Indian Journal of Ecology (2023) 50(4): 1199-1203
DOI: https://doi.org/10.55362/IJE/2023/4037

Manuscript Number: 4037
NAAS Rating: 5.79

Development of Handloom Union Fabric from Ecofriendly Sisal Fibre and Characterization

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***Abstract*:** Sisal, an environmentally friendly fibre, is one of the most commonly used natural fibre because it is cheaper, poses no health hazards, and provides a solution to environmental pollution. The present study investigates the development of eco-friendly handloom union fabric developed from sisal/cotton blended yarns and the effect of weave structure on the physio-mechanical properties of sisal/cotton union fabrics. Three different weaves, viz., plain, basket, and horizontal zig-zag twill, were prepared in handloom by using the 2/20 count cotton yarn as warp and the 12s count sisal/cotton (35/65) blended yarn as weft. The results inferred that handloom fabrics are more eco-friendly than power loom fabrics. Among all the three weaves the mechanical properties of the basket weave were found to be superior as compared to the plain weave and basket weaves. Basketweave had maximum bending length in the weft direction, which means it is stiffer than the other two weaves.

***Keywords*:** Physio-mechanical, Union fabrics, Ecofriendly and horizontal zig-zag twill

Sisal fiber is one of the most widely used natural fibers and is very easy to grow. It has rapid renewal cycles and grows unchecked in the field and railroad track hedges. It occupies the 6th place among plant fibres, which represent 2% of the world's production of plant fibres (Nayak et al 2011). In India estimated area of sisal cultivation is about 50 thousand hectares, as compared to 352 lakh hectares in world area of cultivation (Basu et al 2012). It was introduced in India during the 15th century by the Portuguese. Indian species of Agave/rambansare *A. mexicana, A. veracruz, A.cantala, A. sisalana* and *A.americana*. In India, sisal is grown primarily in Andhra Pradesh, Bihar, Orissa, Karnataka, Maharashtra, Chhattisgarh, Uttrakhand and West Bengal (Shroff and Karolia 2015). Sisal fibers are cheaper, pose no health hazards, and also provide a solution to environmental pollution (Zwane et al. 2019). These versatile plants can survive in various climatic regions that include semi-arid, arid and humid regions, and all types of soil with minimal cost of cultivation.

Sisal plantation is carried out for utilizing the soil which is neither good for agriculture nor tree plantation as it does not produce any pesticide load to the environment. It is not infested by disease and insect pest; and therefore, it helps in reducing soil erosion through its extensive root system and contributes positively to watershed management. It has several distinguishing characteristics which makes sisal a 'specialty crop' for conservation agriculture (Sarkar and Jha 2017). Unlike other fibres, sisal is not a seasonal crop. It is drought resistant and can grow in a variety of soils. Currently sisal is found on embankments, bunds and roadsides, serving the purpose of soil conservation and protection as hedge plantation (Alapati and Shaik 2017).The most elegant and dignified fabric is woven fabric, which is the most adaptable due to the way it is composed of yarns in the shape of thick or thin sheets. It is possible to create a variety of designs, including plain, twill, basket weaves and variations like herringbone, diamond, horizontal zig-zag twill etc., due to the variation in interlacement. The physio-comfort characteristics of woven materials are somewhat impacted by these weave differences (Baruah et.al 2022). 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, 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, sisal acrylic (Nayak et al 2009). Sisal has historically been the most used material for agricultural twine due to its strength, longevity, and versatility, stretchability, a fondness for specific dye substances, and saltwater resistance. Sisal fibre will be useful in the growing market for eco-friendly textiles. However, because it is a harsh fibre, blending it with other fibres is necessary to provide the finished fabric more increased qualities like comfort, flexibility, drapability (Agrawal et al 2018). Cotton fibre was used for blending in order to fulfil these increased qualities. The handloom sector benefits from flexibility in small production volumes, innovation-friendliness, minimal investment, labour-intensive production, and market-requirement adaptability. Despite these benefits, the mechanisation, modernization, and sophistication of the textile industry have made the handloom sector a sunset industry. With the exception of India, Sri Lanka, Bangladesh, Thailand, and Cambodia, handloom textiles have lost their appeal and market over the past century.

MATERIAL AND METHODS

Location: The study was conducted in the department of Apparel and textile Science, PAU, Ludhiana and the handloom weaving was done at Naresh Handloom, VPO Jeevanpur, Rahon Road, Ludhiana Punjab.

Procurement of raw material: The sisal fibre used for the present study was procured from Girish Grah Udhyog Kotdwar, Uttrakhand and cotton fibre and yarns were procured from the Synthetic & Art Silk Mills' Research Association (SASMIRA) Mumbai. Blended yarn of sisal/ cotton 35/65 ratio in 12s count was developed in ring spinning system at Central Institute for Research on Cotton Technology (CIRCOT), Mumbai.

Determination of fabric properties: Developed fabrics were studied for physical and mechanical properties to analyze their suitability for product development. The physical properties studied were fabric weight, fabric count and fabric thickness. The mechanical properties studied were tensile strength and bending length.

GSM (IS: 1964: 1970): The fabric's GSM is determined as the sample's weight in one g/m² of length. To maintain moisture equilibrium, the samples were conditioned at standard atmospheric conditions for 24 hours before being weighed. The specimen's GSM value was derived using the testing method IS: 1964:1970. The fabric sample were spread out on a flat surface, and using a template, square swatches of 25x25 cm were marked. Swatches were then cut and condition. As per Nadiger and Subramanium (2001), the reliability of the weight of the standard swatches was considered to be 0.5 g accurate. The GSM of the fabric was determined.

25cm × 25cm- "a' gram, GSM= 16 x "a' grams/meter square

Fabric Count (Numerical expression): When the fabric was completely free of wrinkles, the number of ends (warp) and picks (weft) per unit area were used to describe the fabric count in woven fabrics. The fabric sample's count was determined using a pick glass using BS Method 2862:1957. With the use of a magnifying counting device, the warp and weft yarn present in a square inch of fabric were counted randomly at various places along the length and width of the fabric sample. The average end and pick values per inch were then calculated.

Fabric thickness (IS: 7702-1985): The thickness of a textile fabric is determined by a precise measurement of the distance between two plane parallel plates when these are separated by the cloth, a known arbitrary pressure between the plates being applied and maintained. One of the plates was considered as pressure foot and the other as the anvil. The principle of the measurement of the fabric thickness is expressed in test method IS: 7702- 1985. The measurement was made at five different portions of the fabric. The thickness was calculated by taking the mean of the five measurements.

Tensile Strength (IS -1969 -1985): Tensile strength is the fabric's ability to withstand a force load which is usually represented in kilogram's or pounds. The tensile property of the fabric was recorded through computer using *Universal Strength Tester' according to IS test method 1969-1985. Samples of the size 325x60 mm were cut from warp and weft direction of the fabrics. The experiment was conducted under standard atmospheric conditions of 65±2 percent relative humidity (RH) and temperature of 27±2°C. The breaking strength of the test specimen was determined using the machine's indicators. The tensile property of all samples was thus determined in this manner.

Bending length (ASTM – D1388-64): The stiffness tester was used to determine the bending height of fabric. Cantilever test method was used in which the fabric specimen is allowed to bend under its own weight as the length, of the overhanging portion of the specimen, is gradually increased. The free length which bends under its own weight sufficiently to make its leading edge intersect a plane of 41.5degree inclination is taken as the measure of stiffness of the fabric. The fabric specimen was cut with the help of acrylic specimen preparing template (150 x 25 mm). Transferred the specimen on to the platform of the instrument. Note the reading on the scale confirming to the reference mark on the platform which was the bending length of the fabrics in cms. Similarly test at least five test specimens each for warp way and weft way.

Constructional details of developed handloom union fabrics: Three weaves were constructed in handloom i.e., HP= Handloom plain weave fabric, HB= Handloom Basket weave fabric and HT=Handloom Twill weave fabric using single ply sisal/cotton(35/65) blended yarn of 12s count in weft and cotton yarn of 2/20 count in warp direction. Thread counts in plain weave were 41 as ends per inch (EPI) and 34 as picks per inch(PPI), basket weave (EPI=63, PPI 43) and in twill weave, (EPI=42, PPI=36) in handloom prepared samples (Sample HP, HT and HT) are shown in Table 2.

RESULTS AND DISCUSSION

Analysis of physio-mechanical properties of handloom union fabrics: Physical properties of union fabrics encompass the features that provides basic texture, hand feel and dimension to the fabric. The physical and mechanical properties of developed handloom union fabrics in different weaves i.e., plain, basket and twill are shown in following figures.

Fabric weight: Figure 1 elucidates the average weight and weight/unit area of the different handloom weaves. HP (Plain weave) fabric has minimum weight of 172.7 g/m^2 and it was maximum for HB (handloom basket weave) i.e., 259g/m^2 respectively. The weight of basket weave fabric is more due to two or more warp and filling yarns that are used to create basket weave.

Elongation at break: The elongation at break is measurement which shows how much a material can be stretched as a percentage of its original dimension before its break. The plain weave had maximum elongation in warp direction i.e, 30.47 percent followed by basket (26.83 %) and twill weave (17.63%) respectively, whereas basket weave had highest elongation (31.43%) in weft direction followed by plain (16.47%) and twill weave (7.6%) (Fig. 2). Twill weave had minimum elongation both in warp and weft direction. This means a higher percentage of elongation indicates a better-quality material when combined with good tensile strength.

Breaking strength (N): Basket weave fabric had maximum breaking strength values 538than plain 441.33and twill weave 498in warp wise direction (Fig. 3). For weft direction, basket weave exhibited highest strength (340±4) as compared to plain and twill weave. So, it can be concluded that basket weave had more breaking strength than plain weave and twill weave.

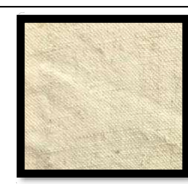
Fabric Stiffness (cm): Stiffness is an important characteristic of a fabric. Stiffness is measured by bending length of the fabric. Bending length is the length of fabric that will bend under its own weight to a definite extent. Bending length determines the draping quality of a fabric. Depicting bending length for the fabrics which evaluates the stiffness of the fabric as bending length is directly proportional to stiffness (Fig. 4). It was seen that HB had maximum stiffness 3.55in warp and 4.65in weft direction whereas it was minimum in warp direction for handloom plain weave fabric.

Fabric thickness (mm): It is the distance between the top and bottom surface of the fabric. Figure 5 reveal the thickness of the union fabrics, where basket weave union fabric had maximum thickness i.e., 1.216 followed by twill weave 0.81 and plain weave 0.80 respectively. Thickness is

Table 1. Sisal fibre used for the study

Sisal specie	Local name	Common name	Scientific name	Family
Agave americana	Pita fibre, Rambans	Century plant, Maguey or American aloe	*Agave americana*	Agavaceae

Table 2. Developed Sisal union fabrics (Cotton × Sisal / Cotton) in different weaves on handloom

Code assigned	Composition / EPI and PPI	Type of weave	Images
HP	Cotton (2/20) × Sisal/ Cotton (12s) EPI=41, PPI=34	Plain	
HB	Cotton (2/20) × Sisal/ Cotton (12s) EPI=63, PPI=43	Basket	
HT	Cotton (2/20) × Sisal/ Cotton (12s) EPI=42, PPI=36	Horizontal zig zag twill	

directly associated with the fabric comfort. The basket weave is thicker as compared to plain and will weave. Thus, it can be used to prepare any upholstery products where heavy fabric is required.

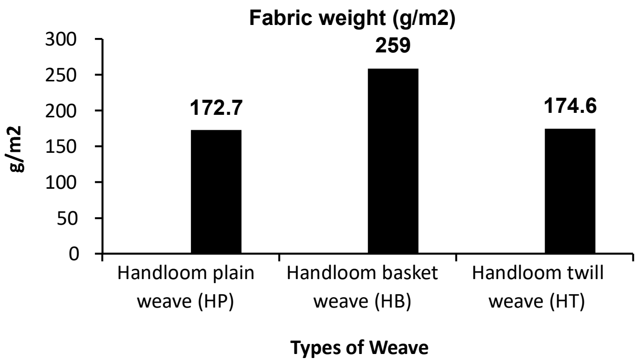


Fig. 1. Fabric weight of different weaves

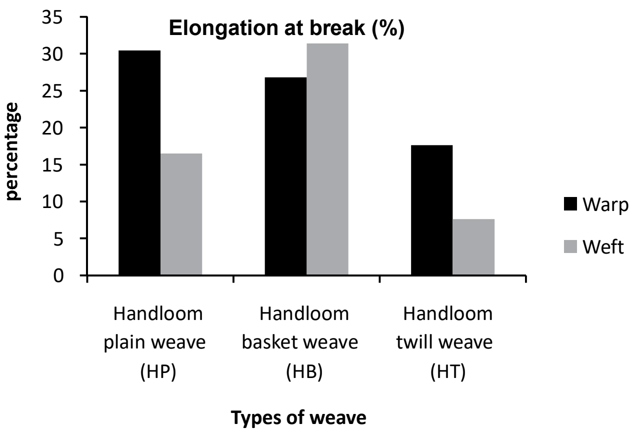


Fig. 2. Elongation at break of different weaves

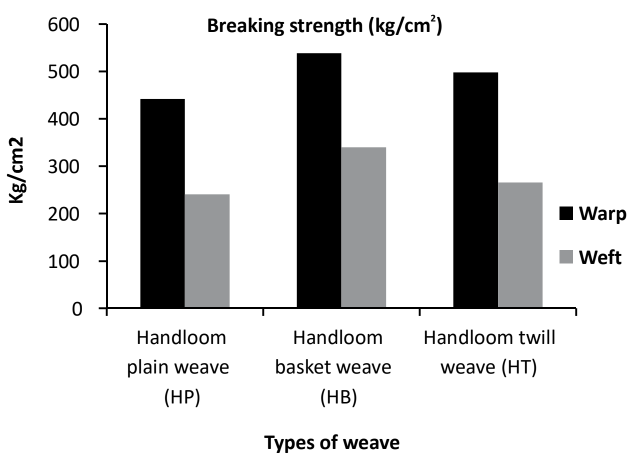
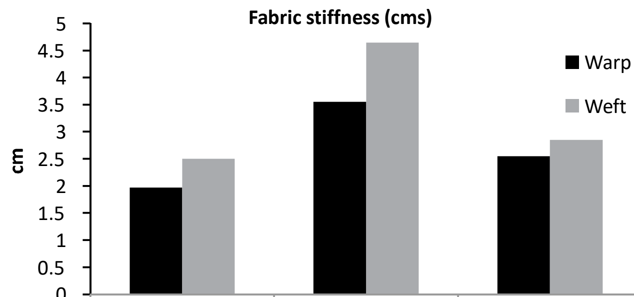


Fig. 3. Breaking strength of different weave



	Handloom plain weave (HP)	Handloom basket weave (HB)	Handloom twill weave (HT)
Warp	1.97	3.55	2.55
Weft	2.5	4.65	2.85

Fig. 4. Fabric stiffness of different weave

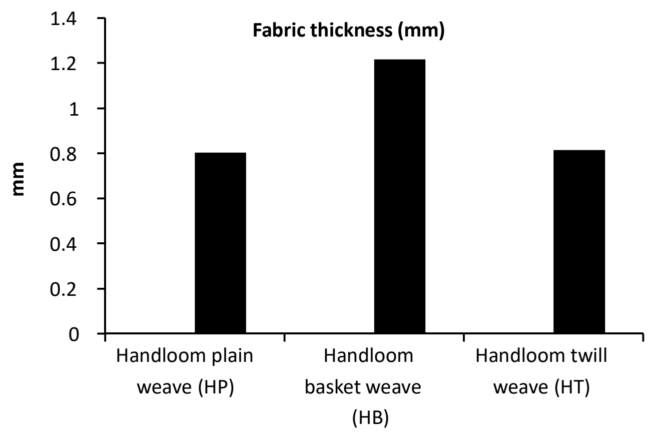


Fig. 5. Fabric thickness of different weaves

CONCLUSION

HP (handloom Plain weave) fabric has minimum weight of 172.7 g/m^2 whereas HB (handloom basket weave) has maximum weight i.e., 259g/m^2 respectively. Basket weave fabric had maximum breaking strength values 538N than plain 441N and twill weave 498N in warp wise direction. For weft direction, basket weave exhibited highest strength 340N as compared to plain and twill weave. So, it can be concluded that basket weave had more breaking strength than plain weave and twill weave both in warp and weft direction. Basket weave had maximum bending length 3.55cm in warp and 4.65cm in weft direction whereas it was minimum in warp direction for handloom plain weave fabric. It was inferred that basket weave was thicker as compared to plain and twill weave. Thus, it can be used to prepare any apparel/home textile products where heavy fabric is required. Twill fabric can be used for preparing waist coat, skirt, trousers, etc. The greater bending length along the weft direction of the fabric tells us that the fabric is stiffer in the weft direction than in the warp direction. This can be due to the result of fabric density which is more in the weft direction of the fabric than in the warp direction and the composition of weft yarn. Plain weave and twill weave had minimum bending length which means they are more comfortable than basket weave and can be used for apparel application.

REFERENCES

Agarwal E and Rastogi S 2018. A study on properties of union fabrics developed with sisal fibre for textile application. *International Journal for Environmental Rehabilitation and Conservation* **1**: 1-5.

Alapati P and Shaik KS 2017. Technology generation for production of value-added products from agricultural waste. In (ed) *Managing rural women's work, health and livelihood.* Pp 217-235. All India Coordinated research projects on Home Science. ICAR Central institute of women in agriculture Bhuwneshwar.

Baruah S, Kalita BB, Jose S, Borah MP and Kalita S 2022. Impact of weave on physico-comfort properties of Eri/Modal Union fabric. *Journal of Natural Fibers* **19**(13): 5371-79.

Basu G, Roy AN, Satapathy KK, Abbas SMJ, Mishra L and Chakraborty R 2012. Potentiality for value-added technical use of Indian sisal. *Indian Crops Production* **36:** 33-40.

Nayak L, Nag D, Das S, Ray DP and Ammayappan L 2011. Utilization of sisal fibre *(Agave sisalana*): A review. *Agricultural Research Communication Center* **32**: 150-52.

Nayak RK, Pung SK and Chatterjee KN 2009. Comfort properties of suiting fabrics. *Indian Journal of Fibre and Textile Research* **34**: 122-130.

Sarkar S and Jha AK 2017. Research for sisal (*Agave* sp) fibre production in India. *International Journal of Current Research and Review* **9**: 61136-61146.

Shroff A and Karolia A 2015. Enzyme Softening of Sisal Fiber: A Sustainable Approach for the Future. *Textile Science* **5:** 55-60.

Yan Li, Yiu-Wing Mai and Lin Ye 2000. Sisal fibre and its composites: A review of recent developments. *Composites Science and Technology* **60**(11): 2037-55.

Zwane PE, Ndlovub T, Mkhonta TT, Masarirambi MT and Thwala MJ 2019. Effects of enzymatic treatment of sisal fibres on tensile strength and morphology. *Scientific African* **6:** 78-89.

Received 12 February, 2023; Accepted 03 May, 2023