

Man Made Textiles in India

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Dhaincha Textiles



Linen Fabrics



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All correspondence regarding the journal should be addressed to:

The Editor

Man Made Textiles in India
The Synthetic & Art Silk Mills' Research Association (SASMIRA)
Sasmira Marg, Worli,
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Tel.: 2493 5351
Fax.: 2493 0225
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SASMIRA Marg, Worli, Mumbai - 400 030

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EDITOR'S PAGE

Dhaincha Textiles

Green undecomposed material used as manure is called green manure. It is obtained in two ways: by growing green manure crops or by collecting green leaf (along with twigs) from plants grown in wastelands, field bunds and forest. The most important green manure crops are sunnhemp, dhaincha, pillipesara, clusterbeans and Sesbania rostrata.

To discourage farmers from cultivating summer maize, which has been termed as 'second paddy' by the experts, Punjab govt has stepped up efforts to provide subsidised dhaincha seeds to the farmers. Dhaincha is a green manure that matures in 70 days, ahead of the paddy season and ensures better soil fertility. Dhaincha can be grown on all season having sufficient moisture in soil. It not only improve physical properties but also helps in meeting nitrogen requirement of succeeding crop. Its average grain yield is 3-4 quintals per acre and it takes about 150 days to mature.

*The advantages of the Dhaincha Plant are plentiful: as an effective means to enhance the physical properties of the soil; fulfilling the nitrogen requirements of the subsequent crops; functioning primarily as a green manure crop, etc. The important one from textile point of view is the usage of its bark for fiber extraction. Dhaincha (*Sesbania aculeata*) stalk is similar to jute stick to produce pulp with properties like hardwood in the point of view of fiber length and mechanical properties. *Sesbania aculeata* (Dhaincha) is a lignocellulosic bast fiber, has been explored here as an ultraviolet blocker due to the presence of natural lignin of about 19 % on its surface.*

*This month the feature article is "Utilization of sesbania aculeate (dhaincha) plant for textile production" which highlights the usage of *Sesbania aculeata* (dhaincha) fibres. The authors claim that the fabric manufactured possessed properties close to the specifications for coir geotextiles given in BIS standard IS 15869:2008. Hence it could be a local alternative to geotextiles made in jute and coir and can be used in prevention of soil erosion and reinforcement of paved and unpaved road.*

If the commercialisation of these products gets under way, it will pave a new path for the eco-friendly geotextiles.

Dr. Manisha Mathur



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Website: www.sasmira.org

Utilization of *sesbania aculeate* (dhaincha) plant for textile production

Monika Negi and

Dev Bhoomi Uttarakhand University, Dehradun

Anita Rani

Department of CT, College of Home Science , G.B.P.U.A & T, Pantnagar

Abstract

The growing ecological consciousness and limited land availability for cultivation of fibres yielding crops have pressed researchers to explore underutilized fibres as *Sesbania aculeata* (dhaincha). The peeled and dried bark of *dhaincha* were retted and scoured with alkali and softened with industrial softener then spun into yarn and two fabric structure nonwoven and woven were prepared and tested. The extracted fibres exhibited good properties that improved after scouring and softening. The fabric manufactured possessed properties close to the specifications for coir geotextiles given in BIS standard IS 15869:2008. Hence it could be a local alternative to geotextiles made in jute and coir and can be used in prevention of soil erosion and reinforcement of paved and unpaved road.

Key Words: Textiles, Agricultural waste, Dhaincha, Woven, Nonwoven and Technical Textiles, *Sesbania Aculeate*, Geotextiles, Softening

Introduction

The global concern for sustainable development and ecological conservation has diverted attention towards exploitation of renewable and biodegradable raw materials to minimize the waste disposal. The constructive idea regarding the exploration and balanced use of natural resources like forestry, agricultural waste and substitution of nonrenewable products has prompted human towards the utilization of natural fibres. These fibres are obtained from resources restricted to specific geographic areas and characterized by seasonality of growth and low yield. These fibres grow naturally and are usually not cultivated which thereby reduces the cost of fabric production from bast fibres.

Bast fibres possess reasonably distinctive properties, distinct composition and features that are essential for fabric structures like woven, knitted, nonwoven, knotted, grids, membranes and composites.

The exploitation of these sources can lead to the economical and social development of a region and the country. In India, the state of Uttarakhand thrives of flora, and other natural resources, mainly the hills of Himalayas, Tarai region of Udham Singh Nagar and Naintal district. These regions are endowed with variety of fibre yielding plant, growing on roadside, hill slopes such as *bicchu* grass, *bhang*, *bhimal*, *bhindi*, *rambans* etc. Conventionally, the local people use these fibres as a

source of raw material for manufacturing of rope, carpet, nets and handicraft article in cottage industries.

One such source of textile fibres is the byproduct of plant used for nitrogen fixation and wind barriers i.e., *dhaincha*. The different parts of plant such as leaves, dry stalks were utilized by local people as a source of fodder for animals, fuel and even for small construction (for small animal, hen and turkey) [1]. According to report on Macro Management of Agriculture in Uttarakhand is about 54 % of farmers in tarai region of Khatima, Kashipur and Jaspur situated in Uttarakhand were growing *dhaincha* as green manures [2]. *Dhaincha* is a green manure crop grown prior to paddy cultivation. The stem possess good amount of fibres that are strong, coarse and shiny and have potential to be developed as technical textiles for agriculture and geotech sectors owing to its set of physical properties. Thus, there is a need for search of renewable, locally available, green and economical alternatives. The *dhaincha* fibres, extracted from stems could be a regional substitute for jute as technical fibre [3].

Scoured and dyed (reactive dyes) fibres are also utilized the fibres for home textiles [4]. Therefore the production of the plant for secondary uses can be taken up as an additional source of income generation to the local people. The fibre obtained is eco-friendly, renewable, abundantly available and economically fibre. Here an attempt has been made by softening of *dhaincha* fibres and using the processed fibre for spinning to develop different fabric structures for geotextile purposes.

Materials and Methods

The stalks of *Sesbania aculeata* (*dhaincha*) were collected in the month of September plantation. The bark was peeled out from fresh plant and the remaining parts like roots, leaves, branches and seed pods were left in the field to decompose. The peeled bark was dried in shade and was used for the extraction of fibres and for the further study.

Extraction, scouring and softening of fibres

The extraction of fibres was done by biological retting. The temperature and relative humidity was in range of 37°C–30 °C and 85 – 75 %, respectively in the months of September and October when retting was done [3]. Scouring of fibres was done with Sodium Carbonate (10 g/l), Sodium Hydroxide (5 g/l) and Wetting Agent (1 g/l) at 95 °C for 45 minutes and MLR was taken as 1:50. Further the fibres were neutralized with 2 ml/l of acetic acid at 60 °C for 10 minutes [5]. The fibres were further treated with 4% commercial softeners (silicon based) at 35 °C for 45 minutes [6]. The scoured and soften fibres were combed and assessed for their physical properties like tenacity, fineness, elongation, moisture regain.

Preparation of yarn

The prepared yarns were tested for different physical properties like count, twist, strength and elongation. The properties of yarn were tested at Kashi Vishwanath Textile Mills Ltd, Kashipur Uttarakhand and NITRA, Ghaziabad, Uttar Pradesh.

Preparation and testing of fabric structure

The woven fabric was the pure fabric made with twisted *dhaincha*

yarn at GBPUAT Pantnagar, Uttarakhand while non-woven fabric structure was prepared on needle punching loom based on Dilo Technology (Germany) at OBEETEE Textiles Limited, SIDCUL, Pantnagar, U. S. Nagar, Uttarakhand. The prepared fabric was tested for application as geotextiles at testing laboratories of BTRA (Bombay Textile Research Association), Mumbai (Maharashtra) and at OBEETEE Textiles Ltd., Sidcul, Rudrapur (Uttarakhand).

Results and Discussion

Physical properties of retted and scoured *dhaincha* (*Sesbania aculeata*) fibres

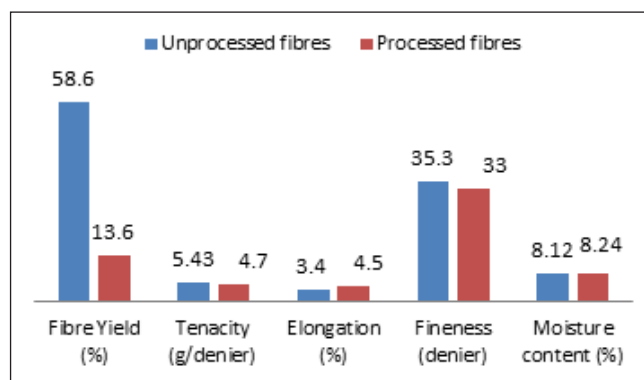


Figure 1: Comparison of properties of unprocessed and processed fibres

It is clear from the Figure 1 that the yield of fibres after 15 days stagnant water retting was 58.6 percent. This might be due to the removal of vegetative matter or noncellulosic matter. According to the observation of researcher the increase in duration of retting of fibers, fibre yield decreased owing to cleaning of fibers and removal of cortical parenchyma and middle lamellae from the stem of plant [7].

In case of processed fibres, instead of fibre yield the weight loss percentage was calculated. It was observed in Figure 1. the weight loss percentage was found to be 13.6 % in case of processed fibres. The weight loss may be related to removal of vegetative, gummy and non-cellulosic matter from the surface of fibre during scouring. The process melted the waxy material present in the fibres which get hydrolyzed into soap and glycerol through the process of saponification [8].

It is apparent from Figure 1 that the tenacity of fibres decreases in *dhaincha* fibres after alkali treatment. It was found to be 4.7 g/denier in case of processed fibres which was 5.53 g/denier. The alkaline treatment of hemp fibres resulted in decrease of tensile strength owing to the removal of reducible hemicelluloses and lignin from the fiber surfaces [9]. The removal of non-fibrous components and complete separation of fibres depended on the concentration, time and temperature of the reaction which affected the fibre strength and other physical properties [10].

It can be observed from the chart given in Figure 1 that the elongation of *dhaincha* fibres increased and was found to be 4.5 % in case of processed fibres which was only 3.4 % before scouring. The difference in the elongation of fibres might be due to variation in severity of agents' action on fibre bonds which

caused the removal of lignin carbohydrate complex content [11]. This in turn results in improved fibre quality in terms of strength and elongation.

It is apparent from Figure 1 that the fineness of dhaincha (*Sesbania aculeata*) fibres before and after chemical scouring was found to be 35.3 denier and 33 denier respectively. The value of fibre fineness in denier, the coarser it will be and vice-versa [12]. Wang et al. (2009) also observed decrease in fineness value of jute fibres after scouring treatment which was due to the removal of lignin located in the cementing layer between the cells. Zannen et al. (2014) also observed similar changes in Doum palm leaf fibre, where the diameter of fibre decreased with increase in concentration of sodium hydroxide owing to removal of noncellulosic matter.

It can be noticed from Figure 1 that the moisture content of dhaincha (*Sesbania aculeata*) fibres improved after scouring treatment. This might be due to removal of non cellulosic waxy matter and the swelling of fibres after alkali treatment. The changes in moisture content with certain treatments were due to changes in crystallinity and porous structure of polymer fibre [13]. The properties exhibited by scoured dhaincha fibres resemble with the finding of Negi et al, [4] where the fibres was scoured with ammonium oxalate and sodium hydroxide.

Physical properties of softened dhaincha (*Sesbania aculeata*) fibres

It can be perceived from Figure 1 that tenacity of scoured dhaincha fibres, taken as control sample, exhibited 4.7 g/denier tenacity. The tenacity of control fibres improved on treatment with industrial softeners. The industrial softener cross linked with hydroxyl group of cellulose to form an evenly distributed film on the fibre surface, thereby, enhancing tenacity and uniformity of fibres [14]. The use of softener imparts smoothness to the fibres by coating the fibre as a thin film layer [15]. This also enhances uniformity of surface and decreases the roughness resulting in improved strength.

It is apparent from Figure 1 that the elongation of control sample i.e., scoured dhaincha fibres was slightly higher (4.5%) as compared to softened fibres (4.25%). It means that the elongation of fibres reduced slightly with softening treatment. The decrease in elongation of *Kydia calycina* and *Dombeya acutangula* fibres after treatment with industrial softeners [16] affirmed that the semal fibers exhibited higher elongation at lower concentration of softener as compared to higher concentration.

Physical properties of yarn prepared from dhaincha (*Sesbania aculeata*) fibres

The properties hand spun yarns of dhaincha (*Sesbania aculeata*) yarns are given in Table 2. The count of manually twisted yarn was found to be 1938 tex. Direct system of yarn count was used to express count of dhaincha yarn, where higher number indicates coarser yarn [17]. Thus, manually twisted yarn (twine) was quite thick. The count of yarn (coarser or finer) depends on the weight and fineness of fibres [18].

It can be noticed from the data in Table 2 that tensile strength of twisted yarn was 10.6 g/tex and elongation was 5.89 %.

Kadolph (2009) had also reported that twisting of more than one ply or bundles of fibres resulted in stronger and uniform yarn. The strength of yarn dependent partly on individual fibres and on degree of cling together and resist and to slippage [19]. The lower strength of spun dhaincha yarn might be due to the use of less number of fibres during spinning that led low degree of cling and resulted in slippage of fibres from yarn structures.

Table 2: Physical properties of twisted dhaincha yarns

S. No	Properties	Twisted yarn
1	Count (tex)	1938
2	Tensile (g/tex)	10.60
3	Elongation at break (%)	5.89
4	Twist (TPI)	4.02 (S)

Twist per inch for twisted yarn was 4.02 in S twist direction. The coarser yarns require lower twist per inch than fine yarn [20]. The amount of twist insertion also determines the count of yarn i.e., coarser yarn lesser twist and finer yarn less number of twist [21].

Assessment of physical properties of pure dhaincha fabrics

In case of pure fabric, dhaincha twisted yarns were used both in warp and weft direction. Further nonwoven fabric was made by needle punching technique (Figure 2). The prepared fabrics samples were tested for different properties to assess suitability for general end uses as well as for application in geotextile sector.

It is apparent from Table 3 that pure fabric had (Figure 2) an open structure and exhibited a thread count of 4x3. The less number of yarns appeared in an inch of fabric in both directions due to more thickness of twisted dhaincha yarns which needed more space in both directions. Thus it can be deduced that pure fabric (4x3) had most open woven structure. Angappan and Gopalakrishnan [12] had stated that fabric count is affected by yarn ply and thickness of the threads.

Table 3: Physical properties of woven dhaincha fabrics

S. N	Properties		Dhaincha fabric
1	Fabric count (per inch)	Warp	4
		Weft	3
2	Fabric weight (g/m ²)		835.6
3	Thickness (mm)		5.96
4	Tensile strength (kN/m)	Warp/ MD	21.3
		Weft/ CD	12.7
5	Elongation (%)	Warp/ MD	9.13
		Weft/ CD	5.44
6	Aperture Size (mm)	Warp/MD	9.93
		Weft/CD	4.52
7	Static puncture resistance (CBR) (N)		1530
8	Porosity		0.893

It is clear that the fabric weight of pure fabric (*dhaincha* yarns) was 835.6 g/m². Pure *dhaincha* fabric was made of twisted coarser yarns that resulted in heavy weight of fabric. It is supported by researcher who also stated that the weight of fabric increases due to the presence of higher number of fibres in per unit area [22]. It can be inferred from the data given in Table 3 pure *dhaincha* fabric exhibited thickness of 5.96 mm, The higher value of thickness in pure *dhaincha* fabric is due to the presence of twisted yarns. Angappan and Gopalkrishnan [12] had also reported that the thickness of woven fabric depends uident from Table 3 that on coarseness of yarn.

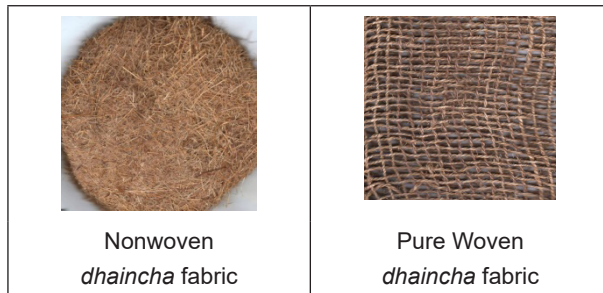


Figure 2: Dhaincha fabric

It is evident from Table 3 that in case of pure fabric though the twisted yarns used were thicker but resulted in open fabric structure i.e., low thread count which gave lower resultant tensile strength. The tensile strength of pure fabric in case of warp direction was more as compared to weft direction which was found to be 21.3 kN/m and 12.7 kN/m respectively. The tensile strength of jute open mesh woven fabric (730 gsm) in warp and weft direction as 12 kN/m which was lower than the tensile strength of pure *dhaincha* fabric [23]. It was observed from the data in Table 3 that the elongation of fabrics was more in warp direction as compared to weft. This might be due the more number of yarns in warp direction that aligned properly as compared to weft yarns. The elongation in jute and flax fabric was more in warp direction as compared to weft direction [24].

It was noticed that the aperture size in warp direction was more

as compared to weft in pure woven fabric. This might be due to the proper alignment and close placement between two warp yarns whereas the weft yarns were not equi-distance due to manual beating process that resulted in more space in between two weft yarns in a fabric. According to researchers the aperture size help to interlock the soil particles with geotextiles that resulted in higher pull out resistance of soil [25]. Thus the scattering of soil reduces to large extent. Pure fabric had an open structure that could not resist the impact of a piercing object, therefore the Static (CBR) puncture resistance for pure fabric was 1530 N. It also has maximum porosity of 0.893 owing to the low twist and fabric count that made it more porous.

The processed *Sesbania aculeate* (*dhaincha*) fibres were also used to prepared nonwoven fabric and the properties were assessed. The properties of nonwoven exhibit excellent physical properties as the structure is slightly thick as compared to usually size. The thickness was found to be 8.92 mm and fabric weight of 16.4 g/m². The tensile strength of thick nonwoven in Machine Direction (MD) was observed to be 6.5 kg with elongation of 21 mm whereas tensile strength in Cross Direction (CD) was 4 kg with 45 mm of elongation. This type of structure has good moisture control as compare to conventional mulching material therefore it could be a alternative source in agrotexile along with geotextile utilization [26, 27].

Conclusion

The results of study clearly depicts that *dhaincha* plant offer an opportunity to produce textiles (fibre, yarn and fabric) for technical end use on basis of the physical properties like tenacity and moisture regain in area of soil protection against erosion on hill side of Uttarakhand. This plant mainly consumed for green manuring could also be utilized as an alternative to jute and coir materials that are gaining importance in area of geotextiles. Hence it deduced that prepared pure fabric of *dhaincha* can be a local alternative to geotextiles made in jute and coir and can be used in prevention of soil erosion and reinforcement of paved and unpaved road.

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Investigation on musculoskeletal disorders of workers in the silk handloom industry

Subrata Das, Keerthana Shanmugaraja, Aarthi Premalatha Ramesh, Marieswari Sivakumar and

Silk Fashion Lab, Department of Fashion Technology, Bannari Amman Institute of Technology, Sathyamangalam

Sangappa Shillin

Mulberry Silk Reeling Division, Central Silk Technological Research Institute, Central Silk Board, Bangalore

Abstract

Handloom weaving is unorganised in nature and employs the vast majority of rural people. It is associated with multiple processes during which the workers are exposed to prolonged working hours and with adverse work postures that lead to musculoskeletal disorders. Therefore, identification of occupational health issues, particularly musculoskeletal disorders, and the associated risk factors are very important. Ergonomic concerns among 206 silk saree workers with a modified Nordic Musculoskeletal Questionnaire method were investigated to assess the prevalence of musculoskeletal issues and the associated factors. Assessment was done on the ergonomic postures to identify the hazards and challenges involved during the activities performed in silk saree manufacturing. REBA and RULA ergonomic assessment techniques were used to identify the risk variables responsive to the musculoskeletal problem by work posture analysis. It has been identified that 50 %, 73.33 %, 75.75 %, and 55.78 % of workers possess very high risks during yarn extraction, yarn pre-preparation, dyeing, and weaving processes. This study revealed that, 45 %, 78.05 %, and 100 % of workers performing warp yarn preparation, weft yarn preparation, and drafting of warp yarn processes experienced high risks.

Keywords: Weaving, Musculoskeletal Disorder, Saree, Ergonomics, REBA, RULA

Introduction

The handloom industry, which is one of the largest home-based cottage industries in India, is the second largest industry after agriculture. Since ancient times, hand woven textiles have played a significant role in India's culture and civilization. The myths, tales, rituals, ceremonies, festivals, social organizations, and cultural standards influenced the textile creation of the artisans who lived in the countryside [1]. Weaving may appear to be a simple operation at first glance, but it involves a lot of painstaking processes and stages, as well as ergonomic risk factors such as uncomfortable posture, high force, repetitiveness, extended work duration, and high

visual demand [2]. The weavers operate on their looms without using ergonomic principles, which may put them at risk at work [3]. Ergonomics is a physical characteristic that deals with the workers' working postures during work. Awkward postures are one of the most significant performance factors and potential workplace issues [4]. Weavers on handlooms adopt a variety of uncomfortable postures while performing a task that requires a lot of force and is very repetitious for >8 h. They are forced to work on handlooms at the expense of their health due to the economic situation. Overuse of muscles, tendons, joints, and nerves occurs as a result of a high postural load caused by a restricted work approach and working environment. If this

unusual posture is maintained for an extended period of time, it might cause health complications [5]. Weaving and related activities are linked to a number of health risks, which, in addition to creating stress and strain on weavers, also expose them to specific health risks. Moreover, the weavers are exposed to noise and dust throughout the handloom weaving process. The risk for developing various types of diseases increases with the environmental challenges.

An attempt had been made by Wani et al. [6] to investigate the health risks associated with the carpet industry at various times of the year. It was determined that, in comparison to other seasons, winter weavers were subjected to a variety of health risks. Long hours of work with traditionally designed tools and unergonomic work places can cause musculoskeletal disorders (MSDs) [7]. Musculoskeletal complaints of 38.5 % to 100 % are there in handicraft workers, with the neck, back, knees, and upper limbs being the most affected body parts. Working posture, repetitive and rapid motions, and age were all found to be strongly linked to the development of MSDs [8]. Wani et al. [6] investigated general working conditions in the carpet manufacturing industry and assessed the health risk factors of weavers working in this industry. A pretested questionnaire was used to evaluate the health problems among different weavers. Furthermore, the ergonomics of weaving workstations and working posture were also evaluated. The majority of ergonomic flaws were discovered to be the result of a poorly constructed weaving workstation [2]. Sen et al. [9] conducted a detailed review on MSDs among mining workers and reported the different approaches adopted to prevent/reduce MSDs. The relationship between work posture and MSDs among weavers was also investigated by few researchers [10–12]. Ergonomic interventions are the use of ergonomic principles to manipulate tools, procedures, and processes in order to decrease exposure to physical dangers. It also emphasizes worker training and the use of personal protective equipment for safety and cleanliness. Ergonomic interventions increase workers' occupational health, allowing them to work safely for extended periods of time [13]. Design teams can play an essential role in achieving ergonomic and productivity goals at the same time [14].

The purpose of the study is to identify the MSDs associated with handloom silk saree workers so that corrective measures may be implemented. Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) assessment techniques are employed to analyze the work posture and its relationship with musculoskeletal issues among handloom silk saree workers. Moreover, this work is the first attempt in which postural and health risks are assessed in all the stages of silk saree manufacturing processes.

Silk saree manufacturing activities

Before the raw silk is woven into a fabric, it goes through a series of preparatory processes, i.e., bobbin winding, doubling, twisting, and rewinding (Figure 1). Dyeing is the process of colouring the yarn, an important requirement in the handloom weaving process. This process is performed by hand in tiny batches, or hanks, with natural or synthetic colorants. Then the weft yarn preparation is carried out using “Charka” and a hank

of yarn are wound onto a small bob- bin called “pirm”. The weft yarn is then placed into a shuttle after being wound on a pirm. During the warp yarn preparation process, the warp strands are dressed and wound, the warp is loaded onto the loom, and the warp yarns are aligned and separated to promote smooth weaving.

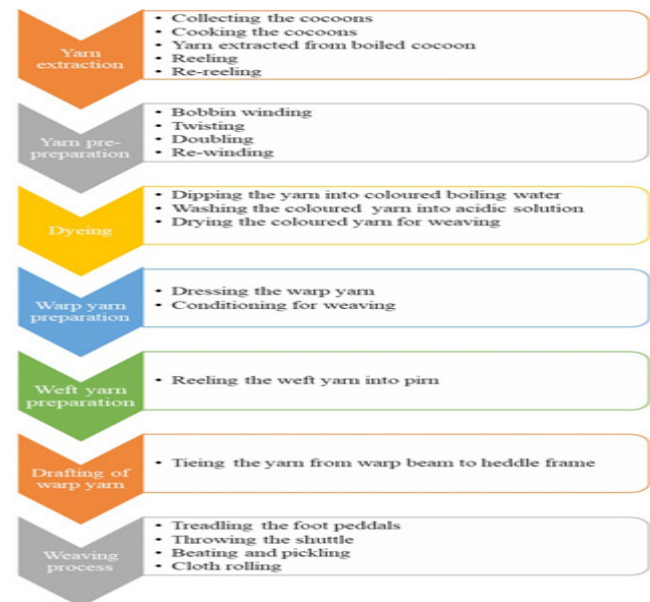


Figure 1: Activities involved in silk saree manufacturing

Subsequently, warp yarn drafting is performed to connect each strand from the warp beam to the heddle frame and finally, it is subjected to the weaving process.

Ergonomic hazards

Silk saree workers are exposing themselves to ergonomic dangers and health issues during yarn preparation due to their posture deviation, including lengthy periods of standing like headaches, noise problems, eye strain, stretching, numbness in the fingers, and pains in the shoulder, neck, calf, back, butt, and foot. During the dyeing process, the workers are subjected to heat exposure, headache, and odor, numbness in the fingers and toes (contact with water), pains in the shoulder, hip, back, and legs. Since the weft yarn preparation is performed in a static position, most of the workers are deviating from their posture. As a result, they feel discomfort in their fingers, wrists, neck, and shoulders. They may also be exposed to the heat environment as a result of using silk yarn for an extended period of time. Drafting of warp yarn activity is one of the most time-consuming and stressful tasks in silk saree manufacturing. During this process, the workers don't have a good seating position, which causes upper shoulder flexion and pressure on their neck and back. Furthermore, poor lighting and prolonged periods of work set strain on their eyes and entire body. The foot pedals are pressed to raise the corresponding heddles in accordance with the weave plan, which must be done in time with the weft or horizontal yarns being thrown across the two sections of warp yarns through the shuttle.

Weavers weave for lengthy periods of time each day, which

necessitates extreme attention and physical power. Eyesight issues are widespread as a result of eye strain and insufficient lighting. Weavers sit on a hard floor (pit loom) or a hard wooden bench of handloom without back support when weaving. As a result, they are subjected to problems like heat exposure, piles, headache, pain in the shoulder, neck, back, and foot.

Methodology

A survey was conducted at various silk saree manufacturing units in and around Sathyamangalam, district of Erode; Tamil Nadu, India, to determine the ergonomic dangers and physical discomfort of the workers. A cluster of silk saree manufacturing units (both organised and unorganised units) was been visited to investigate and analyse the ergonomic concerns associated with it. This study included 206 workers (114 males and 92 females) of different age groups who were separated into seven groups depending on activities: silkworm yarn extraction (N = 20), yarn pre-preparation (N = 30), dyeing (N = 33), weft yarn preparation (N = 41), warp yarn preparation (N = 20), drafting of warp yarn (N = 10), and weaving process (N = 52).

Among those, 19 (9.22 %) participants were under 30 years old, 80 (38.83 %) were between 31 and 40 years old, 69 (33.49 %) were between 41 and 50 years old, 19 (9.22 %) were between 41 and 60 years old, and 18 were above 60 years old (8.73 %). The number of people under the age of 30 was quite small, indicating that young people are not interested in working in the handloom sector. Low wages and extensive work and effort in traditional industries compared to other jobs are the causes

of that. In terms of the educational qualification of workers, 73 (35.44 %) of them were illiterate. About 83 workers (40.29) could read and write, 39 (18.93 %) had primary education (grades 5 to 10), and 11 had a bachelor's degree or higher (5.34 %). According to the findings, there is no significant link between educational attainment and MSDs. However, while making recommendations to address the difficulties, education is beneficial. Workers with <5 years of experience, between 5 and 10 years of experience, between 10 and 15 years of experience, and >15 years of experience are 43 (20.87 %), 56 (27.18 %), 74 (35.92 %), and 43 (20.87 %), respectively.

Furthermore, a cross-sectional study with a modified Nordic Musculoskeletal Questionnaire method [15] has been conducted to assess the prevalence of musculoskeletal issues and associated factors among workers. The ergonomic risk levels during the work activity were determined using the REBA and RULA assessment procedures, and the score sheets. The methods used to evaluate musculoskeletal problems differ depending mainly on the region, organizations and the working environment. As a result, they can be classified as direct, semi-direct, or indirect approaches. Direct approaches necessitate the attachment of electronic equipment to the individual's body, which evaluates the worker in real time. Semi-direct methods rely on pictures that are then analyzed, whereas indirect methods rely on questionnaires. Semi-direct methods are categorized based on the cause of the MSDs. The demographic characteristics of the handloom workers are summarized in Table 1.

Table 1: Demographic characteristics

Characteristics	Category	Number of workers							Total	Percentage
		Yarn extraction	Yarn pre-preparation	dyeing	Weft yarn preparation	Warp yarn preparation	Drafting of warp yarn	Weaving process		
Gender	Male	5	9	33	12	17	3	35	114	55.4
	Female	15	21	-	29	3	7	17	92	44.6
Age (years)	20-30	3	1	8	1	2	-	4	19	9.22
	31-40	12	11	17	12	4	3	21	80	38.83
	41-50	2	15	6	18	5	5	18	69	33.49
	50-60	2	1	1	4	7	1	3	19	9.22
	>60	1	2	1	6	2	1	6	18	8.73
Experience (years)	<5	10	16	6	3	2	1	5	43	20.87
	5-10	6	5	6	20	2	1	6	56	27.18
	10-15	4	5	14	9	13	5	24	74	35.92
	>15	-	4	7	9	3	3	17	43	20.87
Working hours	<8	-	4	5	22	3	2	8	44	21.35
	8-10	18	20	12	10	9	5	14	88	42.73
	>10	2	6	16	9	8	3	30	74	35.92
Level of education	Illiterate	10	11	12	20	-	4	16	73	35.43
	Read and write	8	13	17	9	11	5	20	83	40.29
	Basic education	2	5	3	10	8	1	10	39	18.93
	Degree holder	-	1	1	2	1	-	6	11	5.53

Results and Discussion

Prevalence of MSDs among workers

Wrists, elbow, neck, lower back, shoulders, and arms were the most typically affected body parts of the silk saree workers. MSDs reported by the workers during the production of silk sarees are

listed in the Table 2. It has been inferred that the majority of workers (90.29 %) experienced musculoskeletal problems in the back region. The proportion of workers experiencing pain and discomfort in their wrist, knee, and shoulder was found to be 80.10 %, 68.45 %, and 65.53 % respectively.

Table 2: MSDs reported by the workers

Work	Yarn extraction		Yarn pre-preparation		dyeing		Weft yarn preparation		Warp yarn preparation		Drafting of warp yarn		Weaving process		Total	Average
	N=20	%	N=20	%	N=20	%	N=20	%	N=20	%	N=20	%	N=20	%		
Neck pain	10	50	15	50.00	12	36.36	3	75.61	8	40	9	90	38	73.08	123	59.71
Shoulder pain	2	10	20	66.67	30	90.91	39	95.2	5	25	10	100	29	55.77	135	65.53
Upper arm pain	1	5	12	40.00	29	87.88	20	48.78	14	70	9	90	20	38.48	105	50.97
Lower arm pain	7	35	16	53.33	12	36.36	36	87.80	16	80	8	80	9	36.54	114	55.34
Elbow pain	0	0	2	6.67	8	24.24	12	29.27	2	10	7	70	4	26.92	45	21.84
Wrist pain	18	90	22	73.33	31	93.94	25	60.98	18	90	9	90	42	80.77	165	80.10
Back pain	16	80	28	93.33	24	72.73	39	95.2	19	95	10	100	50	96.15	186	90.29
Knee pain	19	95	27	90.00	21	63.64	4	9.76	18	90	6	60	46	88.46	141	68.45
Ankle pain	17	85	24	80.00	17	51.52	3	31.71	17	85	7	70	35	67.3	130	63.11
Foot pain	12	60	8	26.67	20	60.61	8	19.51	17	85	5	50	27	51.92	97	47.09

Figure 2 shows the average percentage of musculoskeletal symptoms among the workers during silk saree manufacturing.

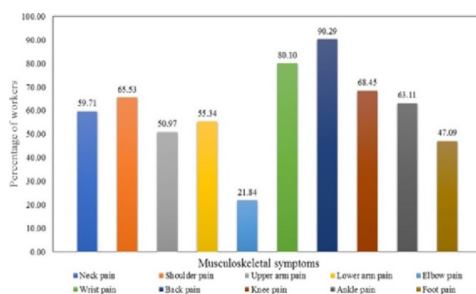


Figure 2: Musculoskeletal symptoms

Task-wise musculoskeletal problems

To acquire a better understanding of MSDs, the data was

analyzed separately for each task (yarn extraction, yarn pre-preparation, dyeing, weft yarn preparation, warp yarn preparation, drafting of warp yarn, and weaving process). Figure 3 depicts the findings of task-wise analysis.

Majority of the workers (95 %) who performed the yarn extraction process experienced knee pain. Wrist pain was experienced by 90 % of workers, whereas 85 % of workers had ankle pain. The workers (93.33 %) reported back pain problems when doing the yarn pre-preparation process. Knee pains were reported by 90 % of workers. The workers (93.94%) participating in dyeing tasks reported wrist-related complaints, followed by shoulder pain (90.97 %). MSDs in the shoulder area were reported by most of the workers (95.12 % and 100 %) while doing weft yarn and drafting of warp yarn operations. The workers involved in warp yarn preparation (95 %) and weaving activities (96.15 %) reported back pain issues followed by knee pain.

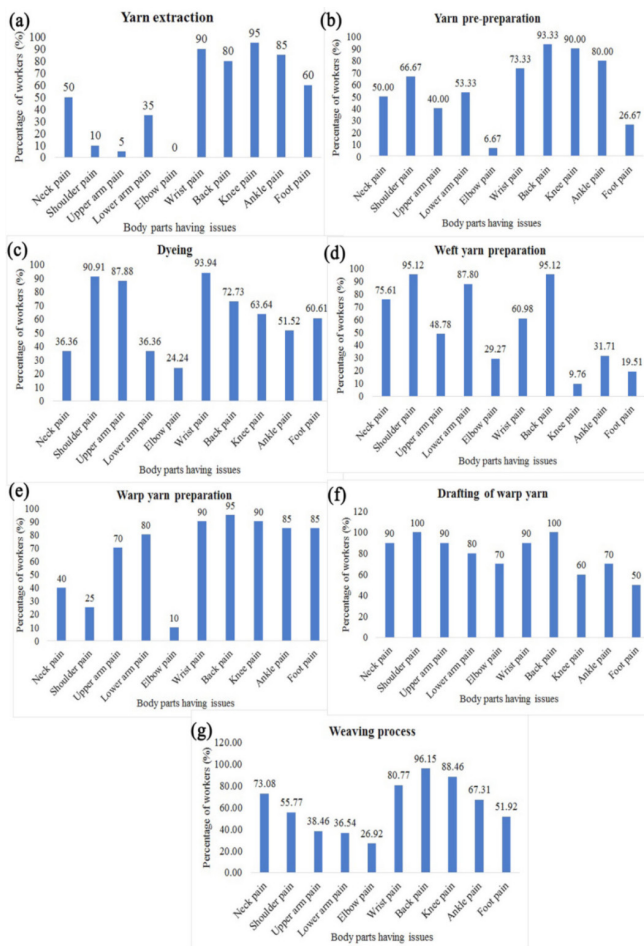


Figure 3: Task-wise musculoskeletal symptoms

Assessment of ergonomic during work activities

REBA analysis can be done manually with the help of the REBA work sheet [16]. A score is awarded to each of the following body regions using the REBA worksheet: neck, trunk, leg, upper arm left, lower arm left, upper arm right, lower arm right, and wrist of both right and left arm. Three summary measures are used to compute the REBA score. Score A is calculated by adding the posture scores of the neck, trunk, and legs to the force score.

Score B is calculated by adding the posture scores for the upper arm, lower arm, wrists, and coupling scores for each hand. Finally, the REBA score is calculated by combining scores A and B to the activity score, which is based on the duration of static posture, the frequency of small range of movements, and the frequency of large shifts in dynamic posture. Among the seven groups of activities, RULA was implemented for the activities involving upper body movements (weft yarn preparation and drafting of warp yarn) and REBA was used for the remaining five processes (yarn extraction, yarn pre-preparation, dyeing, warp yarn preparation, and weaving process) where the entire body parts are in movement.

REBA assessment

The working postures of the workers while performing yarn extraction, yarn pre-preparation, dyeing, warp yarn preparation, and weaving processes were observed and the deviation of postures in each region of the body was identified as shown in Figure 4.



Figure 4: Working postures for REBA assessment

Then the score was assigned for every process using the REBA work sheet and the degrees of risks were found using the REBA decision table.

Table 3 shows the percentage distribution of workers based on the REBA score for the five activities described above.

Table 3: Percentage distribution of workers based on the REBA score

Percentage distribution of workers based on the REBA score												
REBA score	Risk Level	Action	Yarn extraction		Yarn Pre-preparation		Dyeing		Warp yarn preparation		Weaving process	
			N=20	%	N=30	%	N= 33	%	N=20	%	N=52	%
1	Negligible risk	Not necessary	-	0	-	-	-	-	-	-	-	-
2-3	Low risk	Change may be needed	-	0	-	-	-	-	-	-	3	5.77
4-7	Medium risk	Further investigation, change soon	1	5	-	-	-	-	11	55	8	15.38
8-10	High risk	Investigate and implement change	9	45	8	26.67	8	24.25	9	45	12	23.07
11-15	Very high risk	Implement change	10	50	22	73.33	25	75.75	-	-	29	55.78

The Table 3 discloses that 50 % of workers were at very high risk, about 45 % were at high risk and 5 % of them were at medium risk. There were no workers who were in the action of low level and negligible risk levels. In the yarn pre-preparation process, 73.33 % of workers were at very high risk levels, with a REBA score of above 11. And the remaining workers (26.67 %) were in the high-risk level category with a score of 8–10. In the case of the warp yarn preparation process, none of the workers were at a very high risk level, while 45 % and 55 % of the workers were at high risk and medium risk levels, respectively. Furthermore, 55.78 % of workers performing the weaving process were at a very high risk level (requiring immediate implementation of change) and about 23.07 % of workers were at a high risk level, and directed to investigate and implement change.

RULA

Weft yarn preparation and drafting of warp yarn process were analyzed using the RULA assessment technique because the worker's upper limbs were solely involved during those activities. The assessed postures were examined as shown in Figure 5.

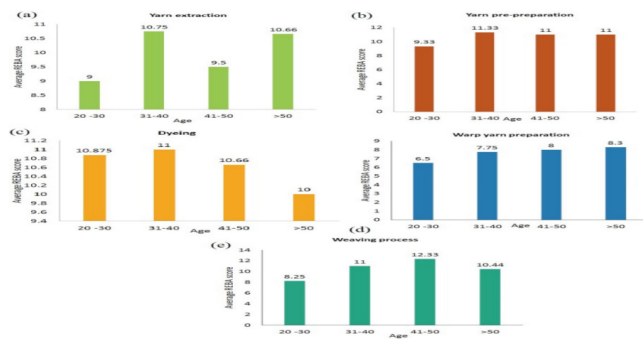


Figure 5: Working postures for RULA assessment

The results of the RULA assessment are shown in Table 4.

Table 4: Percentage distribution of workers based on the RULA score

RULA score	Risk level	Action	Weft yarn preparation		Drafting of warp yarn	
			N=41	%	N=10	%
1	Negligible risk	Not necessary	-	-	-	-
2-3	Low risk	Change may be needed	-	-	-	-
4-8	Medium risk	Further investigation, change soon	9	21.95	-	-
8-10	High risk	Investigate and implement change	32	78.05	10	100
11-15	Very high risk	Implement change	-	-	-	-

The results revealed that medium risks (21.95%) and high risks (78.05%) were associated during the weft yarn preparation process, and there were no low levels or acceptable risk levels observed. The high-risk level workers were recommended to investigate and implement change immediately, whereas medium-risk level workers were recommended for further investigation and scope for change. In the case of drafting of warp yarn process, all the workers were at high risk (100 %), and necessitated immediate changes and implementation. The age-wise distribution of RULA scores for the weft yarn preparation and drafting of warp yarn activities is illustrated in Figure 6.

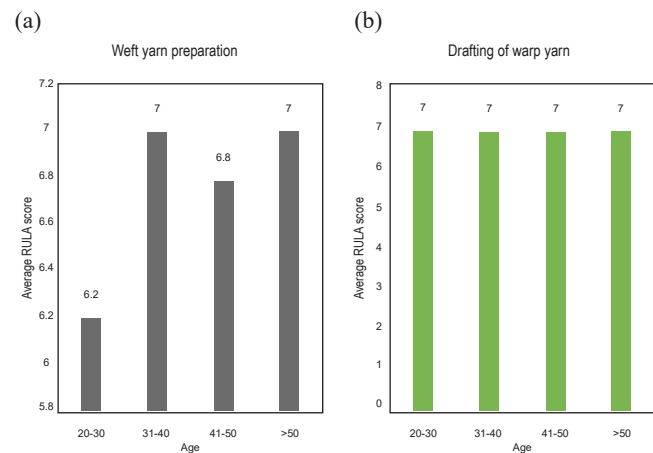


Figure 6: Age-wise RULA assessment

Conclusion

MSDs prevalent during the activities performed by the handloom silk saree workers were investigated. The percentage of workers suffering from pain and discomfort in their wrist, knee, and shoulder was 80.10 %, 68.45 %, and 65.53 %, respectively. Moreover, REBA and RULA assessment techniques revealed that 50 %, 73.33 %, 75.75 %, and 55.78 % of workers possess very high risks during yarn extraction, yarn pre-preparation, dyeing, and weaving processes. High risks were experienced by 45 %, 78.05 % and 100 % of workers performing warp yarn preparation, weft yarn preparation and drafting of warp yarn processes. Musculoskeletal and other occupational health issues result in increased absenteeism, lost working time, adverse effects on labor relations, increased probability of accidents and errors, job transfers, decreased productivity, low quality of work, and high administrative and personnel costs. Recommendations to minimize the risk of MSDs include but not limited to providing floor mats or anti-fatigue mats, positioning the machine at an appropriate height, taking short breaks, and job rotation with motorized “Charka”, cushion seats and back supports, and establishing semi-automatic handlooms.

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Motif adaptation of Rajasthani mandana art using computer aided designing

Amarjot Kaur and Neha Sah

Department of Fashion Design, Lovely Professional University, Phagwara

Abstract

The present study was undertaken to document Mandana art of Rajasthan and its revival. Mandana is a wall and floor art practiced earlier by Meena community and later adopted by other communities also. During this study, Rural areas of Sawai Madhopur were visited to meet local people to know the present status of Mandana art. Out of all the respondents 53 % respondents were from Meena community, who started doing this art whereas rest were from other communities like Brahmins. The study also focused on collecting traditional motifs of this art from primary sources. Twenty folk motifs of Mandana were selected among the collected motifs which were then adapted to make them suitable for handloom weaving using corel draw. During adaptation, it was kept in mind not to interfere with authenticity of folk motifs. Further a survey was done to know the most preferred motifs among these twenty adapted motifs, collecting data from 120 experts from fashion and design field and then calculating mean score for each design. These preferred designs can be used not only for handloom weaving but also for other techniques to develop various articles for rejuvenating this art form and to preserve this cultural heritage. This study can be beneficial for art revivalists, designers, students and all those who are working towards revival of Indian folk art forms by their contemporary use.

Keywords: Adaptation, Corel draw, Folk motifs, Heritage, Innovation, Mandana art

Introduction

India is a country of different cultures, traditions, and rich heritage. Each state, region, community and tribe has its own art and craft called folk art with their own unique style and pattern. These crafts and skills are passed from generations to generations. There are various forms of Indian art and craft like embroidery, painting, handloom weaving, pottery, puppetry, bamboo art, wood carving, metal work, needle work, wall and

floor art to name a few. "The folk arts of India are very ethnic and simple, but at the same time these are colourful and displaying country's rich heritage"[1]. Folk art in India has a great potential in the international market because of its traditional aesthetic sensibility and authenticity. Sachwani also observed that rich heritage of India must be protected and flourished. For this task combined efforts of Govt., NGOs and citizens are required [2].

The one among these arts is Mandana art of Rajasthan. This folk wall and floor art display cultural and traditional vibrancy. The

motifs of this art have social, cultural and religious significance. As per Bagchi and Chaudhuri this art is also known as “Meena Painting” because earlier this art was practiced by Meena community but later on it was adopted by other communities also [3]. This art is fading at fast pace because there are no more mud houses even in rural areas. This is one of the oldest art forms of India. If this art fades away then we will also lose huge variety of beautiful motifs having religious, cultural, and social significance. But mandanas made by other communities differ from those drawn by meena community in terms of motifs [4]. Mandana means to Draw, women used to draw different motifs on walls and floors of their mud houses with the purpose of decoration and also to welcome prosperity and ward off evils. For making Mandnas, first of all ground was prepared with the mixture of cow dung and RATI (local clay). Once it is dried then, designs are drawn with the paste of chalk powder for white colour and Geru for red colour. This folk art is now a rare view even in rural areas due to rise in number of concrete houses. It requires clay walls or natural ground to efficiently absorb colours. Because of modernization and development in rural India, lifestyle of people is changing at fast pace. Now there are no more mud houses and KACHHA floors where these skills can be practiced. It has led this folk art to fade away. Research by Rahman also mentioned that mud houses are vanishing so Mandana art will also be vanished if not preserved [5]. Suhag and Sharma also observed that Mandana is almost at its extinction stage as a result of increasing industrialization and modernization [6].



Figure 1: Mandana motifs on a mud wall in village Kutalपुरa Maliyan, Sawai Madhopur, Rajasthan

Designs of these folk arts having cultural, social and religious significance can be a great source of inspiration for modern designers. Arya et al. also found that Aipan (floor art) practiced in Kumaun region of Uttarakhand can be used for textile designing [7]. Different Designs of Aipan were collected and adapted. These were then used for designing of handloom sarees.

The folk arts can be revived by using their traditional techniques, material or motifs for the development of new products to cater modern domestic and international market. Another research also observed that with slight twist, traditional art and craft is becoming more and more contemporized and artisans also feel that their products are competing with goods

in Global market [8].

Keeping this in mind this study was conducted with following objectives:

1. To know the present status of Mandana art.
2. To explore various traditional motifs of Mandana art of Rajasthan.
3. To adapt traditional motifs for handloom weaving.

Methodology

Visit to rural areas of Sawai Madhopur was planned to know the history and present status of Mandana art. Thirty respondents from villages named Kutalपुरa Maliyan, Ramsinghpura, Kushtala of Sawai Madhopur, Rajasthan were contacted to know the present status of Mandana art. Twenty original designs were also collected during this visit. These designs were then adapted using CAD with corel draw software to make them suitable for handloom weaving. After adaptation, an interview schedule was prepared and these designs were shown to 120 respondents with expertise in design and textiles. These respondents were selected from three different institutions i.e. 40 from each. The collected data was analyzed by calculating Weighted mean score to know the results.

Results and Discussion

Table 1: Percentage of respondents for their response regarding making Mandana by their family members

n-30

Members who practice Mandana in a family	Frequency	Percentage of respondents	Percentage of response
Old generation	30	100 %	50
Middle generation	18	60 %	30
Present generation	12	40 %	20

It is clear from Table that old generation of 100 % respondents make Mandana, whereas 60 % said that middle generation practice it and only 40% responded that present generation make Mandana.

Table 2: Regarding practicing Mandana art in Modern houses

n-30

Practicing Mandana in concrete house	Frequency	Percentage
YES	15	50%
NO	15	50%

Among 50 % respondents who are still practicing Mandana art, out of which 33 % respondents said that they don't have any *KACHCHI* (made of mud) place in their house but they make Mandana on Diwali on concrete floor only with poster colors.

Rest of 17 % respondents said that they make Mandana on chullahs in their house on special occasions as chullah is the only thing made of mud in their house.

Suhag and Sharma also studied present status of Mandana art

and concluded that due to urbanisation, Mandana art is dying as there are no more mud houses. Because traditional Mandana art is practiced on clay walls or floors [6].

Awareness of new generations about traditional motifs of Mandana: When asked 77 % were aware and 23 % were unaware about the traditional motifs of Mandana.

Table 3: Percentage of respondents according to the communities they belong to

n-30

Do you belong to any particular community that is known to practice Mandana	Frequency	Percentage
Yes	16	53%
No	14	47%

As far as communities, who practice Mandana, are related 53% respondents were from Meena community and 47% from different castes other than Meena like brahmins. Earlier this art was practiced by Meena community only but later adopted by other communities also. Mandanas done by other communities like Brahmins, differ from the Mandanas made by Meenas in terms of Motifs.

Table 4: Whether respondents have seen Use of Mandana art on Textile and Non-Textile articles

n-30

Use of Mandana art on Textile and Non-Textile articles	Frequency	Percentage
YES	8	27%
NO	22	73%

Respondents who said yes, have seen use of Mandana on chullahs and earthen pots only not on any textile article.

Revival of Mandana art by its contemporary use

Collection of traditional designs of Mandana

Traditional designs of Mandana art were collected for the study by visiting rural areas of Sawai Madhopur, Rajasthan. Geometrical, animal, birds and floral designs were found. Twenty designs were selected for the study.

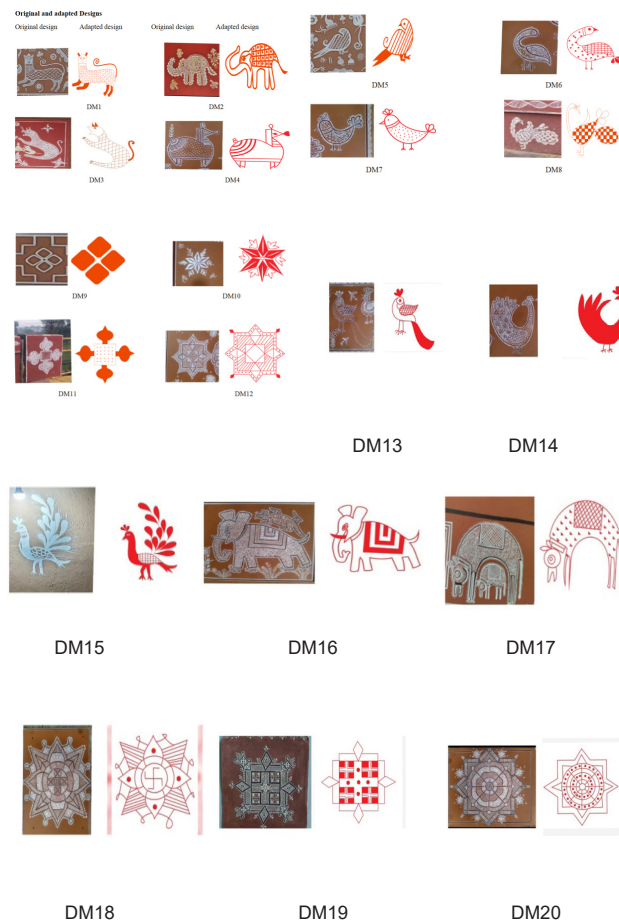
Adaptation of Mandana motifs for Handloom weaving

Twenty designs were selected from primary sources i.e., during personal visit to Sawai Madhopur, Rajasthan. The selected motifs were then adapted to make them suitable for handloom weaving without losing their authenticity. The adaptation was done using Corel draw.



Figure 2: Mandana art displayed at Rajiv Gandhi Regional Museum of Natural History, Ramsinghpura, Sawai Madhopur

Kushwaha et al. also studied revival of Gond Paintings of Gond tribe of Madhya Pradesh. The folk Designs of Gond painting were modified and placements were done through CAD using corel draw and adobe illustrator [9]. These designs were transferred to fabrics with digital printing. In another study, effort was given to add another dimension to use Madhubani painting in textiles [10]. It is a wall/mural painting practiced in Mithila region of Bihar. In this study, designs of Madhubani paintings were developed for their application on articles like cushion covers, folders and table cover. This effort resulted in fresh collection of articles with traditional touch and modern taste.



Evaluation of adapted designs

Adapted designs were evaluated by experts/students from fashion, design, and textiles field. 120 respondents were selected from three institutes of Jalandhar city. An interview schedule was prepared to collect data, designs were evaluated on three parameters i.e Design Composition, Visual Integrity and design suitability for apparels. The collected data was analyzed by calculating weighted mean score for each design.

This evaluation was done to know the most preferred designs among these twenty adapted designs by design and textiles expert. These most preferred designs can further be used for handloom weaving using Jacquard weave. Similarly, these traditional motifs of Mandana can be incorporated in different ways using different techniques to develop modern products to cater domestic and international markets. Use of traditional motifs in modern use will help to revive this art with a little adaptation without losing its authenticity.

Table 5: Weighted mean score obtained for 20 adapted designs of Mandana for assessment parameters evaluated by consumers

n-120

DESIGN NO.	WMS	DESIGN NO.	WMS
DM1	3.527742	DM11	3.558298
DM2	3.847184	DM12	3.972183
DM3	3.166635	DM13	4.052737
DM4	3.613853	DM14	3.566631
DM5	3.755518	DM15	4.080515
DM6	3.894406	DM16	3.797184
DM7	3.466632	DM17	3.355522
DM8	3.811073	DM18	3.813851
DM9	3.436077	DM19	3.874961
DM10	4.058293	DM20	4.077737

Dhir also studied CAD intervention for revival, stylization & adaptation of Madhubani traditional textiles. It was observed

that many designers are working in close association with local artisans, developing contemporary styles for modern era customers [11].

In a related study, Kordhnyamath and Bai designed and developed Murgi Kasuti motifs on Ilkal sarees. The concept behind the study is to use new yarns and colors to give a new look and to revive the traditional art of Ilkal handloom weaving [12].

Conclusion

The purpose of this research was to know the status of Mandana art of rajasthan. This art is practiced on wall and floor of mud houses. It is almost at its extinction stage because of concrete houses replacing mud houses at fast pace even in rural areas. This study focused on knowing the present status of Mandana art. The study also highlighted that losing this art will lead to losing traditional designs of this art having cultural, social and religious significance. During this study traditional motifs of Mandana were collected by visiting rural areas of swai madhopur, Rajasthan. These designs were adapted by not losing their original essence to make them suitable for handloom weaving. Mandana art can be revived by using Folk motifs of Mandana art and adapting them to develop various products using different techniques like painting, printing and weaving to cater modern market.

Acknowledgement

The Authors acknowledge all the respondents in the villages of Sawai Madhopur, Rajasthan who were very kind and supportive to provide required information regarding Mandana art.

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Conflict of Interest

The authors declare that there is no conflict in publication of this paper.

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Ag/PP composite yarn for water filtration

Pragnya Kanade

Textile Engineering Department, Faculty of Technology and Engineering, The Maharaja Sayajirao University of Baroda, Vadodara

Abstract

The components of household water purifiers include sediment filters, chloramine-removal media, flavour enhancers, UV lamps to kill germs, and membranes to remove them. Sediment filters, sometimes referred to as wound filters, are crucial components of this system and are typically made of spun polypropylene yarn coiled on a perforated core. The use of spun polypropylene yarn to destroy microorganisms is investigated in this study. Despite the fact that polypropylene does not naturally possess antibacterial qualities, there are a number of substances that do, including silver, copper, zinc, and others. In the current study, silver metal was used as an anti-bacterial agent and was disseminated during polypropylene melt spinning to produce fibres impregnated with it. DREF spun yarn was created with the goal of using it to make wound filter candles. Microbiological tests demonstrated the yarn's effectiveness against Gram-negative (*E. coli*) bacteria.

Keywords: Melt Spinning, Silver-polypropylene Composite, DREF Spun Yarn, Water Filtration, Microbial Activity

Introduction

In order to make water consumable, it may be necessary to purify it for a variety of reasons; the fact that more residential water filtration systems are in demand can serve as evidence of this. These home water purifiers employ a series of filters and may require up to 5 or 7 processes to produce the desired outcomes, as stated in [1]. Pre-filters are simply wound filter cartridges, while membrane filters—which can be used alone or in combination—provide the fine filters in many situations. In this method, activated carbon performs the crucial task of neutralizing any odours or any dangerous organic compounds (pesticides) that may be present. UV (ultraviolet) lamp use is also common in some purifying systems. The entry of different molecules into the filtered water can also be limited if reverse osmosis is used. UV lamps, on the other hand, can be eliminated if the components employed in the water purification system have a bacteriocidal finish. The filter medium itself is one of your alternatives. If the yarn (on wound filters) could be made bacteria-resistant, its utility would increase, allowing the removal of UV lamps or even the membrane with a similar type of finish. Well-known metals with excellent antibacterial characteristics that

have been utilised for therapeutic purposes for antiquity include copper, silver, zinc, cobalt, nickel, and others. For desired applications, these components can be employed in particle or nano form. According to reports, silver is a safe substance for oral ingestion and has less harmful effects on humans than bacteria [2] when used as an antibacterial agent (in small quantities). In a related research, [3] specifics of the melting and spinning of polypropylene with silver compounds are reported. As a result of the same, they also documented changes in surface, chemical, crystallinity, mechanical, and antibacterial characteristics. Fewtrell [4] stated that the quality of the water can have an impact and that particular microorganisms can make silver's antibacterial properties less effective.

In this investigation, two master batches of polypropylene fibres were spun from melt, one with a lower concentration of the silver compound and the other with a larger concentration; both batches were in the form of particles. Later, the same materials were employed to create DREF spun yarn, which is often the feedstock for making wound candle filters. Silver-polypropylene (Ag/PP) composite yarns' characteristics were assessed in terms of morphological alterations and their

microbiological efficiency. Scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FT-IR), energy dispersive X-ray spectroscopy (EDS), and X-Ray diffraction (XRD) were used to investigate the morphological alterations, while the AATCC and Log reduction test techniques were used to evaluate the anti-bacterial characteristics.

Materials and Methods

Materials

Preparation of PP spun yarn

The primary raw material used to create the Ag/PP composite yarn was polypropylene resin, was sourced from reputable suppliers. Since it is challenging to dye PP in a uniform color, a dye master batch is typically made by mixing black dye with PP resin inside the extruder. The silver compound was also distributed with the polypropylene resin in the extruder itself to make the master batch in order to acquire uniform antibacterial characteristics. It was followed by the standard melt spinning procedure, in which the molten resin plus silver compound were transported by a manifold to the main spinning machine; the former consisted of metering pumps, filters, and spinnerets. A suitable stretch was applied when the filaments solidified, and if necessary, crimping could also be chosen at this point. In order to get staple fibres with the correct cut length, the tow was then given to a cutter. At M/s Zenith Fibers in Vadodara, India, the entire procedure was meticulously supervised. This strategy was adopted to guarantee the silver compound's even distribution in the resulting filaments and its solid attachment inside the polymer matrix. The outcomes of the Ag/PP composite yarn and untreated PP yarn were contrasted. The text will now refer to the untreated PP yarn, the PP treated with silver (lower concentration), and the PP treated with silver (higher concentration) yarn samples, respectively, using the abbreviations "S," "S1," and "S2." The SEM picture of an untreated (S) PP yarn sample is depicted in Figure 1.

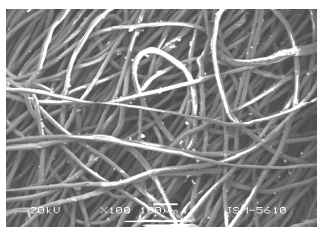


Figure 1: SEM image of S yarn

Antibacterial silver compound

The antibacterial substance utilised in this investigation was PP AMB-07-6000, which was provided by the Indian company Poddar Pigments Limited. M/s. Zenith Fibers provided two test master batches of polypropylene loaded with various concentrations of the ionic silver component. Then, utilising DREF spinning technology, these fibres were spun into yarn. Due to its porosity and low twist, the yarn spun using this process is ideal for producing wound filters and is widely used

as a water filter [5]. As was previously indicated, since silver is regarded safe for oral consumption, silver antibacterial material was believed safe for use in water filtration systems.

Methods

Morphological and chemical characterization of yarn for silver particles

SEM was used to study the surface morphology of the Ag/PP composite yarn on Japanese make instrument Jeol (JSM5610LV and version 1.0). By conducting an elemental analysis on the same instrument with Inca-software from Oxford (U.K.), the presence of silver in yarn was verified. FT-IR was used to further analyse the chemical makeup of the composite material; the data was collected using KBr wafer on a Bomem (MB series).

XRD

To confirm the presence of silver, the S1 sample was examined using Cu-K radiation on an X-Ray diffractometer running at 45 kV and 40 mA. Each sample's diffraction angles (2θ) were determined in continuous scan mode between 10° and 100° .

Antibacterial activity

This can be verified using standard AATCC 100 and 147 test methods and log reduction method (JIS L-1902); latter one being followed in this case as per the recommendation of the supplier.

It is reported that the log reduction approach is used for ionic silver complexes [4]. The material in the current investigation had to be cleaned with water at 80°C for an hour before to testing since oil attracts bacteria. The antibacterial efficacy was determined using log reduction. Following this pre-treatment, a suspension of microorganisms with about 106 organisms/ml was created in sterile normal saline (equivalent to 0.5 McFarland standard). 7.2 pH nutritional broth was incorporated to a the flask containing 0.75 g of sample, and one milliliter of the suspension was combined with the test sample, which was then exposed to viable counts using the proper dilutions. Upon 48 hours of incubation at 37°C for the inoculated bacteria, colony forming units (CFU) were measured. The effectiveness of the Ag/PP composite yarn was tested against both *S. aureus* gram positive (+ve) and *E. coli* gram negative (-ve) bacteria.

Results and Discussions

Elemental analysis of Ag/PP composite yarn

Using the scanning electron microscope and Oxford-Inca software, elemental analysis was carried out to confirm the actuality of silver particles. Silver and its weight % are confirmed by the spectrum obtained for the S1 yarn (lower concentration), which is displayed in Figure 2 and Table 1.

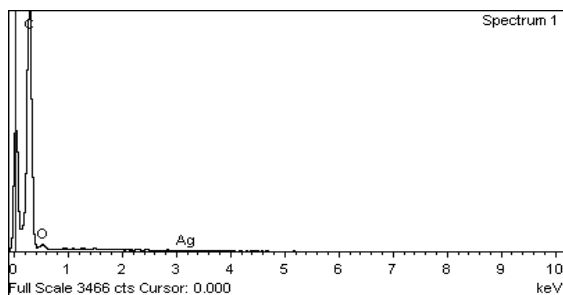
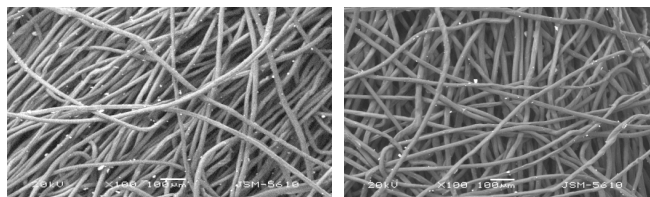


Figure 2: EDS spectrum of S1

Table 1: Elemental analysis of S1

Element	Weight %	Atomic %
C K	95.54	96.81
O K	4.15	3.16
Ag L	0.31	0.03
Totals	100.00	

Silver complex is present, as shown by the EDS spectrum in Figure 2, and according to the elemental analysis (Table 1), its weight percentage is 0.31. Additionally, it shows how evenly spread the silver compound is and how firmly attached it is to the polymer matrix.



(a) (b)

Figure 3: SEM image of (a) S1 and (b) S2 - Ag/PP composite yarn samples

The SEM images of the S1 and S2 yarn samples from the scanning electron microscope are shown in Figures 3 (a) and (b), respectively. The distribution of the silver compound to the yarn samples can be described as uniform. The spectrum taken for the silver composite S2 yarn is displayed in Figure 4 and Table 2, confirming the increased presence of silver in addition to weight percentag.

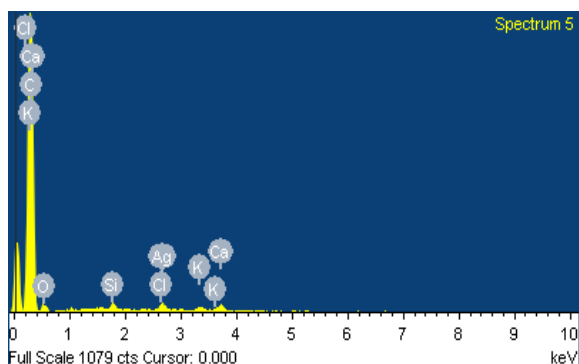


Figure 4: EDS of S2

Table 2: Elemental analysis of S2

Element	Weight %	Atomic %
C K	89.16	93.18
O K	7.21	5.66
Si K	0.62	0.28
Cl K	0.89	0.32
K K	0.62	0.20
Ca K	1.00	0.31
Ag L	0.50	0.06
Totals	100.00	

While the elemental analysis (Table 2) revealed that the silver compound's percentage was 0.50 (weight %), the EDS spectrum seen in figure 4 confirmed its presence. This further demonstrates uniform dispersion and a higher content of the silver compound than in S1.

Fourier Transform Infrared analysis

The chemical morphology of the Ag/PP composite yarn generated at two distinct concentration levels was examined for alterations brought on by the manufacturing process. Figure 5 displays the FTIR of untreated (S), PP yarn containing less silver (S1), and PP yarn containing more silver (S2), respectively.

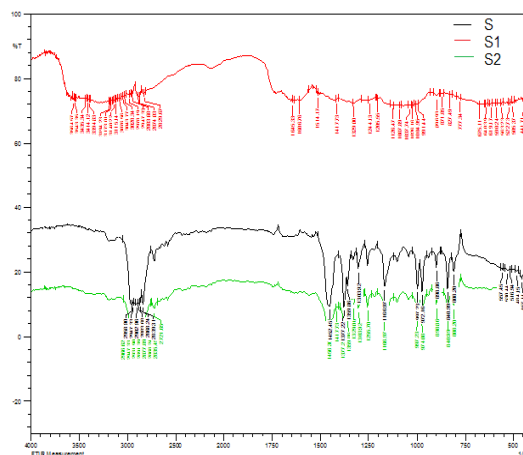


Figure 5: FT-IR spectrum of S, S1 and S2 yarn samples

The spectrum is a typical fingerprint of propene (C₃H₆) which undergoes addition polymerization to produce poly(propene) or also known as polypropylene. Absorption peak observed at ~ 2924 and ~ 2854 cm⁻¹ is due to stretching of CH₃ and CH₂ bonds whereas those observed at ~ 1456 and ~ 1377 cm⁻¹ is due to bending of CH₃ and CH₂. Wave number 3433.41 cm⁻¹ indicates vibrations due to stretching and bending of the alkane group. Presence of silver specifically however could be confirmed from the spectrum. Hence XRD of Ag/PP composite yarn of lower concentration (S1) was carried out.

XRD

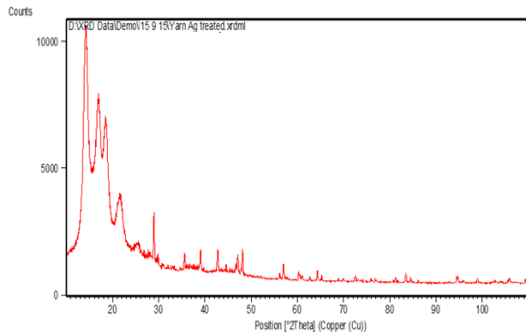


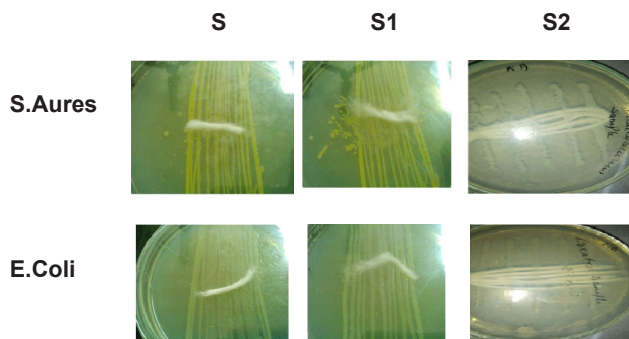
Figure 6: XRD of S1 yarn

It was reported that some of the peaks ($2\theta = 38.0, 44.6, 64.8,$ and 77.6°) correspond to the diffraction of silver metal [3]. Thus the XRD results also confirmed the presence of silver inside the polymer matrix. Since confirmation results were obtained in the PP yarn with lower concentration of silver compound (S1), XRD of S2 sample was not done.

Antibacterial activity

Table 3 shows that neither sample (S1 nor S2) had any antibacterial activity for both gram positive and gram negative bacteria when tested using the AATCC 100 test method, hence the AATCC 147 test method was not carried out.

Table 3: Summary of bacterial efficacy test on S, S1 and S2 yarn samples



However, the supplier had suggested that JIS test method antibacterial activity be used to evaluate Ag/PP composite yarns. Table 4 displays the log reduction findings for the S2 sample utilising E. Coli after 24 hours of microbial strain contact. Even with this test procedure, results for the S1 sample could not be obtained.

Table 4: Log reduction results

Initial Viable (Log_{10} C-FU) count	Exposure time of test	Viable count After exposure (Log_{10} CFU) (24 hours)	Log_{10} reduction (24 hours)	Percent Reduction (%) (24 hours)
$1.5 \times 10^6 = 6.17$	24hrs	$1.3 \times 10^5 = 5.11$	1.06	91.29%

The outcomes demonstrate that even a very modest amount of silver may not be appropriate to serve the objective of giving yarn an antibacterial characteristic for use in water filtering. Results from higher concentrations are encouraging, and employing silver in its nano form can help them further.

Conclusion

The objective of this investigation was to create Ag/PP composite yarn for filter media used in water filtration applications that would offer value. The morphological studies supported the successful integration and uniform distribution of the silver compound in the fibre matrix. The elemental and XRD analyses were able to demonstrate the presence of silver within the matrix. The yarn's effectiveness against the microorganisms was tested. In the qualitative and quantitative tests outlined by AATCC, antibacterial activity could not be seen. The log reduction technique, however, demonstrated that the yarn was effective against E.Coli. It is possible to conduct future research employing silver nanoparticles to increase the antibacterial effectiveness.

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Study of the properties of linen fabrics for the design of clothing decorated with embroidery

Kalyna Pashkevych, Olga Yezhova, Nataliia Ostapenko, Olena Gerasymenko, Bogdan Protsyk and

Kyiv National University of Technologies and Design, Kyiv, Ukraine

Nataliia Skliarenko

Lutsk National Technical University, Lutsk, Ukraine

Abstract

The article is devoted to the research of principles of designing sewing products with embroidery from linen fabrics based on the properties of fabrics. The physical and mechanical properties of linen fabrics are studied: thickness, mass, surface density, stiffness, drapery, tearing elongation and tearing load. The relationship between the physical and mechanical properties of linen fabrics with or without the use of interlinings is established. The classification of types of embroidery techniques is given and recommendations are developed for choosing fabrics and threads for the manufacture of products decorated with embroidery. The complex of scientific research conducted is the basis for the development of recommendations for the selection of linen fabrics for the development of modern collections of women's clothing models of various assortments with embellishments.

Key Words: Fashion Design, Physical and Mechanical Properties of Fabrics, Linen Fabrics, Trimming, Embroidery, Decoration, Clothing Shape, Fashion Designer

Introduction

The creation of new forms of clothing models becomes particularly important in the context of achieving a significant level of saturation of the modern market with clothing of various assortment types and purposes. This is related to the complexity of the structure of consumer needs, in which, along with quantitative indicators of the quality of products, qualitative indicators play an increasingly important role. One of the main conditions for obtaining high-quality products is the correct and reasonable choice of materials, taking into account the design features of the product, the manufacturing methods used and

its operating conditions.

Over the past few seasons, world fashion houses have presented a large number of clothing collections that use eco-friendly materials. Fashion for ecologically clean and safe for health and the environment clothes is experiencing a new round of popularity. Today, organic fibers are used for the production of organic fabrics – cotton, flax, wool, nettle, bamboo, seaweed, hemp, eucalyptus, corn, etc. Clothing and shoes made from cotton, linen, bamboo and hemp grown without pesticides, as well as from processed organic materials are presented in the collections of Stella McCartney, Giorgio Armani, Donna Karan, Levi's and others. Among young modern fashion designers, the

ideas of environmental friendliness and ethnicity are actively used by Maisop Martin Margiela, Yeohlee Teng, Timo Rissanen, Holly McQuillan.

One of the main conditions for obtaining high-quality products is the correct and reasonable choice of materials, taking into account the design features of the product, the manufacturing methods used and its operating conditions. Natural materials always remain in demand among clothing consumers and are considered an indicator of careful attitude to their health.

To meet the demands of a new industrial market, fibre flax must preserve its image as a high quality natural product, grown traditionally. Industrial flax, however, must meet the challenges of excessively rigorous agricultural constraints and risks related to its cultivation and retting [1].

Season after season, linen clothing is gaining popularity on world catwalks. Products made of linen fabrics are presented in the collections of world designers of clothing, shoes and accessories. The analysis of linen fabric products in designers' collections showed that a variety of decoration, especially hand embroidery, is often used in the production of linen fabric products, so the study of the design process of linen fabric clothing with decoration based on the study of fabric properties is an urgent task.

Analysis of previous studies

In the development of multifunctional linen fabrics using environmentally friendly chemicals, namely treatment using chitosan and green tea extract [2] as well as using reduced graphene oxide/silver nano composite [3] in order to give fabrics antibacterial properties and UV protection. The study [4] is aimed to investigate the thermophysiological comfort properties of shirt linen fabrics subjected to various finishing treatments such as enzymatic, softening and wrinkle-resistant treatments.

In the study [5] the authors determined that clothes made from mixtures of viscose fibers or linen can replace cotton fabrics for clothing designed for children with skin problems. In addition, some viscose materials (with chitosan) and linen are antibacterial, antistatic and thermoregulatory.

Research of tear characteristics of fabrics tear strength of a woven fabric is performed in article [6]. The authors conducted a strength study tear strength of four types of fabrics warp rib, weft rib, ripstop and plain weave were analysed, which were produced in different densities and with filament and textured polyester yarns.

Authors [7-9] have conducted a study of the physical and mechanical properties of costume fabrics and determined that the main indicators affecting the design and shape of clothing are thickness, stiffness and surface density.

In paper [10] the experimental paradigm of cognitive behaviors is introduced to study cognitive activities in the contiguous sense cognition of the tested linen clothing. The expression of the experimental stimulus material is realized with the developed dressing contiguous sense measurement device. Changing the relative force for the contact between fabric and human skin, the dressing contiguous sense is tested.

The study [11] is aimed at identifying factors that have raised demand for fashionable linen clothing in Sri Lanka. Factors affecting the purchasing behavior of consumers of linen clothing were discussed.

In the article [3] the authors outline the prospects for the development of the production of linen fabrics and linen products in India. The authors emphasize that linen blends very well with fibers such as; wool, silk, cotton etc. and is used for manufacturing, suitings, shirtings, strong twines, canvas and various in dispensable products for defense purposes. Apart from its versatility, flax is also an ecofriendly fiber. It consumes much less amount of water for irrigation and doesn't require insecticides and pesticides as much as cotton.

Scientists pay considerable attention to the issues of expanding the range of linen fabrics and products by developing new methods of decoration, weaving, giving fabrics unique medical and biological properties, improving the process of processing fabrics and other aspects that contribute to improving product quality indicators.

In the study [12] an analysis of modern trends in clothing design is performed, features and methods of finishing, technological methods of artistic embroidery are considered, and an overview of modern and traditional embroidery techniques is given. The study by Leghari and Shar [13] examines the particular qualities of mirror embroidery of the Sindh region in Pakistan from the point of view of its use in modern textile design. The article by Melnyk *et al.* [14] discusses the use of the folk Ukrainian pattern in the knitted fabric embellishment.

In the article by Cheng *et al.* [15] the method of antimicrobial finishing of cotton fabric with TX-DF by the argon/oxygen-plasma techniques have been discovered.

The analysis showed that the interest of clothing consumers in environmentally friendly and health-safe clothing is growing. In the textile industry, a significant place among environmentally friendly and trendy goods is occupied by flax-containing textile materials containing natural-colored linen fiber, which has exceptional natural properties, high strength, hygiene, natural bactericidal, environmental friendliness and naturalness. Models of clothing of various ranges and purposes made of linen fabrics are often decorated with a variety of embellishments, especially embroidery, which is a historical type of decoration of national clothing [16].

The purpose of the work is to improve the design of products made of linen fabrics with embroidery decoration based on their properties.

Materials and Methods

For a scientifically based selection of materials for the manufacture of women's clothing from linen fabrics, which would satisfy the requirements of consumers, seven samples of linen fabrics of linen weave of different raw materials were studied in order to determine their characteristics (Figure 1). The raw material composition of the studied tissue samples is shown in Table 1.

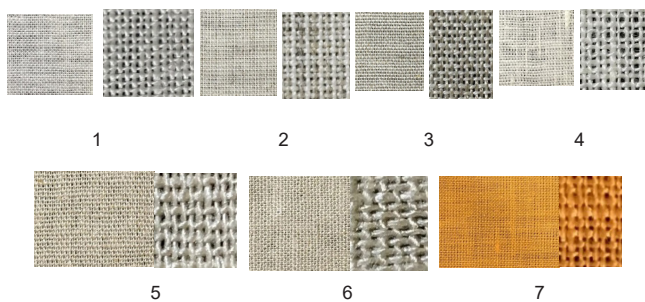


Figure 1. Samples of the studied linen fabrics

Table 1: Raw material composition of linen fabric samples (Fig. 1)

Fabric sample	F1	F2	F3	F3	F5	F6	F7
Raw material composition, %	30% linen / 70% viscose	15% linen/32% cotton / 53% polyester	30% linen/20% cotton / 50% polyester	100% linen	85% linen/15% elastane	55% linen / 42% viscose / 3% elastane	50% linen/ 50% cotton

The fabric obtained from linen is strong and coarse, has a large crease and shrinkage, so to improve the elastic properties of the fabric, other fibers are added to its composition, for example: cotton, elastane, viscose, nylon, etc. Therefore, modern linen-based materials can have a smooth surface, be thin, translucent, or be almost transparent.

According to DSTU 3047-95, pure linen fabrics include fabrics containing at least 100% of linen fiber; to linen – fabrics with at least 92%; semi-linen – fabrics containing at least 30%; to mixed linen – fabrics with at least 15% of linen fiber.

In the manufacture of linen products, various decorations are often used, especially embroidery, for which the fabric is strengthened with an adhesive lining material, which, thanks to its properties, changes the physical and mechanical characteristics of linen fabrics. To conduct the experiment, two samples of each fabric measuring 35050 mm in the longitudinal and transverse directions were prepared, which were doubled with two types of non-woven fabric: L1 – Gunold STIFFY 1620B dot adhesive non-woven fabric; L2 – Peri JUF4111H interlining dot adhesive non-woven fabric. The characteristics of non-woven fabrics are given in Table. 2.

Table 2: Characteristics of non-woven fabrics for embroidery

Code	Name	Raw material composition	Weight, g	Thickness, mm	Surface density, g / m ²
L1	GUNOLD STIFFY 162B	75% cellulose / 25% polyester	0.43	0.10	42
L2	Peri JUF4111H	100% polyester	0.41	0.18	40

Taking into account the aim and the purposes of the researches, it was decided to analyze 7 samples of linen fabrics of different fibrous composition, which differ in their appearance (thickness,

structure, type of weave, etc.). The main focus was on determining the properties of the fabrics, such as: thickness, surface density, flexural rigidity and drapeability. The test was carried out in accordance with the current normative documents, kept up the requirements to the objects of the experimental research; the processing of the results of the measurements was made using the mathematical apparatus of statistical analysis of the data. The test [17] was carried out in climatic conditions according to ISO standard 139:2005. Before the test, each sample had been kept in climatic conditions (relative air humidity 65 ± 4 % and temperature 20 ± 2 °C) for at least 24 hours.

Thickness [18] is measured under the pressure of 1kPa according to ISO standart 5084-1996.

The surface density [19] of the fabric (mass per unit area, Ms) in g/m² was determined according to (ISO standard 3801:1977). Drapeability, in accordance with (ISO standard 9073-9:2008), is “the ability of a circular specimen of a fabric of known size to deform when suspended under specified conditions” [20].

The draperability of the materials is determined by the disk method using the device, the scheme of which is shown in Figure 2.



Figure 2: The device for determination the drapeability of the fabric by the disk method

In evaluating the drapery properties of the dress materials of the different fibrous composition, the recommended values of the drapeability coefficient of the dress fabrics, given in Table 3, were taken into account.

Table 3: Evaluation of the degree of drapeability of the dress fabrics according Suprun at al. [21]

Fibrous composition	Drapeability coefficient, %		
	well	satisfactory	bad
Cotton	>65	45...65	<45
Wool	>80	68...80	<68
Silk	>85	75...85	<75

The rigidity [22] is determined using the console non-contact method according to GOST (State Standard) 10550-93, using a device of type PT-2 (Figure 3). For the study, 5 elementary samples were cut in longitudinal and transverse directions with dimensions of 160 × 30 mm. The elementary samples are weighed on scales with an error of not more than 0,01 g and the total weight (m, g) of the samples of longitudinal and transverse directions is determined separately.



Figure 3: The device type PT-2 for determination of the fabric rigidity by the console method

In accordance with the recommendations ISO 9073-9:2008, the coefficient of rigidity of the linen fabrics shall not exceed 9000 $\mu\text{N}\cdot\text{cm}^2$. The tearing [23] under tension characteristics is determined by the scale of the tearing machine at the time of material rupture according to GOST (State Standard) 3813-72, using a device of type PT-250M (Figure 4).



Figure 4: The fabric tearing under tension determination device

Results and Discussions

Results of the experimental study

Seven samples of linen fabrics of plain weave of various raw materials were studied and their physical and mechanical characteristics of linen fabrics were determined (Table. 4).

The tearing under tension characteristics of linen fabrics rein-

forced with non-woven fabrics and their rigidity are presented in Table 5 and Table 6.

Table 4: Basic physical and mechanical characteristics of linen fabrics

Fabric sample	Raw material composition, %	Thickness, mm	Surface density, g / m ²	Drapery coefficient, %	Warp stiffness, $\mu\text{N}\cdot\text{cm}^2$	Weft stiffness, $\mu\text{N}\cdot\text{cm}^2$
F1	30 % linen / 70 % viscose	0.40	200	21	6799	5923
F2	15 % linen / 32 % cotton / 53 % polyester	0.39	176	51	3470	884
F3	30 % linen / 20 % cotton / 50 % polyester	0.36	150	70	2120	773
F4	100% linen	0.44	194	30	3538	5923
F5	85 % linen / 15 % elastane	0.40	196	56	7302	1587
F6	55 % linen / 42 % viscose / 3 % elastane	0.41	194	52	6459	1049
F7	50 % linen / 50 % cotton	0.28	125	44	6174	2003

Table 5: Tearing under tension characteristics of linen fabrics before and after duplication

№ sample	Tearing Elongation, mm						Tearing Load, N					
	without non-woven fabric		L1		L2		without non-woven fabric		L1		L2	
	warp	weft	warp	weft	warp	weft	warp	weft	warp	weft	warp	weft
F1	20	22	24	26	23	26	601	542	653	550	620	580
F2	27	27	31	32	31	31	900	790	910	815	910	825
F3	30	24	33	31	33	21	1382	870	1365	867	1372	875
F4	22	21	29	17	31	26	400	310	660	584	658	487
F5	18	18	21	49	20	50	384	180	426	230	430	250
F6	23	27	21	58	22	57	377	240	390	280	430	310
F7	11	20	8	33	7	30	490	300	720	480	640	480

Table 6: Stiffness of linen fabrics after duplication

sample No.	Warp stiffness, $\mu\text{N}\times\text{cm}^2$			Weft stiffness, $\mu\text{N}\times\text{cm}^2$		
	without non-woven fabric	L1	L2	without non-woven fabric	L1	L2
F1	6799	75513	217179	5923	76216	69337
F2	3470	41140	81756	884	87232	132976
F3	2120	70076	41694	773	30537	45156
F4	30537	89542	208492	5923	66055	208492
F5	7302	119095	38133	1587	38735	151973
F6	6459	191118	164465	1049	30616	73040
F7	6174	69785	69785	2003	86085	114410

Discussion

The results of the correlation analysis of the physical and mechanical characteristics of linen fabrics are shown in the Table 7.

Table 7: Correlation coefficients between physical and mechanical characteristics of linen fabrics (number of samples N=7)

Physical and mechanical characteristic	Correlation coefficient r				
	Thickness, mm	Surface density, g / m ²	Drapery coefficient, %	Warp stiffness, $\mu\text{N}\times\text{cm}^2$	Weft stiffness, $\mu\text{N}\times\text{cm}^2$
Thickness, mm	-	0,92	-0,26	-0,06	0,39
Surface density, g / m ²		-	-0,39	0,30	0,43
Drapery coefficient, %			-	-0,35	-0,91
Warp stiffness, $\mu\text{N}\times\text{cm}^2$				-	0,13
Weft stiffness, $\mu\text{N}\times\text{cm}^2$					-

Based on the results of the study, it was determined that in most samples, thickness and surface density correlate with each other ($r=0.92$). As can be seen from the Table 7, surface density of fabrics is directly proportional to their thickness, i.e. as the fabric thickness increases; its surface density indicator also increases. Samples F1, F4, F5, and F6 have the highest thickness, respectively, and their surface density is the highest. When evaluating the properties of textile materials, their ability to form is determined by the drapeability ratio. Analysis of the table 3 shows that fabric samples F2, F3, F5, and F6 have the highest drapeability ratio. This is due to the fact that fabric samples F2 and F3 have a low content of linen fiber, while fabric samples F5 and F6 contain elastane. Fabric samples F1, F4 have poor drapery because they have the highest surface density. At the same time, a weak negative relationship was found between

Surface density and Drapery coefficient ($r=-0.39$). The product is made of linen fabric with a high surface density of the fabric, will not have high creasing ability, will retain the shape of the product better and will have high performance characteristics, but will not be convenient in everyday use, as it may limit the consumer's freedom of movement. For such fabrics, it is not recommended to use three-dimensional decorations: assemblies, pleats, flounces, etc.

A comparison of drapery and stiffness of the studied samples of linen fabrics was made, which showed that drapery is inversely proportional to stiffness, the lower the stiffness value in the samples is, the greater the drapery coefficient of the fabric is. At the same time, a strong negative relationship was established between Drapery coefficient and Weft stiffness ($r=0.91$). In the process of manufacturing sewing products and their operation, textile materials undergo a variety of mechanical influences that cause tensile, bending, compression, torsion, and friction deformations. Indicators of mechanical properties are widely used in clothing production, they characterize the property of the material to acquire and maintain a given shape and size, and are of great importance for assessing the quality of textile materials.

Analysis of data from Table 5 and comparison of the values of tearing elongation and tearing load of linen fabrics on the basis showed that samples F1, F2 and F3 have the highest tearing load indicators, samples F4, F5, F6, F7 have approximately the same strength and withstand almost the same tearing load, while samples F4, F5 and F6 are characterized by the fact that at a low tearing load they have a high tearing elongation both on the basis and on the weft. This dependence is explained by the fact that samples F4, F5, F6 in terms of raw material composition have the highest percentage of linen fibers, and samples F2 and F3 have the lowest content of linen fibers (less than 30%) and a high content of impurities from synthetic fibers (more than 50%), so they are stronger.

Comparison of the value of tearing elongation and tearing load of linen fabrics by weft (Table 5) showed that samples F1, F2 and F3 are the strongest, can withstand the greatest tearing load, while the tearing elongation is significant, that is, these fabrics have a direct relationship with a high tearing load and have a high tearing elongation.

The properties of fabric samples after their duplication with two types of non-woven fabrics were studied, the characteristics of which are given in Table 5. A comparison of the stiffness of interlining-reinforced linen fabrics is given in the Table 6.

The analysis shows that samples duplicated with L2 non-woven fabric have higher stiffness values than samples duplicated with L1 non-woven fabric. Thus, the result of the study shows that samples F1, F4, F6 on the basis and samples F2, F4 and F5 on the weft with L2 non-woven fabric have the best performance and can be recommended for use in products with machine embroidery. Comparison of the tearing load of duplicated linen fabrics showed that samples F4, F6, and F7 became significantly stronger after duplication, and their tearing load has increased. Samples F1, F2, F5 have a slight increase in tearing load, sample F3 is the strongest, because

it contains synthetic fibers, so duplication did not significantly affect its characteristics. Usually, fabrics in the weft direction are less resistant to tearing load, so non-woven fabrics have enhanced their breaking characteristics in this direction more. The use of non-woven fabrics L1 and L2 significantly affected the performance of fabric samples on the warp, but when using L2, more fabric strengthening occurred on the weft.

After analyzing the tearing elongation of the fabric samples (Table 5), it was found that the tearing elongation increased after duplication, only in samples F6 and F7 the tearing elongation decreased after duplication, these samples have been quickly teared. Thus, it can be noted that the use of non-woven fabrics contributes to an increase in the tearing elongation of fabric samples, but F5 and F6 samples were most enhanced as a result of duplication, which can be explained by the elastane content in the samples of these fabrics.

A comparison of the tearing elongation obtained by the tissues after duplication is made. A comparison of the properties of L1 and L2 non-woven fabrics showed that L2 non-woven fabric has better properties, since fabric samples duplicated with it have better tearing characteristics than samples duplicated with L1 non-woven fabric. After duplicating fabrics with L2 non-woven fabric, they have become more durable, so this non-woven fabric can be recommended for use in embroidery products. The main factor that must be taken into account when choosing non-woven fabric is recommended to consider the tearing load.

The conducted experiment shows that samples of fabrics F1 and F4 can be recommended for hand embroidery, samples F1, F4 and F5 with L2 non-woven reinforcement can be recommended for use in products with machine embroidery.

Justification of the choice of fabrics and threads for hand embroidery

Embroidery is often used in linen fabric products. Embroidery is a type of decorative design of textile products, in which the figure pattern is applied to the fabric using colored, gold and silver threads, beads, glass beads, beads, etc.

Embroidery decoration is used in the manufacture of the first line of clothing, so designers emphasize the uniqueness and exclusivity of products. Clothing with this type of decoration, according to the analysis of collections at fashion weeks in recent years, is relevant among many world designers. In their collections, embroidery is actively used and demonstrated by such fashion houses as Valentino, Givenchy, Tom Ford, DandG, Chloe, Paula, Cademartori, Balmain, Zuhair Murad, Christian Dior, Elie Saab and others.

Embroidery is divided into hand and machine embroidery. Hand embroidery is popular in the collections of modern designers, because it is unique, original, differs from machine embroidery in the quality of execution and the variety of materials used. Since the 19th century, the development of technologies and the use of special embroidery equipment had made it possible to reduce manual labor and use machine embroidery.

Embroidery is divided into perforating and surface embroidery. Techniques in which the fabric is embroidered on a solid surface without pulling out or cutting the thread are called surface-

embroidered. Perforating – these are openwork embroidery on the fabric, placed not on the surface, but within the fabric, thereby changing its structure.

According to the method of performing embroidery, they are divided into free and counting ones. Counting embroidery involves calculating the number of stitches. Free embroidery techniques are performed according to pre-planned contours of patterns, while the stitch length is not calculated. Free seams allow you to embroider patterns with curved contours on any fabric: silk, velvet, wool fabrics, etc. Most often, free embroidery techniques are used to reproduce plant ornaments.

Embroidery is also divided into one-sided and two-sided. One-sided embroidery form a pattern only on the front side of the product, and only individual stitches and thread transitions will be visible from the reverse side. The two sides form a pattern almost identical on both sides of the fabric.

There is a classification of types of embroidery: cross, smooth, openwork-slotted, knotted, vestibule stitches, etc. Based on the study of technological and artistic features of embroidery, the following varieties can be distinguished: based on the materials used – threads, sequins, beads, pearls, gold or silver thread, etc.; according to the types of seams and stitches: free, with arbitrary arrangement of stitches according to the drawing or counting - according to calculations; by the number of threads of fabric and stitches: openwork embroidery, colored satin stitch, free seam, cross, half-cross, satin stitch, vestibule, tapestry seam, etc.; by the nature of the pattern: ornamental, plot, etc.; by color: white, multicolor, etc.

Cross-stitch is the most common technique of embroidery and decorating clothes and the simplest type of counting embroidery, which uses threads of different colors. The basis of smooth embroidery techniques are stitches that form an even and smooth surface along a free contour. The possibilities of this seam are very diverse. According to the method of creation, the satin stitch is divided into counting (straight and oblique) and free satin stitch, which is performed according to the contour of the drawing. In turn, it can be one-sided or two-sided. The following types are distinguished: close stitch, flat stitch, layered stitch, split stitch, loop stitch, “forward needle” stitch and others.

“Grain output” is an embroidery technique that uses stitches that form diagonal lines made up of small contoured squares. The “grain output” seam is usually used in combination with other seams (“counting stitch”, “punching”) in geometric ornaments. Each stitch of the contour square of the grain output is made double, that is, by superimposing threads on top of each other, while pulling the threads of the fabric. When using embroidery, it is important to choose fabrics with certain properties that characterize its thickness, surface density and raw material composition. An experimental study of 7 samples of linen fabrics showed that all of them are suitable for embroidery decoration. Due to the fact that samples F4, F5 and F7 are similar in properties, four fabric samples were selected: sample F1 (30% linen, 70% viscose; 0.40 mm, 200 g / m²), sample F2 (15% linen, 32% cotton, 53% polyester; 0.39 mm, 176 g / m²), sample F3 (30% linen, 20% cotton, 50% polyester, 0.36 mm, 150 g / m²), sample F4 (100% linen, 0.44 mm, 194 g / m²). On

the selected samples of fabrics, embroidery “satin stitch” and “grain output” is performed with three different types of threads in order to determine the best initial conditions for obtaining high-quality embroidery and provide recommendations on the use of a certain embroidery technique and a certain type of thread for its implementation.

24 embroidery samples were made on selected fabric samples, using two types of techniques: grain output and smooth surface. Each embroidery technique is made with three types of threads. Photos of samples of snippets with embroidery are given in Table 8, Table 9. The samples are marked as follows: the first mark is the fabric sample number; the second mark is the type of embroidery: 1 – grain output; 2 – satin stitch; the third mark is the type of thread: 1 – DMC cotton floss threads; 2 – YarnArt woolen threads; 3 – linen yarn.

Table 8: samples of linen fabrics with embroidery “grain output”

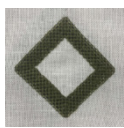








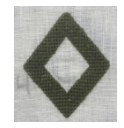














Fabric	Thread type		
	DMC cotton floss threads	Yarn Art woolen threads	Linen yarn
Sample 1 (30% linen, 70% viscose; 0.40 mm, 200 g / m ²)			
	F1.1.1	F1.1.2	F1.1.3
Sample 2 (15% linen, 32% cotton, 53% polyester; 0.39 mm, 176 g / m ²)			
	F2.1.1	F2.1.2	F2.1.3
Sample 3 (30% linen, 20% cotton, 50% polyester, 0.36 mm, 150 g / m ²)			
	F3.1.1	F3.1.2	F3.1.3
Sample 4 (100% linen, 0.44 mm, 195 g / m ²)			
	F4.1.1	F4.1.2	F4.1.3

Table 9: Samples of linen fabrics with embroidery satin stitch

Fabric	Thread type		
	DMC cotton floss threads	Yarn Art woolen threads	Linen yarn
Sample 1 (30% linen, 70% viscose; 0.40 mm, 200 g / m ²)			
	F1.2.1	F1.2.2	F1.2.3
Sample 2 (15% linen, 32% cotton, 53% polyester; 0.39 mm, 176 g / m ²)			
	F2.2.1	F2.2.2	F2.2.3
Sample 3 (30% linen, 20% cotton, 50% polyester, 0.36 mm, 150 g / m ²)			
	F3.2.1	F3.2.2	F3.2.3
Sample 4 (100% linen, 0.44 mm, 195 g / m ²)			
	F4.2.1	F4.2.2	F4.2.3

To determine the best embroidered sample, an expert assessment was carried out. Experts evaluated the following indicators: volume of embroidery, smoothness of the embroidery surface, texture of embroidery (fluffiness), deformation of the embroidered area (bulge, depression, undulation); deformation of the area adjacent to the embroidered one; correspondence of embroidery to the design (skew, curvature of the drawing).

The quality of embroidered materials was evaluated by a group of 10 experts. All experts have a higher education in fashion design and work experience in the field of fashion design or fashion education for 15-26 years, 4 of them have a scientific degree of candidate of technical sciences, 2 have a degree of Doctor of Technical Sciences, 4 have the title of Master of Artistic Creativity. For a comprehensive combined assessment of the quality of embroidered material, an embroidery quality assessment card was developed in accordance with the methodology described in the study Yezhova, Pashkevich at al. (2018), adapted to hand embroidery on linen fabric. Experts were asked to evaluate the quality of each piece of embroidery separately.

Expert quality assessment was carried out on a 4-point scale: 3 – defects are absent or almost invisible, 2 – defect is barely noticeable and somewhat affects the quality of the semi-finished product; 1 – defect is very noticeable and significantly spoils the quality of the semi-finished product; 0 – the semi-finished product is unsuitable.

The quality of embroidered semi-finished products was evaluated after 30 minutes of rest after removal from the embroidery frame. An example of a card for evaluating the quality of embroidered samples is given in Table 10.

Table 10: Embroidery quality assessment card

Embroidery sample No.	Embroidery defect	Defect around embroidery	Rating, points
F1.1.1	-	-	3
F1.1.2	slight deformation of the drawing	-	2
F1.1.3	-	-	3
F2.1.1.	skew, asymmetry of the drawing	bulge	0
F2.1.2.	drawing deformation	bulge	1
F2.1.3	skew, asymmetry of the drawing	bulge	0
F3.1.1	drawing deformation	bulge	1
F3.1.2	drawing deformation	bulge	1
F3.1.3	slight deformation of the drawing	bulge	2
F4.1.1	slight deformation of the drawing	bulge	2
F4.1.2	slight deformation of the drawing	-	2
F4.1.3	slight deformation of the drawing	-	2
F1.2.1	-	-	3
F1.2.2	-	-	3
F1.2.3	-	-	3
F2.2.1	-	undulation	2
F2.2.2	-	-	3
F2.2.3	-	undulation	2
F3.2.1	-	-	3
F3.2.2	-	-	3
F3.2.3	-	-	3
F4.2.1	-	bulge	2
F4.2.2	-	-	3
F4.2.3	-	bulge	2

Average ratings of embroidered samples are shown in Table 11.

Table 11: Average ratings of embroidered samples based on the results of the examination (number of experts N=10)

Embroidery technique	Material No.	Average sample rating, points			Average rating of samples from the material, points
		Threads No.			
		1 – floss	2 – wool	3 – linen	
"grain output"	F1	2.9	2.2	2.9	2.7
	F2	0.4	1.2	0	0.5
	F3	1.5	1.4	1.9	1.6
	F4	2.0	2.2	1.8	2.0
	Average rating value	1.7	1.8	1.7	1.7
satin stitch	F1	3.0	2.9	2.9	2.9
	F2	2.3	2.8	2.2	2.4
	F3	3.0	2.9	3.0	3.0
	F4	2.3	2.6	2.1	2.3
	Average rating value	2.7	2.8	2.6	2.7

Recommendations and implementation of research results

According to the results of the experts' assessment of the "grain output" embroidery technique, the embroidered samples from F1 and F4 materials received the highest average score - 2.7 and 2.0, respectively. This means that when designing products from these samples, it is recommended to use the "grain output" embroidery technique. As can be seen from the Table 4, these are the samples with the highest surface density (200g / m² and 194 g / m² respectively), and with the lowest drapery (21% and 30%, respectively). These samples also exhibit high warp and weft stiffness, with the sample with the highest embroidery quality score of F1 having warp stiffness only 15% different from weft stiffness (6799 $\mu\text{N}\times\text{cm}^2$ and 5923 $\mu\text{N}\times\text{cm}^2$, respectively). Sample F4 received lower ratings, while its warp stiffness (3538 $\mu\text{N}\times\text{cm}^2$) is 1.7 times lower than the weft stiffness (5923 $\mu\text{N}\times\text{cm}^2$). For samples F2 and F3, for which the average score is 0.5 and 1.6 points, respectively, it is not recommended to use counting techniques of hand embroidery, in particular, "grain output". These are samples with a lower surface density (176 g / m² and 150 g / m² and better drapery (51% and 70%, respectively). At the same time, the weft stiffness in these samples is significantly lower than the warp stiffness (F2: 3470 $\mu\text{N}\times\text{cm}^2$ and 884 $\mu\text{N}\times\text{cm}^2$, respectively, F3: 2120 $\mu\text{N}\times\text{cm}^2$ and 773 $\mu\text{N}\times\text{cm}^2$, respectively). So, for counting techniques of hand embroidery, in particular, "grain output", we recommend choosing linen materials with a high surface density (more than 190 g / m²) and low drapery (30% or less). At the same time, the warp stiffness should not differ significantly from the weft stiffness, and should be at least 3000 $\mu\text{N}\times\text{cm}^2$.

We note that the highest ratings (2.9 points each) were given to the F1.1.1 and F1.1.3 samples embroidered with floss threads and linen threads. At the same time, the average score (1.8 points) is the highest for samples embroidered with woolen threads, which is only 3% higher than the average score of all samples embroidered with the "grain output" technique (1.7 points). This indicates that, based on the results of the experiment, it is impossible to provide reasonable recommendations for choosing threads for hand embroidery.

According to the results of the expert evaluation of the satin stitch embroidery technique, all samples received ratings of 2.1 ... 3.0 points. This result indicates that you can embroider with the satin stitch technique on any linen fabric with a surface density of 150 ... 200 g / m². At the same time, embroidered samples made of F1 and F3 materials received the highest average rating – 2.79 and 3.0, respectively, which demonstrates the independence of the quality of embroidery with the satin stitch technique from the surface density of the fabric sample.

We note that the maximum scores (3.0 points each) were given to samples F1.2.1 and F3.2.1 embroidered with floss threads, as well as a sample F3.2.3 embroidered with linen threads. At the same time, the average score (2.8 points) is the highest for samples embroidered with woolen threads, which is only 5%

higher than the average score of all samples embroidered with the “satin stitch” technique (2.7 points). As in the previous case, this indicates that based on the results of the experiment, it is impossible to provide reasonable recommendations for choosing threads for hand embroidery. In each specific case, you should choose embroidery threads in accordance with the creative idea and design of the product, taking into account the color, shine, volume that are inherent in a particular type of thread.

The conducted complex of scientific research is the basis for developing recommendations on the choice of linen fabrics for the development of modern collections of women's clothing models of various ranges.

Based on the data table in Table 3, recommendations for the design of women's products are given for the studied samples of linen fabrics (Table 12).

Table 12: Recommended clothing models for linen fabric samples

Sample characteristics	Fabric sample						
	F1	F2	F3	F4	F5	F6	F7
Raw material composition, %	30% linen / 70% viscose	15% linen/32% cotton / 53% polyester	30% linen/20% cotton / 50% polyester	100% linen	85% linen/15% elastane	55% linen / 42% viscose / 3% elastane	50% linen/50% cotton
Surface density, g / m ²	200	176	150	194	196	194	125
Thickness, mm	0.40	0.39	0.36	0.44	0.40	0.41	0.28
Recommended models of clothing	dress, skirt, shorts, pea jacket,	dress, blouse, skirt	dress, skirt, shorts	dress, skirt, jumpsuit, jacket	dress, skirt, shorts, jacket	dress, skirt, jumpsuit, jacket	top, blouse
Example of recommended models of clothing	 Jacques-mus SS20	 Prada SS20	 Rejina Pyo SS20	 Jacques-mus SS20	 Oscar de la Renta SS20	 Gabriela Hearst SS20	 Rejina Pyo SS20

Sketches of the author's collection of women's clothing made of linen fabrics have been developed (Figure. 5), which consists of five clothing models and is based on the principles of consistency, connections and development of the original basic symbol-shape (rectangle). The collection includes models of women's youth clothing of the spring-summer season made of linen fabrics in warm shades of sand and brown. Products of a semi-fitting silhouette without sleeves or with sewn sleeves and contain relief lines. For decoration, embroidery is used, which is located on different parts of the products.



Figure 5: Sketches of clothing models of the women's clothing collection made of linen fabrics

Conclusion

The sequence of clothing design made of linen fabrics is considered and fashion trends regarding the use of embroidery in clothing collections are determined. Classification of varieties of modern embroidery is provided. Embroidery as a decoration in the work of foreign designers is analyzed and it is established that embroidery is most often used in couture collections by well-known fashion houses such as Dior, Chanel, Balmain. Most designers use embroidery to make the product exclusive, hand embroidery increases the value of the product. Mass market brands usually adapt embroidery and use it in the form of prints and applications.

Samples of linen fabrics were studied and their physical and mechanical parameters were determined: thickness, surface density, tearing load and tearing elongation. The relationship between the physical and mechanical properties of linen fabrics with or without the use of interlinings is established.

24 embroidery samples were made using two embroidery techniques: satin stitch and grain output. An expert assessment was carried out to determine the best embroidered samples in order to determine the best initial conditions for obtaining high-quality embroidery and provide recommendations on the use of a certain embroidery technique and the type of thread for its implementation. It is established that for counting techniques of hand embroidery, it is recommended to choose linen materials with a high surface density (more than 190 g/m²) and low drapery (30% or less). At the same time, the warp stiffness should not differ significantly from the weft stiffness, and should be at least 3000 μN×cm². It is proved that you can embroider with the satin stitch technique on any linen fabric with a surface density of 150 ... 200 g / m².

When choosing embroidery threads, it is recommended to take into account first of all the design of the product, considering the color, shine, volume that are inherent in a particular type of thread.

Sketches of models of the women's clothing collection with embroidery made of linen fabrics are offered. Prospects for further research include consideration of innovative technologies for decorating linen fabrics and products made from them, providing scientifically based recommendations for the selection of fabrics with certain properties in the manufacture of clothing of various assortments and purposes.

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Textile Kaleidoscope News

Mixed trends in ICE Cotton

ICE cotton exhibited a mixed trend in the US trading session. Although the front-month May contract was last traded at 86.38 cents per pound (0.453 kg) with a mild gain of 0.34 cent, it continued to exhibit a bearish tone during the trading. US cotton futures were still struggling to find support, with the July and December futures also experiencing selling pressure.

According to a market analyst, ICE cotton recorded a high volume with nearly 75,000 lots traded, but open interest declined. The dollar index was slightly up, exerting pressure on the cotton market, although the gains were minimal. Crude oil prices continued to fall, nearing \$85 per barrel, which also posed a negative factor for cotton futures. According to ICE data, certificated stocks saw another increase as of April 8, with deliverable cotton contracts rising from 112,054 bales to 125,722 bales. The major focus now is on the next WASDE report and US export sales for more indications about demand and the scenario.

Changing crop preferences may impact India's cotton output

The USDA's Foreign Agriculture Service (FAS) has projected a two per cent decline in India's cotton production due to various factors. It has projected cotton production at 25.4 million bales of 480 lb (equivalent to 0.453 kg) for 2024-25. Additionally, it has estimated cotton sowing to cover an area of 12.4 million hectares in the country. The report suggests that farmers may shift from cotton to crops with higher returns, such as pulses, maize, and paddy. FAS Mumbai, in its report, stated that India's cotton production is expected to be 25.4 million bales of 480 lb (or 32.5 million bales of 170 kg/5.5 million tonnes). The current farmgate prices for seed cotton in March 2024 have seen an improvement from the previous month but are nearly six per cent lower than the previous year, which could deter farmers from planting cotton. However, the anticipation of a normal monsoon season is projected to enhance the yield by two per cent to 446 kilograms per hectare in the upcoming season.

According to the report, India's cotton consumption is projected to be 24.5 million bales of 480 lb (or 31.4 million bales of 170 kg), an increase of two per cent from the previous year. A significant recovery in the exports of value-added cotton products, especially cotton yarn and fabric, in the first six

months of 2023-24 signifies a recovery in mill consumption. As of March 7, the Cotlook A-Index has increased by five per cent since October 2023 (the start of the Indian marketing year), while Indian ex-gin prices and domestic cotton yarn prices have risen by 2.5 per cent and one per cent, respectively, during the same timeframe. Since October 2023, the Indian spot prices (Shankar-6) have increased by three per cent, from 92 cents per pound to 95 cents per pound. Currently, Indian prices are seven per cent lower than the Cotlook A-Index, making them highly competitive. This supports the consumption forecast and a projected rebound in the exports of yarn and textile products. Year-to-date exports (August-February) of cotton yarn by volume are 114 per cent higher than the previous year, and fabric exports are 11 per cent higher.

Textile production increased by three per cent, but apparel production decreased by two per cent in January 2024, according to the Index of Industrial Production - Quick Forecasts for January 2024, compared to the previous year. Cumulatively (April-January), textile production has slightly improved by 0.4 per cent, but apparel production has declined by 17 per cent. Any increase in consumption is expected to lead to a recovery or compensate for the considerable output losses of the past two seasons. For the 2024-25 season, cotton exports are expected to reach 2.4 million

bales of 480 lb (or 3.1 million bales of 170 kg). Higher carryover stocks will provide India with an exportable surplus, and the depreciation of the rupee will facilitate export opportunities for cotton and cotton products. Following the recent revocation of import duty on extra-long staple (ELS) cotton, imports are predicted to be 20 per cent higher at 2.4 million 480 lb bales.

Sustainable fashion amid growing awareness

France's landmark bill proposes a total ban on ultra-fast fashion advertisements and annually increasing fines of up to ten euros per item of clothing as a measure to curb the devastating environmental impact fast fashion is having on the planet. While an outright ban on ultra-fast fashion has not yet been proposed in Australia, brands are facing a growing obligation to provide evidence of ethical production processes.

This is evidenced by a 2023 survey conducted by Monash Business School which revealed that more than half of Australians (51%) say that sustainability is an important factor when making a retail purchase. The greatest harms posed by the rise of ultra-fast fashion include but are not limited to: 1) Unsustainable production and supply chain processes, 2) Environmental pollution and 3) Worker exploitation. By 2030, all textile products for sale in the European Union will need to carry a Digital Product Passport (DPP), containing an unprecedented amount of

environmental impact data. Crucially, the DPP is linked to France's bill which would mandate that all fast fashion retailers include an item's reuse, repair, recycling, and environmental impact near the product's price tag – requiring complete supply chain traceability for all companies exporting to the EU. 200,000 tonnes of clothing goes into Australian landfills each year, with the rise of ultra-fast fashion brands as a major contributor. Announced by the Australian government a year ago, Seamless aims to divert 120,000 tonnes of end of life clothing from landfills by 2027, a goal they are achieving through major partnerships with brands like BIG W, Lorna Jane and David Jones. Circular fashion refers to the creation of a closed-loop system for apparel, reducing waste and maximising the lifespan of clothing and textiles – unlike fast fashion garments, which often fall apart after a few uses. If the approach is implemented correctly, brands can reap the benefits. Australian apparel brands are increasingly embracing the philosophy of 'conscious fashion', which is seen as the antithesis to ultra-fast fashion.

Universal Fibers unveils High Bulk | Low Weight fibre technology

Innovation has always been at the heart of Universal Fibers operations, driving the company to continually push boundaries in the realm of interior design solutions. With over 50 years of expertise, Universal Fibers proudly highlights a breakthrough in fiber technology: High Bulk | Low Weight, a game-changing innovation poised to redefine the industry landscape. Years of meticulous research and development have culminated in High Bulk | Low Weight, a proprietary finishing capability that merges technical prowess with cutting-edge technology. This innovation introduces a highly bulked fiber with voluminous coverage at significantly lower weights than the industry average, setting a new standard for luxurious texture and aesthetic appeal. Beyond its striking visual appeal, High Bulk | Low Weight technology presents a multitude of advantages. By requiring approximately 20 less fiber per square meter, it delivers substantial cost savings and reduces environmental impact. Furthermore, its lower energy

consumption during production translates to decreased CO2 emissions, aligning with sustainability goals. As Universal Fibers continues to pioneer innovation in the interior design industry, High Bulk | Low Weight technology stands as a testament to the company's unwavering commitment to excellence, sustainability, and customer satisfaction.

Lab in a bag showcases sustainability

Engaging with customers, community, and next-generation is important to promote sustainability and new values stated renowned Professor, Texas Tech University, USA.

As part of the 6th annual Engaged Scholarship Symposium organized by Texas Tech University, sustainability aspects of cotton and advanced applications were showcased using a mobile laboratory, termed as "Lab in a Bag." Renowned Professor, Texas Tech University, USA had an opportunity to present his research with High Plains' cotton producers, "Engaged Research in National Defense, Human Health, and Environmental Protection," that focuses on finding new applications for cotton, developing alternatives to plastics, and exploring opportunities for cotton in defense and industrial sectors.

The symposium highlighted various aspects of engagement such as using theatre plays to simulate disaster days, pictorial representation of a situation, etc. The power of effective engagement with stakeholders was stressed in the event. Presentations involved researchers from arts, engineering, family science and English all focusing on outreach and engagement. Their work featured a mobile laboratory using a "Lab in Bag," that has materials to highlight the earth friendliness of natural materials like cotton. The way the mobile laboratory can be put together with ease attracted the attention of the audience in the symposium. Such a makeshift laboratory can be used by different industries to highlight their uniqueness. Lab in a Bag set-up consists of a packet of cotton, cotton nonwoven samples, oil absorption set-up, experimental oil, and safety equipment. This set-up can be quickly assembled and can be used to demonstrate new applications of cotton such as oil absorption to school

students, consumers, and for promoting the product. Practical demonstrations enhance awareness and interest in sustainable products. In the case of oil absorption by raw cotton, "Lab in a Bag," projected the scientific mechanism to show how such products are biodegradable.

Professor, Texas Tech University, USA further stated that it was clear that people are aware of microplastic pollution, and the industry must involve in aggressive engagement with the society to highlight the positiveness of cotton such as the development of value-added products, biodegradability, and providing livelihood to many farmers in developing nations such as those in Africa. It is becoming clear that better messaging and reaching out to practitioners in other disciplines such as theater, music, and art can produce positive campaigns to relay facts about cotton and other natural products.

Glacier protection and circular textile plan

The Lenzing Group, a leading supplier of regenerated cellulose for the textile and nonwovens industries, has created a unique, innovative concept that contributes to the sustainable protection of our glaciers while inspiring collective action for sustainable practices and a circular economy in the nonwovens and textile value chain. The melting of glaciers is being severely impacted by global warming. Geotextiles are used to protect ice and snow. However, the nonwovens used for this are made of fossil-based fibers, which allow microplastics to enter the valley via streams and may enter the food chain through small organisms and animals. Nonwovens made from cellulosic LENZING fibers, which are biodegradable at the end of their life cycle and can be completely recycled, are the sustainable solution to this problem. The covering of a small area with the new material made from LENZING fibers was tested for the first time during a field test on the Stubaui Glacier. Four meters of ice were saved from melting.

Source:

<https://www.fibre2fashion.com/news/>

Nonwovens and Advanced Materials Laboratory, Texas Tech University, Lubbock, USA

Technical Textiles News

Smart textiles for intensive sensory perception

German researchers are developing a virtual encounter system using smart textiles for intensive sensory perception that can appeal to all the senses. The 'Multi-Immerse' project can enable ill children in isolation wards in hospitals feel the closeness of their parents' bodies even during computer-simulated visits, i.e., they can still see, hear and feel the intense closeness despite the spatial separation. The Saarland University of Applied Sciences, the Center for Mechatronics and Automation Technology (ZeMA) and the German Research Center for Artificial Intelligence (DFKI) are working on the technology.

Surfaces are given new abilities using light silicone films. Engineers then turn the 50-micrometres thick films into a second skin, which acts as an interface to the virtual world. This is intended to create a new body perception in fictional reality, a release from the Saarland University stated. Integrated into a textile, the films are intended to transfer the touch to the child's skin that occurs when mother or father strokes a second smart textile somewhere else. "We use the films, so-called dielectric elastomers, as sensors to record the touch movements and at the same time as actuators, i.e. drives, to pass on these movements," explained professor of intelligent material systems. As a sensor, the film detects how exactly hands and fingers press, dent and stretch the film when you move it over it. The film imitates exactly this deformation, which is caused by the touching movements, in a second textile on the child's skin in order to give the impression of being stroked over the child's arm, the release added. "The top and bottom of the film are printed with a conductive, highly stretchable electrode layer. When we apply an electrical voltage to this, the electrodes attract each other due to the electrostatic

attraction and compress the film, which moves to the side and increases its area," stated the bridge professorship 'Smart Material Systems for Innovative Production' between Saarland University and ZeMA. With every slight movement, the electrical capacity of the film changes: a physical quantity that can be measured. So if a finger strokes the film, it deforms it and an exact measurement of the electrical capacity can be assigned to each individual position: a specific number describes a very specific position of the film. A sequence of these individual measured values sets a sequence of movements in motion. The film is, therefore, its own stretchable sensor that detects how it is being deformed. At the Hannover Messe, the team demonstrated its technology with a watch that has a smart film on the back. The process is cheap, easy, noiseless and energy efficient. Film technology can also make gaming experience more intense in computer games through realistic body perception.

Commercial production of polyester chips in India

UFlex, India's largest multinational flexible packaging and solutions company, has successfully commenced commercialising poly-condensed polyester chips at its manufacturing facility in Panipat, India. UFlex's polyester chips manufacturing plant has an impressive installed capacity of 168,000 metric tons per annum (MTPA) and reaffirms the company's commitment to expanding its vertical integration footprint. The Panipat plant will primarily manufacture poly-condensed polyester chips, which is a key raw material required to produce BOPET packaging films, the company stated in a press release.

In addition to catering to its in-house packaging film production, the facility will cater to third-party customers,

contributing to the growth and sustainability of the packaging film industry in India. The Panipat facility complements the company's packaging films India footprint in Noida, the National Capital Region, and Dharwad, Karnataka, further solidifying UFlex's presence and capabilities in serving its packaging film customers across the country. "We are extremely buoyant about the commissioning of our polyester chips plant in Panipat. Now more than ever, our customers are interested in reliability, speed, and quality in their supply chain, and this expansion will allow us to deliver on those expectations. We are relying on our vertical integration strategy to meet the ever-increasing demand of the packaging industry and are betting on new capacities, and the ability to deliver quality, innovation, and customised solutions that the industry expects from UFlex. Leveraging advanced technology and sustainable practices, the company remains dedicated to delivering superior products and solutions that address the dynamic needs of the packaging market," chairman and managing director, UFlex Limited, stated.

Non-fluorinated barrier for firefighter gear

Fire-Dex, a leading US-based manufacturer of gear for first responders, has announced its introduction of a non-fluorinated moisture barrier option for turnout gear, marking a significant advancement in personal protective equipment (PPE) for firefighters. The company has collaborated with Stedfast to incorporate Stedair Clear, the first non-fluorinated moisture barrier of its kind, into their product offerings, showcasing their commitment to innovation and safety. Stedair Clear represents the latest in barrier technology, designed to not only meet but exceed the stringent requirements set by the NFPA 1971 standards. This barrier is made from a

Nomex woven pyjama check, laminated to a non-fluorinated barrier that is enhanced with a highly engineered polymer coating, ensuring both performance and durability. One of the most notable features of Stedair Clear is its impact on overall breathability, Fire-Dex stated.

“By introducing this non-fluorinated option, firefighters can now make the choice that is right for their department. If they choose to move forward with a non-fluorinated moisture barrier, Fire-Dex can offer the most breathable composite options due to our innovative material science,” stated vice president of product innovation and strategy at Fire-Dex.

Fire-Dex’s composites, which include the exclusive TECGEN71 outer shell, have been shown through UL test data to achieve a Total Heat Loss (THL) of over 300, the highest available on the market by a significant margin. This enhancement in breathability is pivotal in reducing heat stress for firefighters by decreasing weight and increasing flexibility in three-layer composites. In addition to the non-fluorinated moisture barrier, Fire-Dex has also introduced AeroFlex, innovative turnout gear designed to further assist firefighters in managing their core body temperature. AeroFlex incorporates AeroVent Technology, a patent-pending design that facilitates the one-way release of sweat vapor, while preventing the ingress of heat or carcinogens. This is complemented by VaporLite Panels, which are constructed with the TECGEN71 outer shell and a CoreCXP 1-layer thermal liner, allowing for the efficient release of heat. These advancements by Fire-Dex signify a monumental leap forward in firefighter safety and performance. By choosing materials and designs that enhance protection, breathability, and thermal regulation, Fire-Dex is setting new standards for the industry and providing firefighters with the gear they need to do their jobs safely and effectively.

New era in menstrual care

India’s Eicher Goodearth Private Limited has introduced Mahina, a pioneering brand in women’s menstrual management and intimate health products. Mahina period underwear pioneers a new era in menstrual care with its innovative features and eco-conscious design. Each

product is meticulously constructed to offer unparalleled absorbency and leak-proof protection, empowering women to navigate their menstrual cycles confidently and comfortably. Notably, Mahina stands as India’s premier provider of bonded leak-proof absorbent underwear, setting a new standard in menstrual hygiene.

Mahina period underwear eliminates the need for additional pads, tampons, or menstrual cups. Worn like regular underwear, Mahina offers a hassle-free period. The three-layered gusset is crafted from highly absorbent natural materials, efficiently wicking moisture, absorbing liquid, and securing it in place to prevent leaks. Its elongated design from front to back ensures uninterrupted sleep, the company stated in a press release. Designed for durability, Mahina products are built to last up to 2 years or 100 washes, with stringent testing to ensure no bacterial contamination for complete protection. It is available in four absorbency levels - light (10ml), medium (25ml), heavy (40ml), and super heavy (50ml) - catering to diverse flow needs. With a wear duration of up to 12 hours, Mahina period underwear offers long-lasting comfort without the need for frequent changes or restroom visits. Mahina prioritises user safety by conducting thorough testing and certification to ensure the absence of toxins, providing peace of mind and confidence in product safety. “Mahina period underwear is a game changer for the Indian market,” stated Founder and CEO of Mahina. “It is the most comfortable and effective solution for our period. We’re excited to transform menstrual health in India, providing a planet and body-friendly alternative that prioritises performance, comfort and environmental consciousness.”

Plant-based topsheets, crafted using advanced spunlace technology

Glatfelter has launched GlatPure plant-based topsheets, crafted using advanced spunlace technology. These versatile and innovative topsheets bring together comfort, sustainability, and customisation, offering a variety to fit every need. They redefine hygiene standards, providing a soft and gentle feel with superior performance.

Through advanced spunlace technology, Glatfelter’s range of GlatPure topsheets offers a diverse selection of premium, plant-based, and natural fibre options for environmentally conscious consumers. Designed with sustainability in mind, each variant, such as GOTS-certified organic cotton, raw cotton, hemp, Lyocell, and their blends, delivers fast liquid handling, softness, and comfort. Each fibre contributes its own distinct performance attributes, ensuring an optimal level of hydrophilicity and other desired qualities. Whether it’s the hypoallergenic appeal of cotton or eco-friendly hemp and Lyocell, these topsheets are uniquely tailored to meet various consumer preferences. Demonstrating remarkable liquid handling capabilities, this range not only exemplifies Glatfelter’s sustainability values but also improves the user experience for those searching for environmentally conscious hygiene products, the company stated in a press release. While the company’s Sultz, France site currently produces these innovative topsheets, it is well-positioned to expand production to the Asheville, NC site as part of its ongoing commitment to innovation. This strategic positioning ensures the potential to enhance production capabilities for plant-based, plastic-free, and bio-based hygiene products, fortifying the supply chain and embracing a transformative standard of hygiene. “Spunlace is an exceptionally clean technology – our solutions contain no binders, adhesives or chemical additives – and are manufactured under stringent hygiene controls. Our nonwoven fabrics provide outstanding absorbency with improved strength for wet and dry applications. Our predominantly cellulosic raw materials are responsibly sourced from renewable and certified forest resources which guarantee the chain of custody and ensure responsible management of the world’s forests,” stated the Asheville site leader.

Biobased binders based on shrimp shells and cellulose

OrganoClick has developed biobased and biodegradable binders based on shrimp shells and cellulose that can replace plastic binders in these materials. OrganoClick produces binders that have the same performance compared to many

commercially available plastic binders, but in some cases, they cannot meet the requirements for certain applications.

The role of the binders is mainly to build up the strength of the fiber web while contributing to the right hand feel, and also providing the right level of hydrophilicity/hydrophobicity of the nonwoven material. The right biopolymers and biomolecules are extracted from the shells or fruit peels and thereafter purified to >99% purity. After that, the right combination of various biopolymers and biomolecules is blended in order for them to react with the nonwoven fibers in the right way for every application.

Wetlaid, airlaid and chemically bonded carded nonwovens all use binders in various degrees. As of now, OrganoClick's biobased binders are commercially used in tabletop, hygiene products, home textile, packaging and agricultural textiles. OrganoClick is also in the process of implementing its binders in dry and wet wipes. "These products are single-use and shall therefore be discarded right after use or designed to decompose during usage," "Here, a home compostable binder can be used with great advantage." stated OrganoClick's R&D director. For agricultural textiles, many thousands of tons of plastics are discarded and create microplastics on farmlands while nonwovens with OrganoClick's binders will degrade into soil. "Many of our binders are also classified as plastic-free according to the EU's Single-Use Plastic Directive and when combined with a cellulosic fiber, the nonwoven can then be classified as plastic-free," she added. R&D stated further that there have been many challenges in going from the lab to the industrial scale. One has been to scale up both its own production as well as the processes at its suppliers to get the right biopolymers purified with stable quality. Another challenge has been to implement the biobased binders in its customers' nonwoven production. "There are certain differences in comparison with the traditional plastic binders which have needed some adjustments in how to use them in nonwoven machines," she explained. "However, with good collaboration with both suppliers and customers, we have been able to implement our binders at high volume production for wetlaid, airlaid and carded

nonwoven applications."

In the short-term, the change in the nonwovens industry has already begun since they already see several 100 % biobased, biodegradable and plastic-free nonwoven applications on the market. The OrganoClick team also believes that airlaid and wetlaid nonwovens based on cellulosic fibers and/or pulp will be recyclable which will prolong the lifecycle of the materials even longer before eventually being composted or becoming bioenergy.

Compostable coffee pod solution developed

A compostable coffee pod solution compatible with Keurig brewers for the North American market has been developed. IMA Coffee, a global manufacturer of coffee handling, processing, and packaging technologies, in partnership with a PLA producer, developed a solution that delivers high-quality brewing performance, can be produced at commercial speeds matching incumbents, and is made from compostable, biobased materials.

The partnership developed a simpler compostable coffee pod solution and supply chain. For the rigid capsule body, the PLA producer was able to combine non-compounded, highly crystalline, and heat resistant PLA grades with a refined single-stage thermoforming process to achieve production rates comparable to incumbent polypropylene (PP) capsules. The rigid thermoformed capsule was then combined with a nonwoven filter and multi-layer top lidding solution also made with PLA. The use of one primary material through all three components of a coffee pod is more cost-effective and offers greater consistency when heat sealing the components together, thus preserving the taste and aroma of the enclosed coffee. IMA Coffee Lab validated the new solution by conducting compatibility testing on the rigid capsules, filter, and top lidding films. The sophisticated microleakage detection testing performed at IMA Coffee Lab helped identify and achieve the optimal material sealing parameters and limits for the compostable components to ensure reliable performance when brewing pods. IMA was also able to define the suitable setup of IMA packaging machineries to handle the assembly, filling, and sealing

of the pods successfully at commercial line speeds.

Polymer aerogel for aerospace

Airbus Ventures is investing in thermal solutions company Oros Labs, the developer of Solarcore, which has raised a total of \$22 million to support its expansion. Solarcore exploits the thermal properties of polymer aerogel, the world's lowest thermally conductive solid, in insulation for a range of applications, from structures and packaging to cold weather apparel. For aerospace and space in particular, thermal insulation materials and thermal management are operationally critical and Solarcore is said by Airbus to be setting a new standard in thermal efficiency, along with being durable, versatile and applicable to many different product categories. "We were instantly attracted by the potential of Solarcore to serve a wide array of dual-use applications," stated Airbus Ventures partner. "The Oros Labs thermal product suite represents the most versatile aerogel materials ever made." "This investment opens doors for us to pursue strategic partnerships, bolster our manufacturing capabilities, scale our product offerings and advance our research and development efforts to continue introducing groundbreaking materials to the market," added co-founder and CEO at Oros Labs.

Oros Labs continues market expansion through key strategic partnerships with the US Department of Defense and renowned consumer brands such as The North Face, Icebreaker, Columbia Sportswear, adidas, Merrell and L.L. Bean. As one example of its collaboration with the US Department of Defense, Solarcore is set to transform the US Army's cold weather tactical shelters, offering enhanced heat retention, reduced weight, and improved efficiencies in transportation and setup. With the department investing billions annually in heating and cooling tactical shelters, the adoption of Solarcore presents significant cost-saving opportunities and carbon footprint benefits.

Source:

<https://www.innovationintextiles.com/>

<https://www.technicaltextile.net/news/>

<https://www.nonwovens-industry.com/>

Events Calendar

National

May 2024

9-11 YARNEX and F&A Show
Bombay Exhibition Centre, Mumbai

June 2024

4-6 DyeChem World Exhibition, Tirupur
21-24 TEXFAIR, Coimbatore

July 2024

4-6 DyeChem World Exhibition, Tirupur

August 2024

1-3 Fabrics & Trims Show-2024
New Delhi, India
1-3 Gartex Texprocess, New Delhi

International

May 2024

3-4 Global Textile Trade Fair, Atlanta, USA
5-7 Advanced Textiles Association (ATA) Outlook
Conference Wild Dunes Resort Isle of Palms,
S.C., USA
7-9 Interwoven, High Point, USA
14-15 Federal and Defense Textile Summit,
Raleigh, USA
19-21 Southern Textile Research Conference (STRC)
Hilton Myrtle Beach Resort, USA
20-22 International Apparel and Textile Fair,
Dubai, UAE
21-23 Intertext, Santa Maria da Feira, Portugal
23-25 Garment Technology Bangladesh (GTB),
Chittagong, Bangladesh
28-30 International Exhibition for Textile and Fashion
Industries Expo Tashkent, Uzbekistan

June 2024

1-2 Great British Fibre Festival, Devon, UK
4-6 INDEX, Dubai, UAE
4-8 Hightex, Turkey
4-8 ITM, Istanbul, Turkey
5-6 The Vietnam Textile Summit,
Ho Chi Minh City, Vietnam
6-8 GarTex, Dhaka, Bangladesh
10-12 Textstyle Expo, Algiers, Algeria
25-26 Future Fabrics Expo, London, UK
25-26 Sustainable Apparel and Textiles Conference
New York, USA
26-27 Better Cotton Conference, Turkey

July 2024

1-3 Texworld Apparel Sourcing, Paris, France
2-3 SPINEXPO, Paris, France
11-12 SPINEXPO, New York, USA
16-17 Functional Fabric Fair, New York, USA
16-18 Sportec, Tokyo, Japan
18-20 Source Textile & Apparel West Africa,
Lagos, Nigeria
31-2 Indo Garment & Textile Expo,
Jakarta, Indonesia

August 2024

14-16 Intertextile Shanghai Home Textiles,
Shanghai, China
14-17 Yarn & Fabrics Sourcing Fair, Dhaka,
Bangladesh September 2024
3-4 Munich Fabric Start September,
Munich, Germany

October 2024

2-4 Textile Show Fall, Amsterdam,
Netherlands
6-8 Textile Discovery Summit,
Georgia, USA
15-16 Interfilere Shanghai, Shanghai, China

November 2024

5-6 North Carolina Cotton Festival,
Dunn, USA
6-8 Heimtextil, Tashkent, Uzbekistan
6-9 Texcare International,
Frankfurt, Germany

sasmira

The Synthetic and Art Silk Mills' Research Association

(Linked to the Ministry of Textiles, Govt. of India)

NABL and A2LA (USA) ACCREDITED MICROBIOLOGY TESTING LABORATORY

Recognized by IOPEPC- Indian Oilseeds and Produce Export Promotion Council

PROUDLY ANNOUNCES THE OPENING OF ACCREDITED FOOD TESTING LABORATORY



TESTING FACILITY FOR

- Cereal, Pulses and cereal products
- Herbs, Species and condiments
- Fruits and vegetable products
- Milk & Dairy Products
- Frozen Foods
- Snacks & Instant Mixes
- Ready to eat/Cooked Food samples
- Canned and processed foods
- Oil Seeds & by products

STANDARDS TESTED

- IS 5401- 1 / ISO 4832
- IS 5402 / ISO 4833-1
- IS 5403 / ISO 21527
- IS 5887
- IS 17112
- IS 14843
- IS 14988 / ISO 11290
- ISO 6579-1

For more details, contact:

The Synthetic & Art Silk Mills Research Association (SASMIRA)

Sasmira Marg, Worli, Mumbai- 400 030

Phone: 022-24935351 Email: testing@sasmira.org Website: www.sasmira.org

CUSTOMER SATISFACTION IS OUR MOTTO

SASMIRA's Microbiology Testing laboratory is Nationally and Internationally accredited by

National Accreditation Board for Testing and Calibration Laboratories (NABL), India and
American Association for Laboratory Accreditation (A2LA), USA as per ISO/IEC 17025: 2017

Analysis carried out for

Textile products

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|-------------|--|
| AATCC 147 | - Antibacterial Activity Assessment of Textile materials: Parallel Streak Method |
| AATCC 100 | - Assessment of Antibacterial Finishes on Textile Materials |
| AATCC 30 | - Antifungal Activity -Assessment on Textile Materials |
| ASTM E 2149 | - Standard Test Method for Determining the Antimicrobial Activity of Immobilized Antimicrobial Agents under Dynamic Contact Conditions |
| JIS L 1902 | - Testing of Antibacterial Activity and Efficacy on Textile Products |
| ISO 20645 | - Textile fabrics – Determination of Antibacterial activity – Agar diffusionplate test |
| ISO 20743 | - Determination of Antibacterial Activity of Antibacterial finished products |
| AATCC 174 | - Antimicrobial Activity Assessment of New Carpets |

Plastic products

- | | |
|-------------|--|
| JIS Z 2801 | - Antibacterial Products -- Test for Antibacterial Activity and Efficacy |
| ISO 22196 | - Measurement of Antibacterial Activity on Plastics & Other Non-Porous Surfaces |
| ASTM E 2180 | - Standard Test Method for Determining the Activity of Incorporated Antimicrobial Agent(s) in Polymeric or Hydrophobic Materials |

Water

- | | |
|---------|--|
| IS 1622 | - Microbiological Examination of Water |
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NABL accredited Food Testing services

- | | |
|----------------|---|
| IS/ISO Methods | - TPC, YMC, Coliforms, E. coli, Salmonella, Shigella, Staphylococcus, B. Cereus, Listeria, Enterobacteriaceae |
|----------------|---|

Miscellaneous Test methods

- | | |
|-------------|--|
| FDA BAM/ EP | - Bioburden testing - Membrane Filtration / Pour plate method |
| Pathogens | - Enterobacteria, E. coli, Salmonella, Pseudomonas, Staphylococcus, Clostridia |

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