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COMPARATIVE STUDY OF MECHANICAL PROPERTIES OF UNION WOVEN FABRICS COTTON AND REGENERATED FIBERS VISCOSE BAMBOO AND MODAL

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ABSTRACT

The objectives of the present research work to develop the Union Fabrics having the 100% Cotton (2/50) in warp and 100 % Bamboo (1/30), 100 % Modal (1/30), 100 % Viscose(1/30) and 100 % Cotton(1/30) in weft and find out the most comfortable fabric in terms of mechanical properties Mechanical Properties Tensile Strength and breaking elongation, Tearing Strength and Abrasion Resistance of union fabrics with cotton yarn as warp and yarn from regenerated fibers (Viscose, Bamboo and Modal) as weft having properties similar or better than 100% cotton. Regenerated fibers were taken in order to reduce consumption of cotton. Three union fabrics i.e. Cotton-Modal, Cotton-Bamboo, Cotton-Viscose and the fabric with Cotton-Cotton composition were developed having same EPI, PPI and weave. Cotton –Modal fabric was found the best fabric out of Cotton-Bamboo, Cotton-Viscose and Cotton-Cotton

KEYWORDS: *Cotton, Viscose, Bamboo, Modal, Strength, Warp, Weft, Load*

INTRODUCTION

In recent years, the fabrics of different blends and union fabrics available in the market for various end uses. The raw material for the yarn of different types is used for producing different varieties of fabrics to meet the fashion. Raw materials used for fabric construction are cotton, silk, wool, jute, synthetic etc. Union fabric is made by using different yarn in warp and weft direction. Union fabric is durable, crease resistant, absorbent, lustrous and resiliency etc. Various kinds of union fabrics can be produced by combination of cotton, rayon, ramie, polyester, acrylic etc. with silk to reduce the cost of the silk fabric as pure silk fabric is very costly for common consumer. Union fabrics are the fabrics where in the fiber content of warp is different from that of weft.

Union fabrics should ideally be made with materials which are similar in properties such that resultant union fabric performs satisfactorily in both the directions in warp and weft. As such union fabrics can be made by combining any two of the materials like Cotton, Viscose, Rayon, Modal, Lyocell, Bamboo etc. or polyester, Acrylic etc. In certain cases, it is advantageous to produce a variety of union fabrics selecting one type of warp as common and by changing weft yarns; each type of weft yarn creating a new union fabric.

MATERIALS AND EXPERIMENTAL METHODS

Three union fabrics were developed using 100% Cotton yarn as warp and 100% weft yarn made from Modal, Bamboo and Viscose fibers. In order to compare the above union fabrics with the fabrics that are widely used as kids wear, another set of fabrics were prepared using 100% cotton yarn as warp and weft.

Weaving Parameters

The Specifications of Weaving Machine and Fabrics used are as Follows:

Loom: Sample power loom, over pick with Dobby

Speed (rpm): 120

Woven fabrics with the following specifications:

Table 1: Specifications of Fabrics Used

Warp Yarn	100% Cotton
Weft Yarn	100% Cotton, 100% Bamboo, 100% Viscose, 100% Modal
Weave	Twill weave (2/1)
EPI	84
PPI	72
Warp Count	2/50 Ne
Weft Count	1/30 Ne
Fabric Weight	150 g/m^2

RESULTS AND DISCUSSIONS

Results and Discussions

This chapter mainly deals with results obtained on the series of testing carried out on the prepared fabric samples under study and discus the factors that are highly influence the properties of the product.

Table 2: Comparison of Yarn Test Values

Yarn	Count(Ne) (Actual)	Count Strength Product (CSP)	Twist per inch (TPI)	Hairiness (No. of fibers per 200m)	Uster Uneveness	No. of Fibers in Yarn Cross-Section
Modal(1/30)	29.78	2925.88	16.12 ‘s’	13.22	0.80	598.82
Bamboo(1/30)	30.14	2293.47	16.04 ‘s’	11.20	1.19	701.58
Viscose(1/30)	28.69	2203.23	15.50 ‘s’	30.17	2.17	749.41
Cotton(1/30)	29.98	2617.96	16.08 ‘s’	18.63	1.54	761.81
Cotton(2/50)	24.38	2751.55	25.37 ‘z’	9.71	1.19	914.18

Table 3 Mechanical Properties (Tensile Strength, Tearing Strength and Abrasion Resistance) of Grey and Scoured Fabric

Fabric Types	Tensile Strength (kg)				Tearing Strength (lbs)				Abrasion Resistance (cycles)
	Grey		Scoured		Grey		Scoured		
	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft	
Cotton-Modal	51.23	28.24	54.65	30.47	4.8	4.5	5.9	4.9	9045
Cotton-Bamboo	47.16	16.97	50.68	18.10	3.9	3.5	4.5	4.0	7925
Cotton-Viscose	40.18	16.12	43.19	17.10	3.6	3.2	4.2	3.6	4050
Cotton-Cotton	53.58	17.91	57.26	19.47	4.2	4.0	5.3	4.4	8200

Tensile Strength

Effect of fiber type on Tensile Strength of grey and scoured fabrics

Table 4 Tensile Strength of Grey and Scoured Fabrics

Fabric Types	Tensile Strength (kg)			
	Grey		Scoured	
	Warp	Weft	Warp	Weft
Cotton-Modal	51.23	28.24	54.65	30.47
Cotton-Bamboo	47.16	16.97	50.68	18.10
Cotton-Viscose	40.18	16.12	43.19	17.10
Cotton-Cotton	53.58	17.91	57.26	19.47

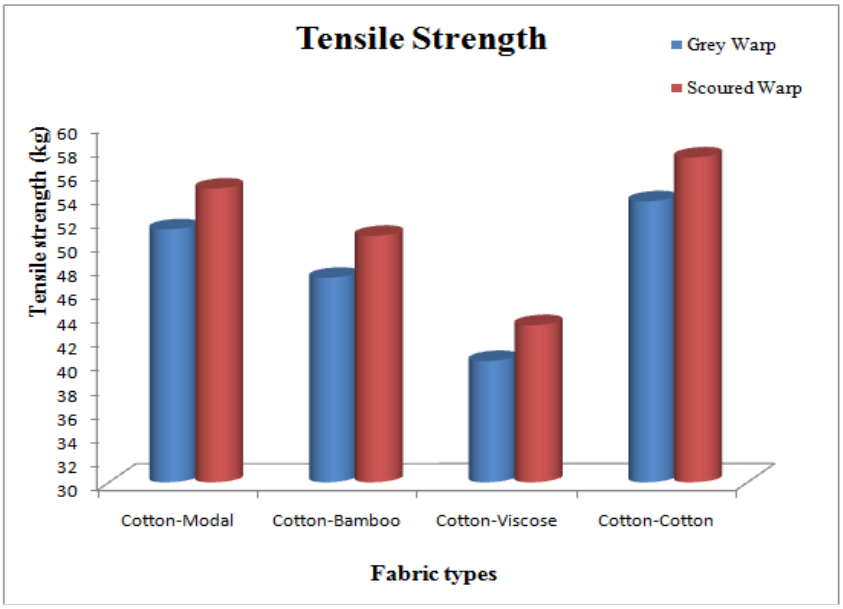

Figure 1: Tensile Strength (Warp Way) of Grey and Scoured Fabrics.

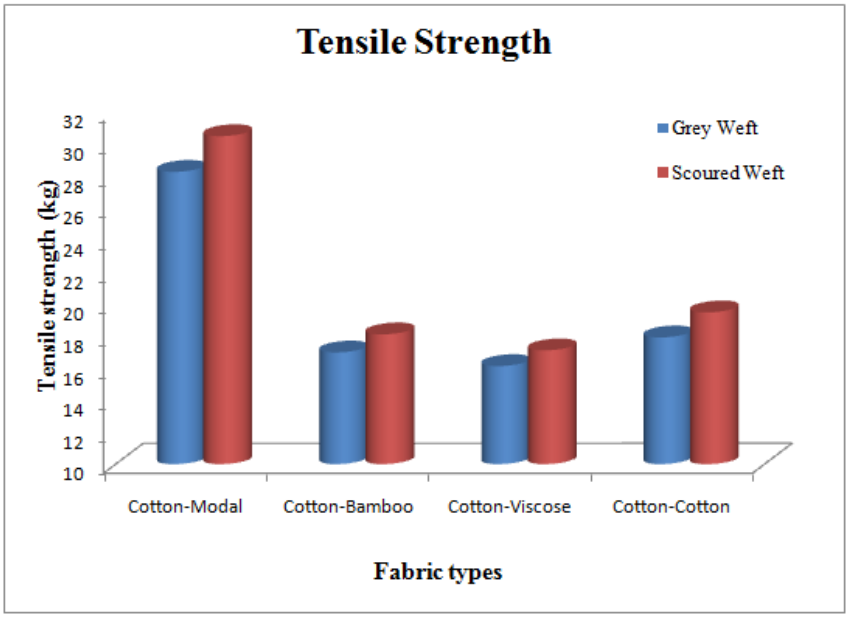

Figure 2: Tensile Strength (Weft Way) of Grey and Scoured Fabrics.

From the Table 4 and Fig.1, 2 it is found that Cotton-Modal exhibits the highest value of tensile strength in warp and weft way while Cotton-Viscose fabric shows lowest value of tensile strength in warp and weft way and the other two fabrics i.e. Cotton-Bamboo and Cotton-Cotton exhibit intermediate values of tensile strength in warp and weft way[3].

Tensile strength of fabric is mainly depends upon fabric construction parameters, fiber tenacity and yarn strength, as in the present study fabric construction particulars are same for all the four fabrics hence, the fabric tensile strength in all the fabrics depend on the fiber tenacity and yarn strength(64).

Increase in the fiber tenacity there will be a great increase in yarn strength and further increase in tensile strength of fabric. Modal fiber has highest fiber tenacity and yarn strengthvalue as compared with other three fibers i.e. Bamboo, Viscose and Cotton therefore Cotton-Modal fabric shows maximum tensile strength [4].

With the help of statistical analysis using sigma plot software it was found that the difference in the mean values of tensile strength are statistically significant (anova report can be seen from annexure A.1).

Tearing Strength

Effect of fiber type on Tearing Strength of grey and scoured fabrics

Table 5: Tearing Strength of Grey and Scoured Fabrics

Fabric Types	Tearing Strength (lbs)			
	Grey		Scoured	
	Warp	Weft	Warp	Weft
Cotton-Modal	4.8	4.5	5.9	4.9
Cotton-Bamboo	3.9	3.5	4.5	4.0
Cotton-Viscose	3.6	3.2	4.2	3.6
Cotton-Cotton	4.2	4.0	5.3	4.4

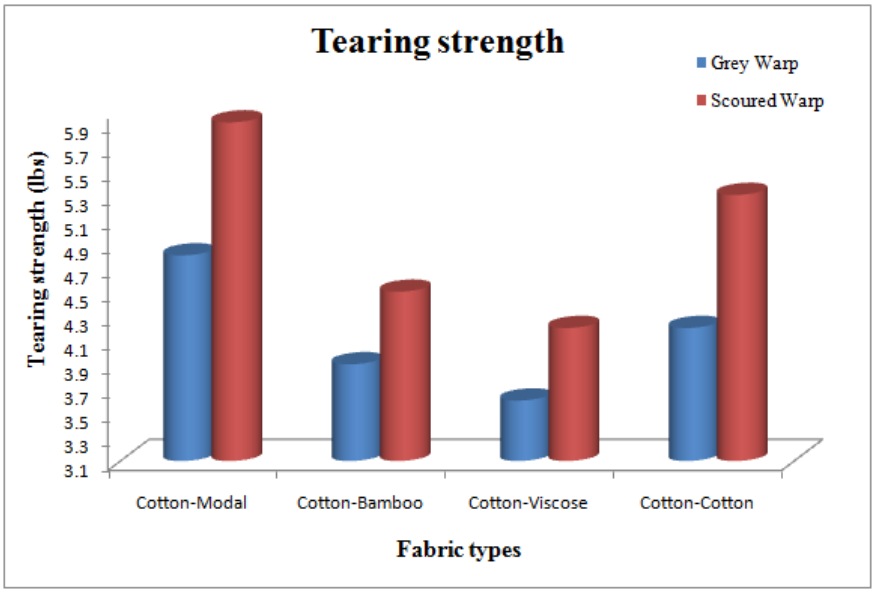

Figure 3: Tearing Strength (Warp Way) of Grey and Scoured Fabrics.

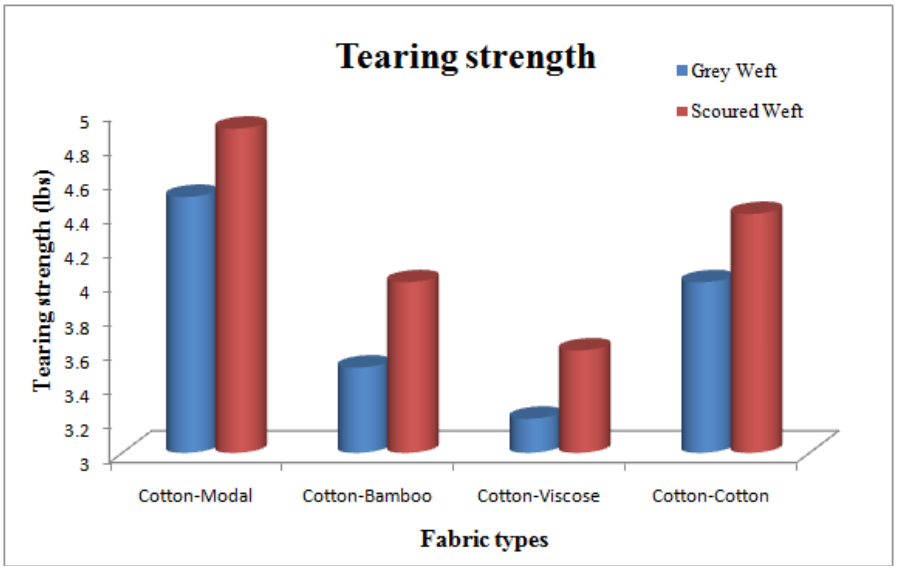

Figure 4: Tearing Strength (Weft Way) of Grey and Scoured Fabrics.

The results in Table 5 and Fig.3, 4 shows that Cotton-Modal fabric exhibits the highest value of tearing strength in warp and weft way whileCotton-Viscose fabric shows lowest value in warp and weft way and the other two fabrics i.e. Cotton-Bamboo and Cotton-Cotton exhibit medium value of tearing strength in warp and weft way[7].

Increase in the fiber tenacity, there will be a great increase in yarn strength and further increase in tearing strength of fabric. Modal fiber has highest fiber tenacity and yarn strength value as compared with other three fibers i.e. Bamboo, Viscose and Cotton which in turns increase in tearing strength therefore Cotton-Modal fabric shows great increase in tearing strength [8].

From the statistical analysis it was observed that there is a significant difference in tearing strength values of all the experimental fabrics (statistically significant one way anova report can be seen from annexure A.2).

Abrasion Resistance

Effect of fiber type on Abrasion Resistance of scoured fabrics

Table 6: Abrasion Resistance Values of Scoured Fabrics

Fabric Types	Abrasion Resistance(Cycles)
Cotton-Modal	9045
Cotton-Bamboo	7925
Cotton-Viscose	4050
Cotton-Cotton	8200

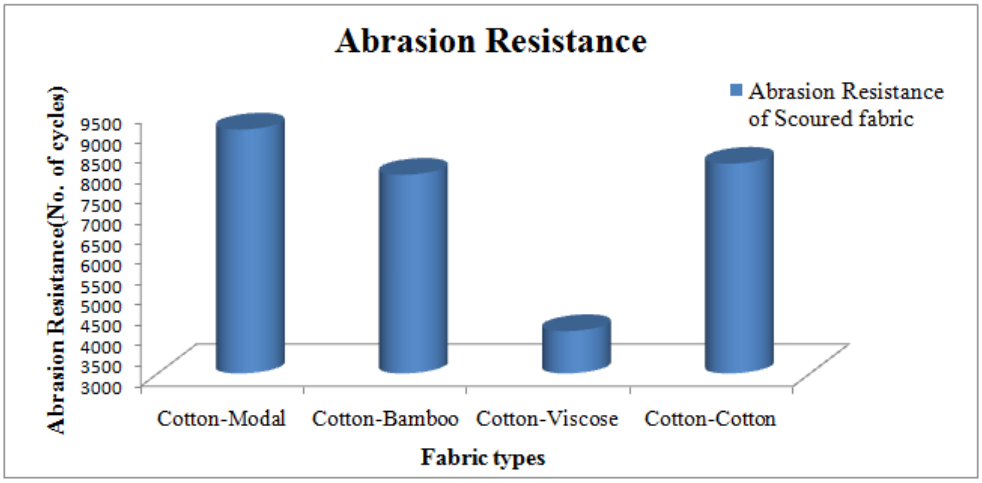

Figure 5: Abrasion Resistance of Scoured Fabrics.

As can be seen from Table 6 and Fig. 5 Cotton-Modal fabric exhibits the highest value of abrasion resistance while Cotton-Viscose fabric shows lowest value and the other two fabrics i.e. Cotton-Bamboo and Cotton-Cotton exhibits intermediate values.

Fibre tenacity and fibre length affect the abrasion resistance. With increase in the fibre tenacity and fibre length, greater will be the abrasion resistance. As modal fibre having maximum fibre tenacity and fibre length values hence, Cotton-Modal fabric exhibits better abrasion resistance [9].

Yarn cross-sectional shape also affects the abrasion, more uniform is the yarn cross-section and more will be the abrasion resistance of fabric. As modal yarn having more circular and uniform cross-sectional therefore Cotton-Modal fabric exhibits the highest value of abrasion resistance [10].

Statistically it was found that the difference in values of abrasion resistance of scoured fabrics were significant (anova report can be seen from annexure A.3).

CONCLUSIONS

Cotton-Modal fabric shows highest values of tearing strength, tensile strength and abrasion resistance followed by Cotton-Cotton and Cotton-Bamboo fabric respectively whereas Cotton-Viscose fabric shows lowest value of tearing strength, tensile strength and abrasion resistance.

Further studies can be made in the following areas

- Different weave combinations can be taken for optimizing the fiber and fabric properties.
- Varying linear density can be utilized to see the effectiveness of yarn count on physical, handle, comfort, aesthetic and mechanical properties.
- Different chemical finishes can be applied on the union fabrics made of Cotton-Modal, Cotton-Bamboo and Cotton-Viscose.
- Varieties of union fabrics can be developed by using different blend % of Modal, Bamboo and Viscose in warp and weft directions.

- Comparison can be made from fabrics developed using parent yarn as well as union fabrics.
- Design of experiments can be utilized for the optimization of variety of union fabrics.

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ANNEXURE A.1

One Way Anova Test Results of Tensile Strength

One Way Analysis of Variance

Data source: Data 1 in finished 2

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Equal Variance Test: Passed (P = 1.000)

Group Name	N	Missing	Mean	StdDev	SEM
C-M tesile	10	0	42.112	1.509	0.477
C-C tesile	10	0	38.072	1.498	0.474
C-B tesile	10	0	34.078	1.500	0.474
C-V tesile	10	0	30.028	1.492	0.472

Source of Variation	DF	SS	MS	F	P
Between Groups	3	809.876	269.959	120.006	<0.001
Residual	36	80.984	2.250		
Total	39	890.860			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):

Overall significance level = 0.05

Comparisons for Factor

Comparison	Diff of Means	t	P	P<0.050
C-M tesile vs. C-V tesile	12.084	18.016	<0.001	Yes
C-C tesile vs. C-V tesile	8.044	11.992	<0.001	Yes
C-M tesile vs. C-B tesile	8.034	11.978	<0.001	Yes
C-B tesile vs. C-V tesile	4.050	6.038	<0.001	Yes
C-M tesile vs. C-C tesile	4.040	6.023	<0.001	Yes
C-C tesile vs. C-B tesile	3.994	5.954	<0.001	Yes

ANNEXURE A.2

One way Anova test results of tearing strength

One Way Analysis of Variance

Data source: Data 1 in finished 2

Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Equal Variance Test: Passed (P = 1.000)

Group Name	N	Missing	Mean	StdDev	SEM
C-M tearing	10	0	5.400	0.149	0.0471
C-C tearing	10	0	4.800	0.149	0.0471
C-B tearing	10	0	4.300	0.149	0.0471
C-V tearing	10	0	3.700	0.149	0.0471

Source of Variation	DF	SS	MS	F	P
Between Groups	3	6.475	2.158	97.125	<0.001
Residual	36	0.800	0.0222		
Total	39	7.275			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):

Overall significance level = 0.05

Comparisons for Factor

Comparison	Diff of Means	t	P	P<0.050
C-C tearing vs. C-V tearing	1.100	16.500	<0.001	Yes
C-M tearing vs. C-V tearing	0.800	12.000	<0.001	Yes
C-B tearing vs. C-V tearing	0.600	9.000	<0.001	Yes
C-C tearing vs. C-B tearing	0.500	7.500	<0.001	Yes
C-C tearing vs. C-M tearing	0.300	4.500	<0.001	Yes
C-M tearing vs. C-B tearing	0.200	3.000	0.005	Yes

ANNEXURE A.3

One way Anova test results of abrasion resistances

One Way Analysis of Variance

Data source: Data 1 in Notebook2

Normality Test (Shapiro-Wilk) Passed (P = 0.671)

Equal Variance Test: Passed (P = 0.123)

Group Name	N	Missing	Mean	StdDev	SEM
C-M abrasion	10	0	9045.000	38.152	12.065
C-C abrasion	10	0	8200.000	78.031	24.676
C-B abrasion	10	0	7925.000	65.617	20.750
C-V abrasion	10	0	4050.000	40.069	12.671

Source of Variation	DF	SS	MS	F	P
Between Groups	3	148080500.000	49360166.667	14673.543	<0.001
Residual	36	121100.000	3363.889		
Total	39	148201600.000			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):

Overall significance level = 0.05

Comparisons for Factor

Comparison	Diff of Means	t	P	P<0.050
C-M abrasion vs. C-V abrasion	4995.000	192.575	<0.001	Yes
C-C abrasion vs. C-V abrasion	4150.000	159.997	<0.001	Yes
C-B abrasion vs. C-V abrasion	3875.000	149.395	<0.001	Yes
C-M abrasion vs. C-B abrasion	1120.000	43.180	<0.001	Yes
C-M abrasion vs. C-C abrasion	845.000	32.578	<0.001	Yes
C-C abrasion vs. C-B abrasion	275.000	10.602	<0.001	Yes