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COMPARATIVE STUDY OF AESTHETIC PROPERTIES OF UNION WOVEN FABRICS MADE UP OF 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 aesthetic appealing properties like pilling Resistance, color fastness to wash and drape coefficient 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 and to provide substitute of cotton with use of cotton, bamboo, viscose and Modal. After the completion of research modal was found the best fabric out of four in terms of pilling resistance and drape co-efficient properties.

Index Terms - Cotton, Viscose, Bamboo, Modal, Warp, Weft, Pilling, Fiber Length, Hairiness, Resilience, Drape Coefficient, Bending Length and Color Fastness etc.

I. INTRODUCTION

Pills appear on fabric when groups of short or broken fibers on the surface of the fabric become tangled together in a tiny knot or ball, a pill. The pills form due to rubbing or abrasion during normal wear and use [(1)]. The pills are usually found on the areas of clothing or linens that receive the most abrasion in day-to-day use, such as center of bed sheets, under the arms of clothes, around the collar and cuffs of a shirt, and between the thighs and on the rear of pants; but can happen anywhere on fabric [(2)]. While it is difficult to predict which fabrics will pill, there are some types of fabrics and fibers that are more prone to pilling. Knitted fabrics tend to pill more than woven fabrics because the threads are looser. Fabrics made of long fibers like silk and linen pill less than wool, cotton, polyester, and other synthetic threads. When fibers are mixed in a fabric like a cotton/polyester blend, one fiber is usually much stronger than the other [(3)]. The weaker fiber will break, knot

around to the stronger fiber, and a pill is formed. There are many causes of pilling, but the main ones are fabric content and rubbing [4]. General wear can cause pilling, as the fabric rubs against itself, and activities like running or walking long distances can make pilling even more likely. Laundering certain fabrics can also cause pilling, given the rubbing that occurs during washing, especially if the machine is overloaded. Suggestion—washing your clothes inside out can help protect their surfaces [5]. In addition to choosing 100% natural fibers, like cotton, bamboo, viscose and Modal you can help prevent or delay pilling.

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

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 1 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 2 Specifications of fibers Used

Property	Cotton	Viscose	Bamboo	Modal
Fiber Length (mm)	38	35.5	40	38.5
Fiber fineness (micronire)	4.3	4.23	3.96	3.38
Cross-sectional Shape	Kidney bean	Serrated	Round	Circular
Specific gravity	1.54gm/cm^3	1.52 gm/cm^3	1.50gm/cm^3	1.51gm/cm^3
Dry Tenacity	20-43 cN/tex	18-26 cN/tex	22-25cN/tex	24-36 cN/tex
Wet Tenacity	27-58 cN/tex	9-15 cN/tex	13-17cN/tex	12-24 cN/tex
Degree of polymerization	9000-15000	300-450	700-800	450-750
Moisture Regain (%)	7-8.5%	10-14%	13	13
Elongation at break (%)	6-10%	15-25%	14-24	13-25
Fiber tenacity	24	26	32	36

Yarn	Warp(Double)	Weft(Single)			
	Cotton-100%	Cotton-100%	Viscose-100%	Bamboo-100%	Modal-100%
Count(Nominal)	2/50s Ne ~25s Ne	1/30 s Ne	1/30s Ne	1/30s Ne	1/30s Ne
Count(Actual)	2/48.76 ~24.38s Ne	29.98s Ne	28.69s Ne	30.14s Ne	29.78s Ne
Twist per inch	25.37‘S’ twist	16.08‘Z’twist	15.50‘Z’ twist	16.04‘Z’ twist	16.12‘Z’twist

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 4 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

Table 5 Aesthetic properties (Drape coefficient, Pilling Resistance and Color Fastness to washing) of grey and scoured fabric

Fabric types	Drape coefficient		Pilling Resistance (grades)	Color Fastness to washing	
	Grey	Scoured	Scoured	Color Change	Color Staining
Cotton-Modal	0.43	0.40	4	2	2-3
Cotton-Bamboo	0.44	0.42	4	2	2-3
Cotton-Viscose	0.48	0.46	2	2	2-3
Cotton-Cotton	0.58	0.54	3	2	2-3

Aesthetic Properties

Pilling Resistance

Effect of fiber type on Pilling Resistance of grey and scoured fabrics

Table 6 Pilling Resistance values of scoured fabrics

Fabric types	Pilling Resistance(grade)
Cotton-Modal	4
Cotton-Bamboo	4
Cotton-Viscose	2
Cotton-Cotton	3

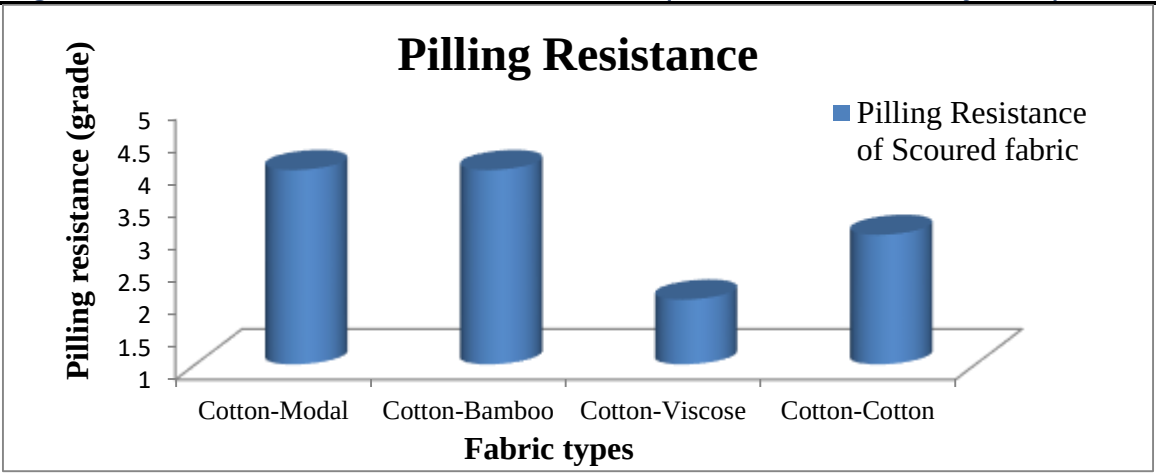

Fig.1 Pilling Resistance values of scoured fabrics

Table 6 and Fig.1 show, that Cotton-Modal and Cotton-Bamboo fabric exhibit the lowest value of pilling while Cotton-Viscose fabric shows highest value of pilling and the Cotton-Cotton fabric exhibits medium value of pilling. Behaviour of Cotton-Modal, Cotton-Bamboo, Cotton-Cotton and Cotton-Viscose fabrics related to pilling can be explained on the basis of yarn hairiness and fibre length. More the yarn hairiness more will be the pilling and less is the pilling resistance [(6)]. Viscose yarn has highest number of protruding hairs on yarn surface while modal yarn has lowest number of protruding hairs on yarn surface that is why Cotton-Viscose fabric shows highest value of pilling and Cotton-Modal fabric exhibits the lowest value of pilling respectively [(7)].The Pilling resistance property of fabric also affected by fibre length, shorter the fibre length more will be the pilling in the fabric or vice-versa. Pilling Resistance property of fabric decreased with the increase in the fiber length, as viscose fiber length shortest as compared with other three fibers hence, Cotton-Viscose fabric shows highest value of pilling [(8)].By using the one way ANOVA method on sigma plot software it was proved that the difference observed in the scoured fabrics is statistically significant (ANOVA report can be seen from annexure A.1).

Drape Coefficient

Effect of fiber type on Drape Coefficient of grey and scoured fabrics

Table 7 Drape Coefficient of grey and scoured fabrics

Fabric types	Drape Coefficient	
	Grey fabrics	Scoured fabrics
Cotton-Modal	0.43	0.40
Cotton-Bamboo	0.44	0.42
Cotton-Viscose	0.48	0.46
Cotton-Cotton	0.58	0.54

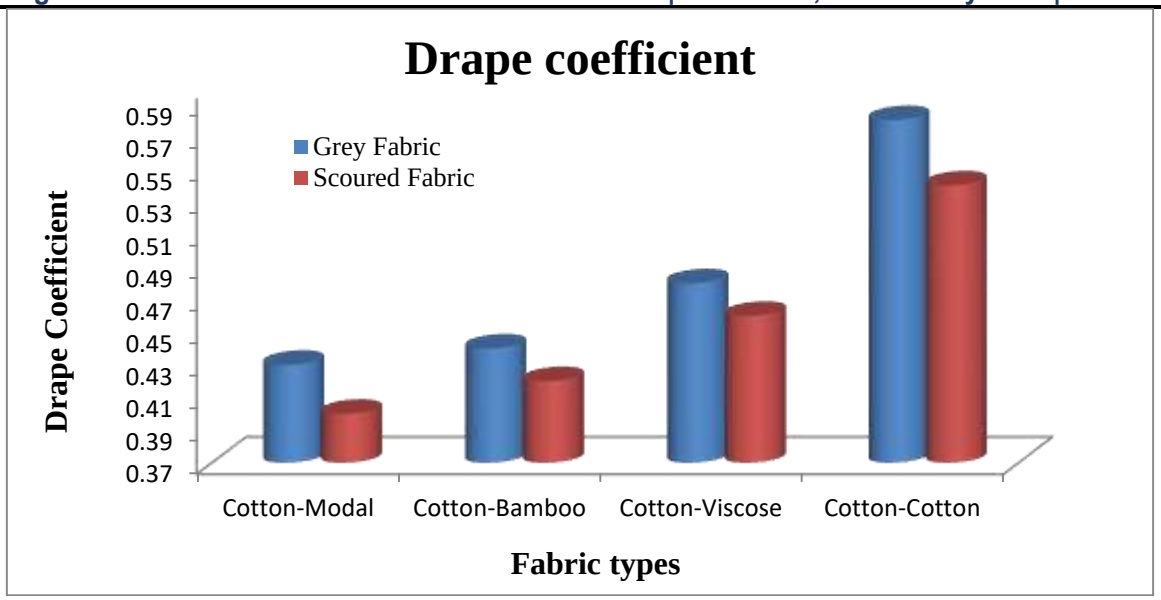

Fig.2 Drape Coefficient of grey and scoured fabrics

From the Table 7 and Fig. 2 can be seen that Cotton-Modal fabric exhibits the lowest value of drape coefficient while Cotton-Cotton fabric shows highest value and Cotton-Bamboo and Cotton-Viscose exhibit the drape coefficient values in between that of Cotton-Modal and Cotton-Cotton fabric.The fiber resilience value affects the drape coefficient; less the fiber resilience less the drape coefficient.Modal fiber has lowest fiber resilience value as compared to other three fibers i.e. Cotton, Bamboo and Viscose that is why Cotton-Modal fabric shows lowest drape coefficient [(9)]. Drapes coefficient is directly proportional to bending length hence, more the bending length more the drape coefficient or vice-versa.Cotton- Cotton fabric has the highest bending length and Cotton-Modal fabric shows the lowest bending length, hence, drape coefficient value for Cotton-Cotton fabric is showing highest and for Cotton-Modal fabric is showing lowest out of four experimental fabrics[(10.11)]. Drape coefficient values were found to be statistically significant (statistically significant one way ANOVA report can be seen from annexure A.2).

CONCLUSION

- Pilling of Cotton-Viscose is found to be worst followed by Cotton-Cotton fabrics respectively whereas Cotton-Bamboo and Cotton-Modal fabric is showing the best result of pilling resistance
- Drape coefficient of Cotton-Cotton fabric is showing maximum values followed by Cotton-Viscose and Cotton-Bamboo fabrics respectively whereas Cotton-Modal fabric is showing the minimum values of drape coefficient.

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.

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Annexure A.1

One way anova test results of pilling 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 pilling	10	0	9045.000	38.152	12.065
C-C pilling	10	0	8200.000	78.031	24.676
C-B pilling	10	0	7925.000	65.617	20.750
C-V pilling	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 pilling vs. C-V pilling	4995.000	192.575	<0.001	Yes
C-C pilling vs. C-V pilling	4150.000	159.997	<0.001	Yes
C-B pilling vs. C-V pilling	3875.000	149.395	<0.001	Yes
C-M pilling vs. C-B pilling	1120.000	43.180	<0.001	Yes
C-M pilling vs. C-C pilling	845.000	32.578	<0.001	Yes
C-C pilling vs. C-B pilling	275.000	10.602	<0.001	Yes

Annexure A.2

One way anova test results of drape coefficient

One Way Analysis of Variance
Data source: Data 1 in Notebook2

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

Equal Variance Test: Passed (P = 0.818)

Group Name	N	Missing	Mean	StdDev	SEM
C-M drape	10	0	0.400	0.0115	0.00365
C-C drape	10	0	0.540	0.0176	0.00558
C-B drape	10	0	0.420	0.0176	0.00558
C-V drape	10	0	0.460	0.0176	0.00558

Source of Variation	DF	SS	MS	F	P
Between Groups	3	0.115	0.0383	143.750	<0.001

Residual	36	0.00960	0.000267
Total	39	0.125	

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 drape vs. C-M drape	0.140	19.170	<0.001	Yes
C-C drape vs. C-B drape	0.120	16.432	<0.001	Yes
C-C drape vs. C-V drape	0.0800	10.954	<0.001	Yes
C-V drape vs. C-M drape	0.0600	8.216	<0.001	Yes
C-V drape vs. C-B drape	0.0400	5.477	<0.001	Yes
C-B drape vs. C-M drape	0.0200	2.739	0.010	Yes