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Study on Properties of Sisal-Cotton Union Fabrics Developed in Handloom and Power-Loom for Textile Application

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Abstract: ***Present study was done to explore the properties of sisal-cotton union fabrics developed in handloom and power loom. Cotton yarn of 2/20 used as warp and sisal-cotton blended yarn of 12s count used as weft. Ratio for blended yarn (sisal:cotton) was taken as 35:65. Union fabrics were developed in three weaves i.e., plain, basket and twill and analysed for their physical and mechanical properties. The developed union fabric samples were shown to a panel of ten judges consisting of industrial person, interior designer and the professional from Apparel and Textile Department and Family Resource and Management department and preferences were taken for smoothness, softness, surface texture, uniformity, aesthetic appearance and tactile sensation. On the bases of these properties preferences were taken for product development. Handloom twill weave found to be best for its smoothness and handloom plain weave for tactile sensation. So, it can be used in upholstery, home textiles and in some parts of garments using lining.***

Keywords: Union Fabrics, Professional, Blended

I. INTRODUCTION

Agave americana, widely known as sisal, is a species of agave that produces a stiff fibre that is used to make a variety of products. Sisal fibre is a natural fibre. The first sisal fibre exports from Brazil happened in 1948, after the country launched its first commercial sisal plantings in the late 1930s. With 1, 30,000 tonnes of annual production, Brazil is presently the world's top producer of sisal fibre. Sisal plants have a rosette of 1.5–2 m tall sword-shaped leaves. Young leaves may have a few tiny teeth along their borders, but as they mature, they become loose. Sisal is generally propagated via suckers that grow around the base of the plant and are grown in nursery fields until they become big enough to be moved to their final location, or by bulbils that are formed from buds in the flower stalk.

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The sisal plant has a lifespan of 7 to 10 years and normally yields 200 to 250 leaves that are suitable for commercial use. On average, there are about 1,000 fibers per leaf. Only around 4% of the plant's weight is mainly composed of fibres. Sisal is characterized as a tropical and subtropical plant since it grows best in warm, sunny environments with temperatures above 25°C. In a technique called decortication, leaves are crushed and beaten by a rotating wheel equipped with blunt knives until only fibres are left. Due to its strength, toughness, durability, affinity for some dyes, and tolerance to degradation in saline water, sisal has traditionally been the most popular material for agricultural twine. Sisal fibre will be useful in the growing market for eco-friendly materials. However, as it is a harsh fibre, blending it with other fibres is necessary to provide the final fabric with more enhanced qualities like comfort, flexibility, drapability, etc. Cotton fibre and yarn were employed for blending in order to achieve these improved qualities (Vyshnavi and Nair 2017) [3]. Handlooms, a traditional textile in India, have steadily lost appeal with the arrival of affordable, eye-catching synthetic materials. However, it is restoring its own identity because of the "Make in India" program and the fact that the planning commission has granted it a respectable place in the economy among other important sectors. Different types of yarns are used in both the warp and weft directions of the fabric to create union textiles. Union fabric exhibits excellent strength, enhanced crease-resistance, greater moisture absorption, a high luster, and other desirable qualities. In order to lower the expensive price of textiles as well as the weight of the fabric, a variety of union fabrics may be made by combining several types of yarns, such as silk with cotton, ramie, rayon, polyester, acrylic, etc (Nayak et al 2009) [2]. In the present study, sisal/cotton union fabric was developed by using cotton yarn in the warp and sisal/cotton blended yarn in the weft direction on a power loom as well as a handloom.

II. MATERIALS AND METHODS

Sisal fibre, cotton fibre and cotton yarn were used in this study. Sisal fibres were procured from Girish Grah Udhyog Kotdwar. The cotton fibres were procured from CIRCOT, Mumbai, and cotton yarns were purchased from Ludhiana Choura Bazar. Spinning of blended yarns were done at ICAR-Central Institute for Research on Cotton Technology (CIRCOT), Mumbai. Weaving of union fabrics was done to create different textures in three different weaves i.e., plain weave, basket weave and twill weave on a power-loom as well as handloom.

Powerloom weaving was done at the Synthetic & Art Silk Mills Research Association (SASMIRA) weaving centre, Bhiwandi, Maharashtra. The handloom weaving was done at Naresh Handloom, VPO Jeevanpur, Rahon Road, Ludhiana Punjab. Two ply cotton yarn of 2/20 count was used as warp and single ply Sisal/Cotton blended yarn of 12s count was used as weft in both looms.

The two-ply cotton warp was used to provide dimensional stability to union fabrics. The fabric count for all the power loom plain weave fabric (PP) was 40×36, power loom basket weave fabric (PB) was 40 × 54 and power loom twill weave (PT) was 40 × 54 whereas, fabric count for handloom plain(41×34), basket (63×43) and twill weaves (42×36) were different .

Table 1. Constructional Details of Power-Loom and Handloom Developed Union Fabrics

S. No.	Union fabric	Code	Direction	Fibre content	Weave type	Ratio of weft yarn
1	Cotton(2/20)× Sisal/cotton(12s)	PP	Warp	Cotton	Plain weave	35:65
			Weft	Sisal/Cotton		
2	Cotton(2/20)× Sisal/cotton(12s)	HP	Warp	Cotton	Plain weave	35:65
			Weft	Sisal/Cotton		
3	Cotton(2/20)× Sisal/cotton(12s)	PB	Warp	Cotton	Basket weave	35:65
			Weft	Sisal/Cotton		
4	Cotton(2/20)× Sisal/cotton(12s)	HB	Warp	Cotton	Basket weave	35:65
			Weft	Sisal/Cotton		
5	Cotton(2/20)× Sisal/cotton(12s)	PT	Warp	Cotton	Twill weave	35:65
			Weft	Sisal/Cotton		
6	Cotton(2/20)× Sisal/cotton(12s)	HT	Warp	Cotton	Twill weave	35:65
			Weft	Sisal/Cotton		

*PP= Power loom plain weave, HP= Handloom plain weave, PB= Power loom basket weave, HB= Power loom Basket weave, PT= Power loom twill weave, HT= Handloom twill weave

III. RESULTS AND DISCUSSION

Comparison of Physio-mechanical properties of power-loom and handloom union fabrics

The union fabrics woven in power loom with sisal cotton blended yarn count of 8s and 12s were woven in plain, basket and twill weave and for handloom fabric 12s yarn count was chosen for weaving. The comparison of union fabrics woven in power loom and handloom using 12s yarn count has been furnished in table 2.

Weight per unit area (GSM)

It was found that union fabrics developed by power loom and handloom in basket weave had maximum fabric weight i.e., 241.3g/m^2 and 259g/m^2 respectively. This was followed by twill weave and plain weave union fabrics in both power loom and handloom with fabric weight of 239.8g/m^2, 174.6g/m^2, 209.9g/m^2 and 172.7 g/m^2 respectively. This means basket weave in both union fabric gave thicker fabric which can be used for making apparel and household products where more thickness is required.

Elongation at break

Percentage elongation at break in handloom basket weave union fabric was more (30.47±1.06) in warp as compared to power loom fabric(15±0.7) whereas in case of twill weave power loom fabric it was more (21.55 ±1.76) as compared to handloom fabric in twill weave where it was 17.65 ±1.13 respectively. In weft direction it was higher in basket weave both in power loom and handloom union fabrics which shows more strength of weft in basket weave fabrics.

Breaking strength

Fabric breaking strength is also called tensile strength which refers to as the maximum tensile force when sample is stretched to break. It is one of the main standards to assess the intrinsic quality of textiles. Data in table 2 revealed that power loom union fabric in twill weave has maximum breaking strength of 552kg/cm^2 in warp and 372 kg/cm^2 in weft direction. Whereas in case of handloom union fabric in basket weave it was found as 340 g/cm^2 in weft.

Stiffness

Stiffness of material refers to the material ability to resist external forces and still return to its original form. Fabric stiffness and handling is important deciding factor for the end use application. Data in table 2 elucidate that power loom fabric in all the weaves is more thick means having more stiffness in both warp and weft direction as compared to the handloom union fabrics in all the weaves. Power loom fabrics were not suitable for apparel applications because of higher stiffness.

Thickness

Fabric thickness measurement is generally carried out by measuring the distance using thickness tester. It is measured in mm. Results in table 2 shows that power loom union fabric in twill weave is thicker as compared to basket and plain weave. In case of handloom union fabrics, basket weave has more thickness(1.216mm) followed by twill and plain weave. Plain weave in both the loom was having minimum thickness which means it will have less bending length and more comfortable for apparel applications.

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Table 2 Comparison of physio-mechanical properties of handloom and power-loom union fabric

Fabric / Test parameters	Power loom Union fabric (35/65)			Handloom Union fabric (35/65)		
	PP	**PB**	**PT**	**HP**	**HB**	**HT**
PI/PPI	40/36	40/54	40/54	41/34	63/43	42/36
Fabric weight GSM (g/m^2)	209.9±2.55	241.3±6.5	239.8±0.4	172.7± 0.026	259± 0.064	174.6± 0.056
Breaking strength (N)						
Warp	441.5 ± 29.5	263 ± 2.0	552 ± 24.5	441.33 ± 38.02	538± 43.03	498± 7.0
Weft	329.5 ± 40.31	263 ± 2.83	372 ±23.33	240.67± 10.07	340± 4	265.67± 5.13
Elongation at break (%)						
Warp	30.35 ± 5.02	15.1 ± 0.70	21.55 ± 1.76	30.47± 1.06	26.83± 2.3	17.63± 1.95
Weft	19.1 ± 0.424	35.25 ± 2.05	18.35±6.57	16.47± 1.33	31.43± 1.15	7.6± 0.85
Stiffness						
Warp	3.3±0.6	4.3± 0.67	3.97± 0.56	1.97±0.18	3.55± 0.54	2.55± 0.17
Weft	4.1± 0.56	4.8± 0.45	4.5± 0.8	2.5± 1.33	4.65± 1.15	2.85± 0.85
Fabric thickness (mm)	0.514±0.052	0.740± 0.026	0.896± 0.029	0.802±0.03	1.216± 0.02	0.81± 0.055

*All the values are presented as mean±SD,
PP= Power-loom plain weave fabric
PB= Power-loom Basket weave fabric
PT=Power-loom Twill weave fabric
HP= Handloom plain weave fabric
HB= Handloom Basket weave fabric
HT=Handloom Twillweave fabric

3.2 Subjective evaluation of developed union fabrics

The developed fabrics were analysed for hand values by evaluating through various parameters as shown in table 3. The fabrics were evaluated by panel of 10 judges. Data furnished in table 3 presented the ranking given by judged for acceptability of union fabrics pertaining to texture, lustre, tactile sensation and aesthetic appearance.

Table 3 Subjective Evaluation of Developed Union Fabrics (n=10)

Fabric / Parameters	Developed union fabrics					
	HP	HB	HT	PP	PB	PT
	Median	**Median**	**Median**	**Median**	**Median**	**Median**
Smoothness	3.5	3.1	3.9	2.2	2.4	2.6
Softness	3.1	3.8	4.2	1.4	3	2.0
Surface texture	2.4	3.5	4.0	2.9	3.6	4.0
Uniformity	4.1	3.5	4.1	3.5	4.1	4.5
Aesthetic appearance	4	4	4	4	4	4
Tactile sensation	**3.9**	3.5	3.3	2	2	2

*HP= Handloom plain weave fabric, HB= Handloom Basket weave fabric, HT=Handloom Twill weave fabric, PP= Power-loom plain weave fabric, PB= Power- loom Basket weave fabric PT=Power-loom Twill weave fabric

The Power-loom fabrics (PP, PB and PT) have fair tactile sensation as compared to handloom fabrics (HP, HB and HT). In terms of smoothness, softness and surface texture, the handloom twill weave fabric (HT) was preferred by most of the judges and softness of power-loom plain weave fabrics were very poor as compared to other five fabrics. The fabrics (HP, HT and PB) were found to be very good in terms of uniformity. It was found that most of the judges preferred fabric PT as compared to other fabrics (HP, HB, HT, PP, PB) in terms of uniformity. All the fabrics were preferred by the judges in terms of aesthetic appearance. Panellists suggested potential end uses for the developed fabrics, the majority of respondents perceived the fabrics as being suitable for cushion cover, dining table mat, Nehru jacket, shopping bag, straight skirt and table runner.

IV. CONCLUSION

The research project Study on properties of sisal-cotton union fabrics developed in Handloom and Power-loom for textile application was carried out to address the coming natural fibre shortage and to take advantage sisal fiber's distinctive characteristics. Although both fabrics samples had good appearance and shine, it was discovered that power loom fabrics were stiff and harsh. Thus, it was determined that they can be utilized for upholstery materials and in several garment using linings. (Agrawal, 2007) [1]. Handloom fabrics were having good hand and comfort properties so it can be used for apparel in outerwear fabrics and home textiles. Handloom fabrics were found to be more soft as compared to power loom fabric because power loom fabrics were having more compact structure as compared to handloom.

DECALARION

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Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
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Authors Contributions	All authors have equal participation in this article.

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