibric geometry *etc.*

Among the fabrics, the cloth thickness was found to significantly greater in excel fabric (0.617) then cotton (0.591), due to the fibre morphology and greater fibre density of excel fiber resulting into greater thickness. Similar results were found with the results of Lavate *et al.* (2016) [3, 4] who reported that, the regenerated cellulosic fabric *viz.*, Tencel, modal, were thicker than cotton fabrics. Kadole *et al.* (2016) [3] resulted that, all the regenerated cellulosic fabrics *i.e.*, viscose, modal, tencel and bamboo exhibited approximately same thickness value. Ajmeri and Bhatacharya (2013) [1] reported that, the pique fabrics knitted with cotton yarns exhibited lower thickness than the pique fabrics knitted with modal yarns.

Further, the after treatment, the cotton fabrics (0.592) has significantly increased in cloth thickness than excel fabric (0.520). It may be due to the more consolidation of yarns take place during scouring and bleaching process resulting into thicker fabric (Table 5).

Table 5: Effect of scouring and bleaching on cloth weight of excel and cotton fabrics

Sl. No.	Type of fabrics	Treatment	Cloth weight (GSM)		
			Percent warp	Percent weft	Cloth weight
1.	Cotton	Control	35	64	147
		Scoured and bleached	37	63	176
2.	Excel	Control	38	61	197
		Scoured	45	55	174

Variables	S.Em. ±	C.D. (1%)	C.D. (5%)	C.V.
Warp	0.21	0.88	0.64	0.87
Weft	0.18	0.79	0.57	0.72
Cloth weight	0.80	3.33**	2.41**	0.10

3.3 Effect of scouring and bleaching on cloth weight of excel and cotton fabrics

Fabric mass per unit area is expressed either as grams per square meter or grams per linear meter. The type of fibre, yarn density, weave type, wet process treatment and finishes applied are the factors which effect or contribute to the fabric weight.

In general, irrespective of control and scoured and bleached fabrics, the control excel fabric exhibited significantly greater GSM than other samples. Further, in all the treated samples per cent weft was found to be significantly greater than the per cent warp (Table 6).

The total cloth weight of excel fabric (control) was found to be significantly greater (197) than cotton fabric (147). Similarly, the greater amount of per cent warp (38, 35) and per cent weft (61, 64) was recorded in control fabric excel and

cotton respectively.
The total cloth weight of combined scoured and bleached cotton fabric (176) was found to be greater than the scoured excel (174). Further, in all the fabrics, the per cent weft (63, 55) was found to be greater than per cent warp (37, 45) respectively. It may be due to the combined effect of pre-treatment *i.e.*, consolidation of threads/unit area resulting into greater cloth thickness which yield to higher cloth weight.
The results are on par with the results obtained by Lavate *et al.* (2016) [3, 4], who reported that the all the regenerated cellulosic fabrics *i.e.*, tencel and modal has similar GSM as cotton fabrics. Among the regenerated cellulosic fabrics, Viscose fabric found to have lower weight per unit area as compared to modified regenerated cellulosic *viz.*, modal, tencel and bamboo fabrics (Kadole *et al.*, 2016) [3].

Table 6: Effect of scouring and bleaching on cloth stiffness of excel and cotton fabrics

Sl. No.	Type of fabrics	Treatment	Cloth stiffness (cm)	
			Warp	Weft
1.	Cotton	Control	2.41	2.01
		Scoured and bleached	2.07	1.37
2.	Excel	Control	1.75	1.32
		Scoured	1.27	1.30

Variables	S.Em. ±	C.D. (1%)	C.D. (5%)	CV
Warp	0.05	0.22*	0.16*	1.75
Weft	0.04	0.18*	0.13*	0.15

3.4. Effect of scouring and bleaching on cloth stiffness of excel and cotton fabrics

The term bending length suggests that, a simple antilever test in which the material is allowed to bend under its own weight. The higher the bending length, the stiffer is the fabric and vice versa.
Table 7. inferred the stiffness property of excel and cotton fabrics. Among the control fabrics, the cloth stiffness was found to be greater in cotton in warp (2.41 cm) and weft (2.01 cm) then excel fabric (warp: 1.75 & weft: 1.32) respectively. Further, after scoured and bleached both cotton and excel fabric found to be significantly decreased in cloth stiffness in both the direction *i.e.*, warp and weft as compared to control samples. Among the scoured and bleached samples, the scoured and bleached cotton fabric exhibited significantly greater bending length in warp (2.07) and weft (1.37) direction than scoured excel fabric (warp:1.27 & weft:1.30) respectively. It may be due to the removal of impurities, present in the woven fabric structure makes the fabric softer and pliable. The results are on par with the results of Shrikant *et al.* (2005) [8] revealed that, fabric became less stiffer after the scouring possibly due to the removal of fats and waxes. Further, the value of bending rigidity and hysteresis of bending movement decrease by 30-50 per cent at all the four stages of wet processing, *i.e.*, the fabric becomes more pliable and softer reported in the study effect of finishing agents on low-stress mechanical properties of cotton full voile fabric investigated by Selvarju *et al.*, 2000.
The Lavate *et al.* (2016) [3, 4], investigated that, the tensel/cotton and excel/cotton fabric showed the lowest value of bending than cotton, this is because of structural characteristics of modified rayons and also after wet processing, the excel and tencel fabrics become smoother and suppler surface than cotton.

Table 7: Effect of scouring and bleaching on cloth crease recovery angle of excel and cotton fabrics

Sl. No.	Type of fabrics	Treatments	Cloth crease recovery (Degree)		
			Warp	Weft	Crease recovery angle
1.	Cotton	Control	73.8	66.7	70.1
		Scoured and bleached	90.4	91.4	90.8
2.	Excel	Control	99.3	89.8	94.4
		Scoured	104.0	110.0	106.9

Variables	S.Em. ±	C.D. (1%)	C.D. (5%)	C.V.
Warp	0.99	3.82*	2.85*	0.13
Weft	0.78	3.02*	2.25*	0.17
Crease recovery angle	0.53	2.03*	1.52*	0.14

3.5 Effect of scouring and bleaching on cloth crease recovery angle of excel and cotton fabrics

Crease in an international fold incorporated in the fabric to enhance the aesthetic appeal. Creasing of a fabric during wear is not a change appearance that is generally desired. Create recovery is the ability of the fabric is determined by measuring the crease recovery angle increases the fabric bonding length decreases.
Irrespective of types of fabrics and pre-treatments, the cloth crease recovery was significantly greater in scoured excel fabric than other samples. Among the control fabrics, the excel control exhibited greater crease recovery angle (94.4) in warp (99.3) and weft (89.8) way than cotton control fabrics (crease recovery angle: 70.1, warp: 73.8 & weft: 66.7) respectively.
Scoured excel fabric exhibited significantly greater crease recovery angle (106.9) in warp (99.3) and weft (89.8) way than scoured and bleached cotton fabric (cloth crease recovery: 90.8, warp: 90.4 & weft: 90.8) respectively.
In general, the cloth crease recovery angle was increased in both scoured and bleached excel and cotton fabrics than control. Among the controls the greater cloth recovery angle was observed in excel than cotton fabric (Table 8).
This is because of degree of orientation of excel fibre and modified regenerated cellulosic fibres are smoother, pliable in nature which resulting into increase in crease recovery angle.

The results are on par with the results of Lavate *et al.* (2016) [3, 4] who reported that, the regenerated cellulosic fabrics *viz.*, Tencel & modal were found to be significantly greater recovery angle than cotton fabrics.

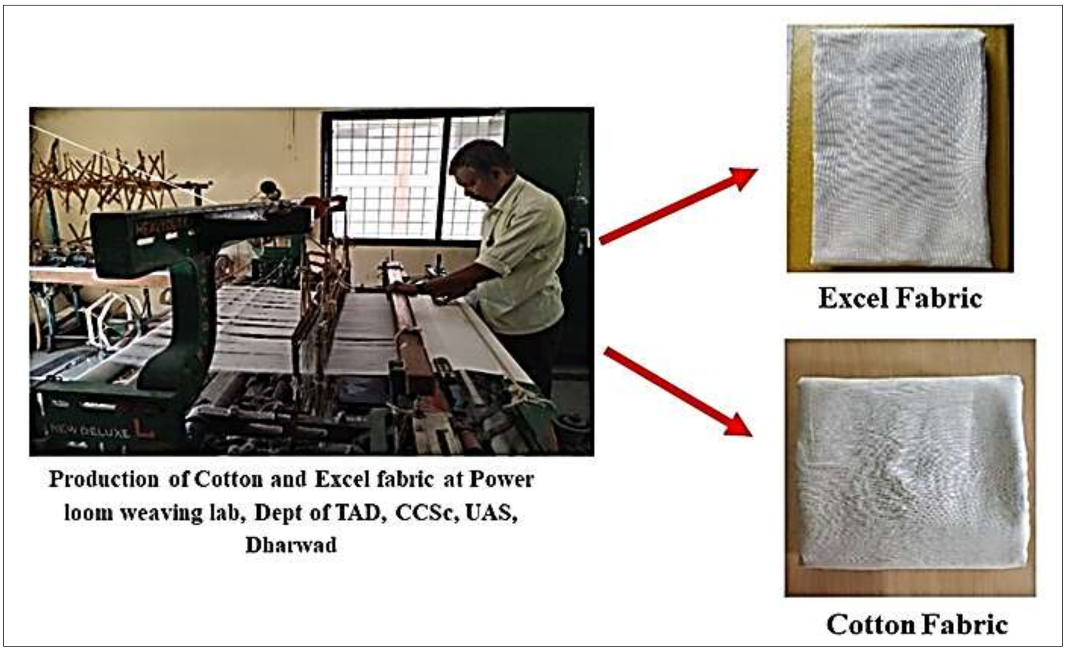

Fig 1: Plate 1, Development of excel and cotton fabrics

4. Conclusion

A significantly greater thread per unit area was found in scoured and bleached fabrics *i.e.*, cotton and excel in both the direction *i.e.*, warp and weft way, than control fabrics. The cloth thickness was found to be significantly greater in excel (control) than cotton fabric and the effect of scouring and bleaching on cotton fabrics has significantly increased in cloth thickness than scoured excel fabric. Among the fabrics, the cloth weight was found to be significantly greater in excel than cotton fabric and the effect of scouring and bleaching on cotton was found to be increased in the cloth weight, whereas decreased in excel fabric. The cloth stiffness was found to be greater in control and scoured and bleached cotton than control and scoured excel fabrics. Whereas, the greater cloth crease recovery was possessed by control and scoured excel fabrics than control and scoured and bleached cotton fabrics. The effect of scouring and bleaching on excel and cotton fabrics improved the mechanical properties than the control fabrics. Among the control fabrics, the excel fabrics was found to be greater mechanical properties *viz.*, cloth count, cloth thickness, cloth weight, cloth stiffness and cloth crease recovery angle than cotton fabric. The excel fabric (control) became softer, stronger and flexible than cotton fabric. Hence, the excel fabric can be used for apparel purpose, babies clothing and women garments to add better drape and softness to the fabrics.

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