Conclusions

Wilson's model worked well for the correlation of both static and dynamic frictional data of the fabrics. The frictional coefficients of fabrics surface were proportional to yarn values of coefficient of dynamic friction in comparison to core-spun fabrics with the lowest value.

The fabrics had different compression values. Open - end and carded fabrics were considered as hard and soft fabrics respectively.

The tenacities of the weft yarn and the fabrics in the weft direction were not related to each other. Air-jet and combed fabrics were the weakest and the strongest respectively.

Bending modulus of the air-jet fabrics were almost twice of the combed ones. Air-jet and combed fabrics were almost twice of the combed ones. Air-jet and combed fabrics were considered as stiff and flexible respectively.

Air-jet fabrics had the highest reduction in mass under wear. This low resistance to abrasion is attributed to the formation of weft yarn with no twist. It should be pointed out that the air-jet yarn is formed with the aid of false twist.

A comprehensive conclusion based on the results has been derived in the form of a circular chart. Users can select a fabric for an optimum performance from this chart.

Acknowledgment

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Abrasion Resistance

The importance of fabric abrasion resistance is related to its influence on the fabric hand, surface properties and appearance lightness. in this study, the reduction of the fabrics mass was considered. The abrasion resistance of the fabrics was measured under a pressure of 22 g/ cm^2 for 600 cycles. Table 4 presents the reduction of the mass of the fabrics. Air- jet fabric was the most inferior with 5.7% reduction in mass. This was 8 times higher than open - end fabric with a mass reduction of 0. 705%.

One would expect the yarn twist to play a major role in abrasion resistance. This was justified by the fact that the linear correlation coefficient between weft yarn twist and the reduction of mass was - 0.90.

Comprehensive Presentation of Fabric Properties

After normalizing the fabrics properties by the corresponding maximum value of each characteristic, a circular chart was used to represent the properties of different fabrics for various practical applications. The chart consisted of a circle with eight equal sections. Each radius represented one fabric characteristic. The fabric tested was represented by its locus formed on the chart. This was done by connecting together all its data points on the radii [10]. Figure 3 shows the comprehensive presentation of the fabrics properties.

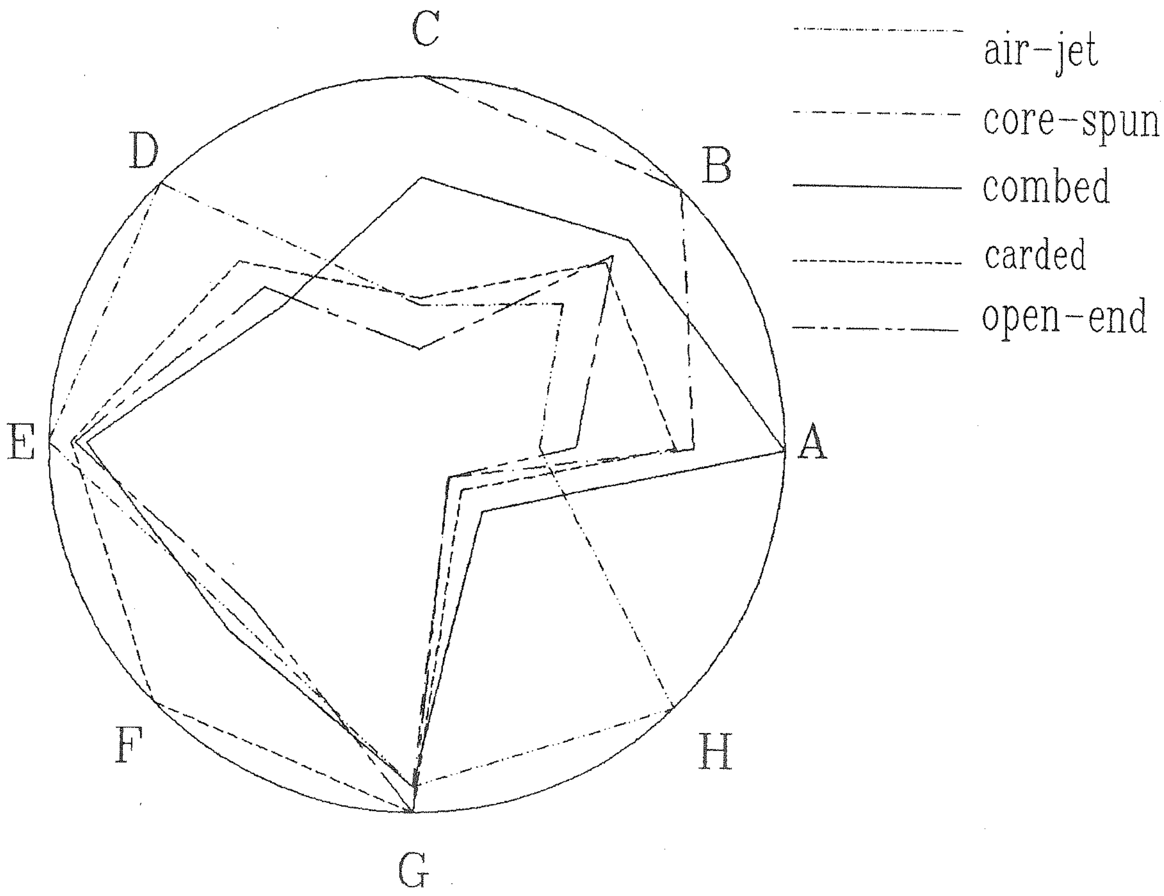

Figure (3) Circular chart for comprehensive presentation of fabric properties: (A) tenacity, (B) extension at break, (C) tear strength, (D) average of bending modulus, (E) drape coefficient, (F) compression rate under normal load of 0.9 N/cm2, (G) coefficient of dynamic friction under normal load of 1708 N/cm^2, (H) resistance of mass under abrasion.

yarn and fabric weftwise tenacities is low (0. 41). The tenacities of core-spun fabrics in the weft direction were about 75% of combed fabrics. It should be pointed out that the core spun yarns were about 170% stronger than the combed yarns. This indicates that the tensile failure mechanism of core - spun yarns is different depending on being isolated or in the fabric. Ignoring the core - spun data, the tenacities of yarns and fabrics could be related to each other with a correlation coefficient of 0.97. There is also a high correlation between extension at break of the yarns and the fabrics (0. 98).

The tenacity of the air - jet fabric in the weft direction is about 33% of the combed fabric. Air - jet and combed fabrics were the weakest and the strongest respectively.

In the warp direction, according to earlier findings [5], the open - end and carded fabrics had similar tensile properties. Also the other three were similar.

Table 3 shows the tear strength of the fabrics. The tear strength of the fabrics exceeded 3500 gr. f, when the warp yarns were broken in the test. The correlation coefficient between weft yarn strengths and fabric weftwise tear strengths is low (0. 71). This indicates that tear strength depends not only on yarn properties, but also on fabric structure.

Open - end and core - spun fabrics were the weakest and the strongest products respectively.

Bending Modulus and Drape Coefficient

A fabric that bends easily is described as flexible, i. e., not stiff. Such a fabric possesses a low bending modulus and high flexion [1]. Also the bending behaviour of fabrics can generally influence the appearance of a garment. The ability of a fabric to drape well is very important when consumers decide to buy a garment.

Table 4 shows the bending modulus and drape coefficient of the fabrics. The results show that the air - jet and the combed fabrics had the highest and lowest values of bending modulus and drape coefficient respectively. Therefore, air - jet and combed fabrics are considered as stiff and flexible fabrics respectively.

Table (4) Bending modulus, drape coefficient and reduction of mass under abrasion of fabrics.

	air-jet	core-spun	combed	carded	open-end
Bending modulus:					
Filling dir., kg/cm^2	31.3	NR	16.5	18.8	16.8
Warping dir., kg/cm^2	27.5	NR	14.5	22.5	18.9
Average, kg/cm^2	29.4	NR	15.5	20.6	17.8
Drape coe., %	97.0	NR	87.0	91.0	90.0
Reduction of mass under abrasion, %	5.7	0.71	1.42	1.0	0.705

Compression Property

Variation of fabric compression versus pressure for different fabrics are shown in Figure 2. It can be seen that at first the compression increases rapidly up to a certain point and then remains almost unchanged. The intersection of the tangent at the origin with the tangent having the least slope can be a good indication of the pressure needed to compress the protruding and loose fibers on the fabric surface. The carded fabrics had the highest values of compression, while the open - end ones had the lowest.

Considering the point that fabrics which are compressed easily have been deemed soft [2], Open - end and carded fabrics are considered as hard and soft fabrics respectively.

Tensile Properties and Tear Strength

Table 3 shows tensile properties of the fabrics. The correlation coefficient between

Table (3) Some details of fabrics, tensile property, and tear strength

	air-jet	core-spun	combed	carded	open-end
Details of fabrics:					
Mass, g/m^2	131.00	137.00	130.80	131.60	128.9
Thickness,mm	0.488	0.459	0.44	0.469	0.453
Yarn crimp:					
Warpwise,%	9.07	11.52	8.51	9.18	8.54
Fillingwise,%	4.07	2.77	6.28	5.27	5.38
Tensile properties in filling direction:					
Tenacity,g/yarn	139.64	317.9	421.57	296.49	183.52
CV of tenacity,%	27.9	16.61	5.18	4.52	25.29
Extension at break,%	6.9	11.3	9.08	8.02	8.4
CV of extension,%	11.5	17.67	4.7	4.35	12.46
Tenacity relative to combed,%	33.12	75.40	100.00	70.32	43.53
Tear strength:					
Filling being broken,gr.f	1350	>3500	2562	1400	900
Tear strength relative to combed,%	52.69	>136.12	100.00	54.64	35.12

Results And Discussion

Frictional Property

The effect of the normal load on the frictional properties of the fabrics is presented in Table 2 which shows the friction of fabric - on - fabric in the warp direction. The data fit very well into an empirical parabolic relationship between frictional force F and normal load N in the form $F = KN^n$, where K and n are the frictional constant and index respectively [6]. The relationship between log F/A and log N/A is linear for all fabrics. A is the area of contact between two surfaces. A typical plot of log F/A versus log N/A is shown in Figure 1 for the air-jet fabrics. The values of correlation between log F/A and log N/A for static and dynamic friction is between 0.993 and 0.999 respectively.

The Wilson's model is able to correlate F and N, using the relationship logF=C+nlog N [13]. The values of n and C are shown in Table 2. The value of n and C lie between 0.57-0. 70 and - 0.01-0.41 respectively. These agree with values found by Wilson for cotton fabrics [13]. Open - end and carded fabrics had the highest and the core spun had the lowest dynamic frictional coefficient. Hence, core-spun fabrics with a low coefficient of friction are described as a smooth fabric [7]. Carded and open-end would be the rough fabrics. The higher irregularity of open-end and carded yarns in comparison to core - spun yarns leads to a rougher surface.

Linear correlation coefficient between weft yarn irregularity and dynamic frictional force under the normal load of 1708 N/m^2 is 0.85.

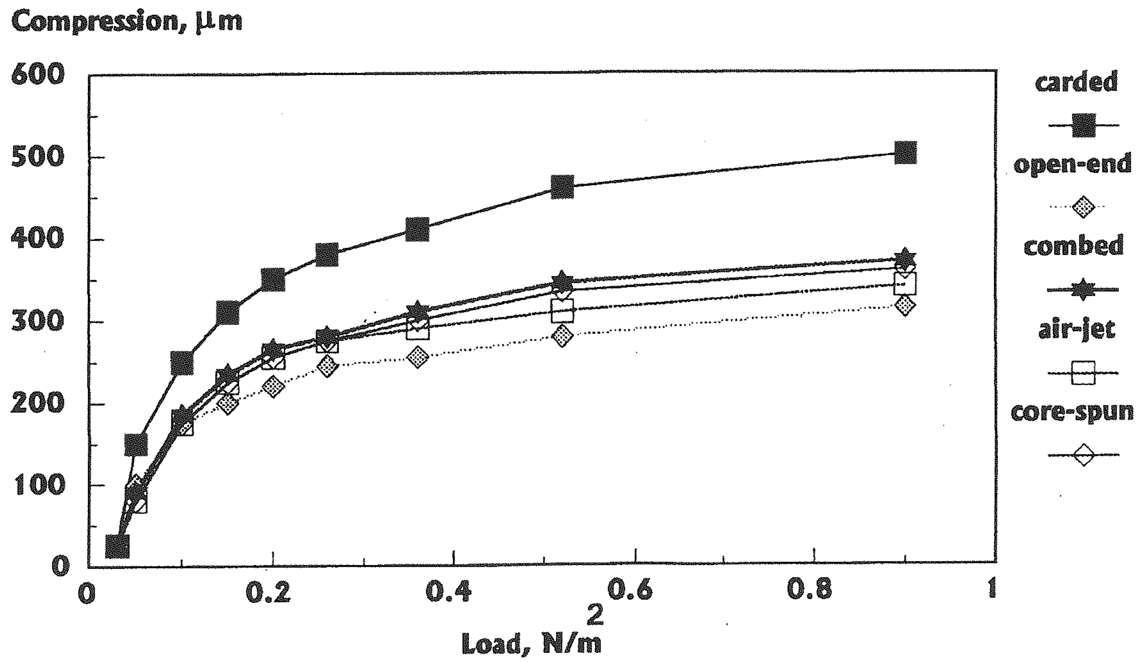

Figure (2) Variation of compression as pressure is increased.

Table (2) Coefficients of friction and values of n and C.

Type of fabrics		Normal load, N/m^2 454	924	1238	1708	2492	3276	values of n	C
air-jet	μ_s	1.31	1.01	0.88	0.78	0.69	0.63	0.62	0.36
	μ_k	0.66	0.51	0.45	0.42	0.38	0.35	0.68	0.01
core-spun	μ_s	1.34	1.05	0.84	0.72	0.64	0.59	0.57	0.41
	μ_k	0.62	0.48	0.43	0.40	0.35	0.34	0.69	-0.01
combed	μ_s	1.31	1.06	0.92	0.72	0.65	0.62	0.59	0.40
	μ_k	0.67	0.51	0.46	0.40	0.37	0.35	0.66	0.04
carded	μ_s	1.40	1.09	0.92	0.81	0.69	0.66	0.60	0.41
	μ_k	0.67	0.54	0.48	0.43	0.39	0.35	0.67	0.04
open-end	μ_s	1.39	1.07	0.94	0.87	0.78	0.69	0.65	0.36
	μ_k	0.65	0.51	0.47	0.43	0.38	0.36	0.70	0.01

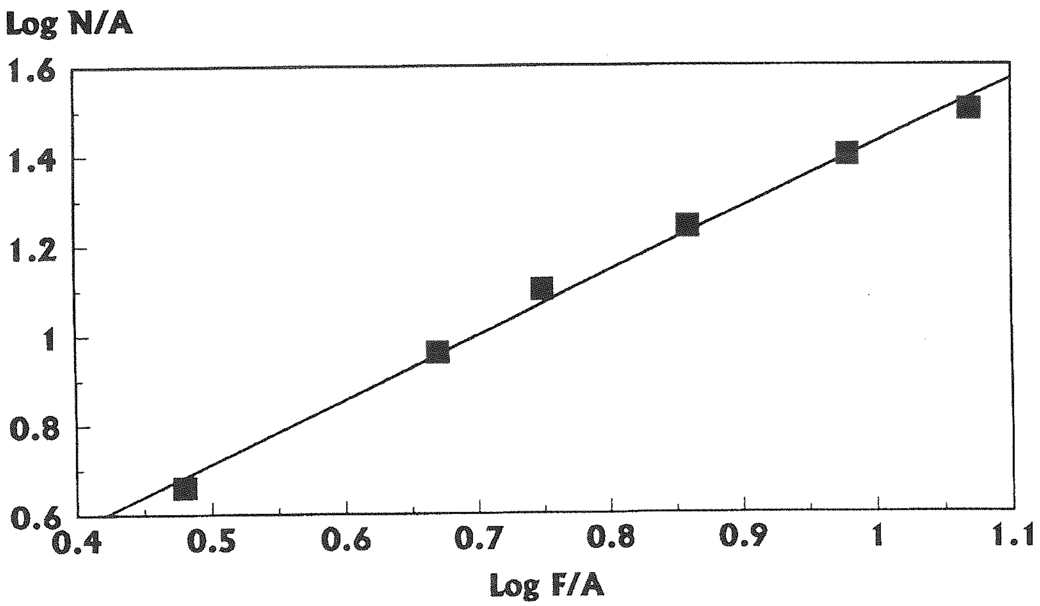

Figure (1) Relationship between log F/A and logN/A for air - jet fabrics (dynamic friction).

Experimental

Five plain-weave fabrics were woven by an air- jet loom, with constant yarn densities of 16.4 and 26 th/cm for weft and warp yarns, respectively. The warp yarn was a blend of cotton - polyester with a linear density of 22/1 tex. The weft yarn with a linear density of 28/1 tex were commercial cotton yarns produced in Japan using the combed, carded, air-jet, open-end, and core-spun systems. Details of the yarns are given in Table 1.

Table (1) Details of yarn used as weft

	air-jet	core-spun	combed	carded	open-end
Yarn cont, tex	28.54	28.25	27.88	27.77	27.39
Unevenness CV%	11.13	7.77	9.82	16.41	14.56
Tenacity, g/tex	5.61	30.15	17.71	11.36	8.83
CV of tenacity, %	10.6	4.71	8.07	11.36	10.21
Extension at break, %	4.11	26.71	6.05	5.23	5.31
CV of extension, %	18.9	9.24	10.31	17.98	13.9
Modulus, g/tex	192.44	460.53	274.74	324.63	286.41
Twist multiple,	--	3.65	2.7	3.15	4.04
Tenacity relative to combed, %	31.67	170.24	100.00	64.14	49.85

Fresh samples were used for the test.

For fabric friction measurements, an Instron tensile tester was fitted with an appropriate assembly. Detailed procedures are reported elsewhere [3].

In order to determine the compression properties of the fabrics, an instrument was developed. This instrument consisted of a load cell, an amplifier, an A/D converter, a PC computer and a control motor. The samples (3 × 3 cm) were put between a metallic loaded plate (1. 5kg) and a glass plate (25 × 25 × 1. 5mm). While the linear actuate goes up constantly, the variation of load because of compression of the fabric is transformed into a signal and the amplified signal is converted to digital signal by A/D converter. Then, the variation of compression with increasing load is obtained.

The yarn tensile test was conducted at an elongation rate of 20 mm/min. The fabric tensile test was carried out using a 152. 4 mm by 25. 4 mm wide ravel strip geometry at an elongation rate of 80 mm/min.

The tear strength, bending stiffness, drape coefficient and abrasion resistance of the fabrics were measured by conventional testing equipments.

Evaluation of Optimum Performance of Plain Weave Fabrics Woven from Cotton Yarns Produced by Different Spinning Systems

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Abstract

Yarns spun by different systems influence fabrics properties and its end use. In this study fabrics were woven from combed, air-jet, open-end, carded, and core-spun weft of the same count. The most important characteristics of these fabrics are discussed. A circular chart is used to evaluate the overall fabric characteristics. This is a good reference for the consumers to predict optimum performance of garments in use.

Key Words

Static and Dynamic Friction, Compression, Bending Stiffness, Tensile Properties., Tear Strength, Drape, Abrasion Resistance, Modulus, Carded, Open-end, Air-jet, Combed, Core-spun.

Introduction

In traditional textile processing, fibers are converted in a yarn by a series of drafting processes involving interaction between different group of fibers and between fibers and other materials. New spinning technologies do not have the mechanical control such as an apron in the drafting zone of ring spinning machines. With the development of these new yarns, there was a need for a better understanding of the performance of them in the final product. Lord et al. [9] discussed fabric assistance for different yarn systems. He showed that friction and rotor spun yarns had a relatively higher assistance than similar ring spun yarns. Also, they found [8] that friction fabrics had a hand that was equivalent to ring fabrics. Rotor fabrics had a harsher hand than the other two. Yarn failure in fabrics woven from yarns produced by different spinning technologies has been discussed in the literature [11, 12].

For yarn spun by different spinning systems, the effect of weft yarn irregularity on weft spacing and the objective measurement of the strength-generating mechanism of thread interaction within the fabric and factors causing it has been studied [3, 5]. It has also been shown that, the protruding yarn changes with wear [4]. However, little has been published about the characteristics of the fabrics prepared from these yarns. The aim of this study was to determine properties such as surface frictional, compression, bending, tensile, tear strength, drape and abrasion resistance of the fabrics.