EXPLORING INNOVATORS IN TEXTILES

TEXPLORER

TEXTILE RESEARCH MAGAZINE

VOL 4 -APRIL 2024

ABOUT KUMARAGURU COLLEGE OF TECHNOLOGY (KCT)

Kumaraguru College of Technology (KCT), Coimbatore is a private Engineering College started in 1984 under the auspices of Ramanandha Adigalar Foundation, a charitable educational trust of Sakthi Group. Situated in a sprawling 156-acre campus in the IT corridor of Coimbatore, KCT is an autonomous institution affiliated to the Anna University, Chennai and approved by All India Council for Technical Education (AICTE). KCT has been accredited by National Assessment and Accreditation Council (NAAC) with Grade ‘A’ and all the eligible UG programs have also been accredited by National Board of Accreditation (NBA). Under the able guidance and adept administration of Dr. B. K. Krishnaraj Vanavarayar, Chairman, Sri. M.Balasubramaniam, Correspondent and Sri. Shankar Vanavarayar, Joint Correspondent, the college has developed excellent facilities and resources such as spacious classrooms, seminar halls, well-equipped laboratories, excellent sporting facilities, dedicated high speed internet connectivity (broadband) and well qualified faculty. Five academic Blocks house the different departments. The administrative building “Dr.Mahalingam Vigyan Bhavan” is an architectural beauty and a land mark in Coimbatore. Currently the college, as an autonomous institution affiliated to the Anna University, offers 15 undergraduate (B.E., B.Tech.) and 14 post-graduate (M.E., M.Tech., MCA, MBA) programs of study The College has 15 academic departments and 9 research centers, each headed by a competent and experienced professor. Altogether, the college has over 391 well-qualified teaching faculty and 156 supporting technical staff, in addition to 199 administrative staff. The combined student intake during the current year is 2000 and the total number of students on roll is 6200.

ABOUT DEPARTMENT

Department of Textile Technology was started in the year 1995 with the Objective of imparting comprehensive knowledge in all the faces of Textile Manufacture to students through UG & PG programmes. Professionally well qualified, highly experienced faculty members and well-equipped laboratory with modern facilities provide ample opportunity to the students to pursue their education with excellence. Students are provided with good industrial exposure taking full advantage of college location in the Textile City, Coimbatore. The accreditation status has been awarded to the B.Tech Textile Technology undergraduate programme by National Board of Accreditation, AICTE, New Delhi for Three Years with effect from September 2019

EDITORIAL BOARD

EDITORIAL MESSAGE

Prof. Pavendhan A,
Associate Dean-Textile Cluster

I m delighted in acknowledging the national level technical project display context, titled, "K-TEX TECH CHALLENGE 2024" conducted by Department of Textile Technology. This edition brings out all papers that were presented during the context which was held on-line. My heartiest congratulations to all participants. I extend my warm appreciation to the students, faculty and Head of the Department who were behind the success of the context as well as this edition of the magazine. Context of this nature provides opportunities to students to explore research areas of their interest (as the theme has not been restricted to any single topic/ area). There are plenty of problem statements around us, and we only need keen eyes and right interactions with industry, researchers, and our professors to unearth them. Projects pursued in under-graduate level by students help exposed to various phases of research including framing research questions, designing, selecting appropriate methodology, experimenting, analysing, and reporting the results. I am sure all the participants of this context would have been benefitted from such exposure. I am sure this edition would inspire young students to explore more.

EDITORIAL MESSAGE

Dr.V.Ramesh Babu,
Head & Associate Professor

On behalf of the editorial staff and students, it is my pleasure to introduce the issue of TEXPLORER, yearly magazine of Department of Textile Technology that showcases technical papers of students and faculty in textile domain and its allied field This new magazine is envisioned and found to represent the technical as well as cultural skill of the students. Its mission is to become the voice of thetextile student's community, addressing faculty, industry persons and alumni from various fields of Textile Technology. This volume comprises of technical papers from fibre, yarn, fabric, fashion technical textiles and few new innovations in machinery and textile products. It is our hope that this fine collection of articles will be a valuable resource for Textile Technology. I would also like to thank the faculty members who worked with the students. Students from various colleges submitted their papers and presented the projects using the platform provided exchanged ideas which will enhance further advancement in thrust areas of research. Much appreciation is also due to all the faculty members and students of the editorial team. Finally, I would like to express my appreciation to the students who contributed their writing and to the students who have done a great job in putting this research magazine together. I hope you will enjoy reading these papers, and if you are textile/fashion technology student or faculty or industry expert consider submitting your own writing to be published in next year's TEXPLORER Research magazine.

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1.IDENTIFICATION OF FABRIC STRUCTURE BY IMAGE ANALYSIS METHOD

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ABSTRACT

In today's cutting-edge technology, time is important factor for various production process and quality management. With use of modern technology and software time management can be possible. Image analysis is a useful tool which can provide reliable information for identification, analysis and problem detection for manufacturing process. Image analysis can be used at intermediate or final quality analysis of process or product. This paper is focused oninvestigation of fabric structure with image analysis method.The data extracted with the help of portable instrument and simple softwareto identify the fabric structure.The collected data can provide some reliable information related to fabric structure with less time and efforts.

Keywords : Image analysis,Fabric structure,Quality control,Grey image

.Introduction

In mid-1980s, Japanese researchers firstly propose a method for fabric structure recognition and yarn density measurement based on the image diffraction and digital image processing technology. Also, there are some automatic methods used for assessment of woven fabric structures by visual analysis based on human eyes and experience. The image analysis offers a comprehensive review of automatic methods utilized in identifying woven fabrics over a span of nearly 43 years. It emphasizes the advantages of objective evaluation technology based on image processing and artificial intelligence compared to manual methods. This shift brings benefits such as rapid response, digital solutions, and increased accuracy.[2] The image processing approach for identifying weave patterns in woven fabrics utilizes maximum and minimum gray-level sums to locate yarns and crossover points. Decision rules based on geometric features are developed to recognize warp and weft floats. The experimental results with plain, twill, and satin weaves basic patterns identified, and measurements align with computer program with manual fabric counts. It sounds like your approach to adjusting warp and weft yarns, along with the use of a microscope for proper alignment, contributes to the successful identification of basic weave patterns. Additionally, your image processing approach offers an efficient and reliable nondestructive analysis for identifying these patterns, with computer measurements showing good agreement with manual measurements of fabric counts.[5]The integration of dedicated hardware, high-resolution imaging, image analysis techniques, and artificial neural networks demonstrates a promising leap in automating woven fabric structure analysis. This could potentially revolutionize fabric design and quality control processes. It's fascinating how your system leverages both reflective and transmissive light images to analyze the intersecting structure of warps and wefts in woven fabrics. The combination of shape parameters extraction and neural network training for determining thread interactions is innovative. Enhancing the system with additional shape parameters could indeed lead to increased accuracy, contributing to the automation of woven fabric structure analysis. The color quantization algorithm adds another layer of complexity, showcasing the comprehensive nature of your approach.[6]

Material And Methodology

Image analysis is the most common technique, used to identify weave of a fabric.Thismethod is used for speedy evaluation of fabric weave for evaluation of structural parameters of a woven fabric. It is useful tool to represent woven fabric structure and extract data from image. The extracted data is useful to represent structure graphically.The basic object of study is to develop the portable image capturing instrument and analyze the image with the help of simple software for representation fabric structure.

Basic object of work

- Fabrication of setup for image capturing.
- Selection of fabric sample for image analysis.
- Identification of the fabric parameters by manual method.
- Identification of image analysis software and understanding the process of image analysis with software.

❖ **Advantages of Image Analysis**

- Easy to assess weave.
- To speed up the production process for the industrial application.
- Chances of human errors can be avoided.
- Analysed data accuracy is more.
- Quicker and time saving.
- Reproducibility of results.
- Digital solution with accuracy.
- Data can be stored, retrieved at any time for future reference.

Images should be analysed and evaluated like any other source, such as journal articles or books, to determine their quality, reliability, and appropriateness. Images should be analysed evaluated on several levels. Visual analysis is an important step in evaluating an image and understanding its meaning. It is also important to consider textual information provided with image, image source, original context, and the technical quality of the image. Image analysis can include tasks such as finding shapes, detecting edges, removing noise, counting objects, and calculating statistics for texture analysis or image quality.

Materials required for instruments

Light Source: -

To capture good quality of image light source plays important role. The portable light intensity control device is fabricated with the help of LED light and regulator to adjust the intensity of backlight for fabric sample.The specification is used for back light LED are square shape (105mm X 105mm)LED operating at 100-300 AC Voltage. Also 230 volt AC voltage regulator is used to adjust intensity of light.

Magnifier glass:-

Paramount image magnifier is used to capture magnified image of fabric sample at different magnification level. By adjusting different magnification level image can be captured on same device. The magnification level of instrument can be adjusted at 5X, 6X,7X,8X, 9X 10X, 11X, and 12X.

1Paramount Image Magnifier (5X- 12X)

Digital Camera: -

The camera of 50 megapixels is used to capture the photograph. This camera captures high resolution image quality.

Computer Software: -

A Java-based image processing computer program is use to analyse the image. This software is compatible any windows 32 bit or 64 bit operating system.

Assembly of Instrument

Figure: Portable Light Brightness Intensity Control Device

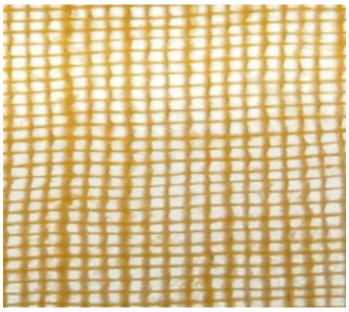
❖ Sample preparation:

- Place fabric on plain table and remove wrinkles.
- Fabric sample should cover area of (3"X3") on the instrument avoiding selvedge.
- Identify the direction and mark on sample.

❖ Method for Image capturing:

- Place fabric on the platform.
- Adjust the light source intensity.
- Adjusting microscope and camera on fabric sample.
- Capture image.

Original Image

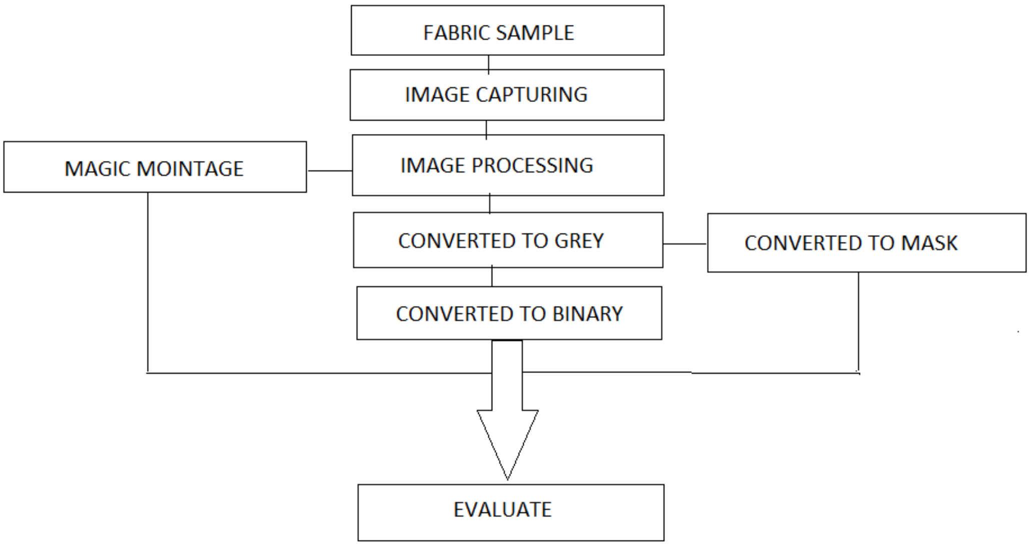


Captured Image 5X

❖ Image processing through software:

- To capture the fabric image, we will use a software called Image analysis software. Software is a Java-based image processing program developed at the National Institutes of Health and the Laboratory for Optical and Computational Instrumentation.

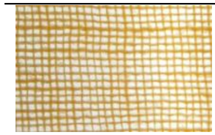
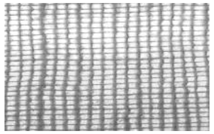
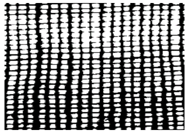
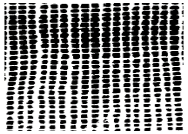
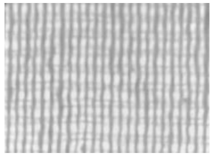
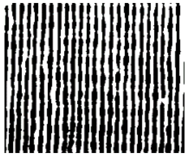
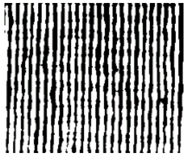
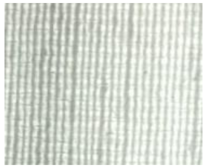
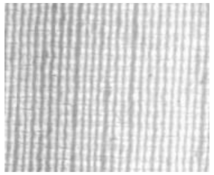
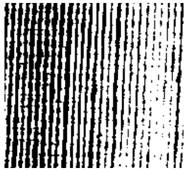
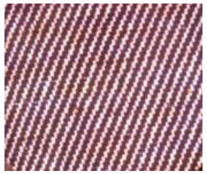
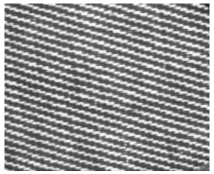
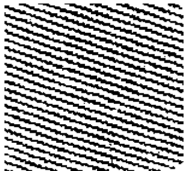
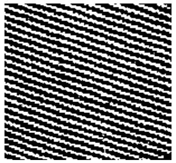
Process flow for image analysis

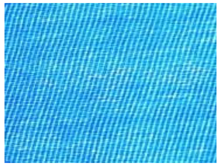
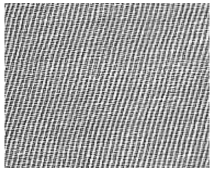
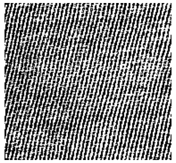
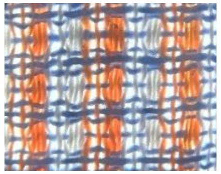
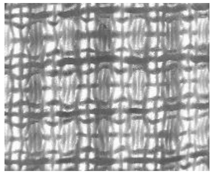
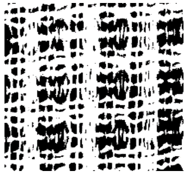
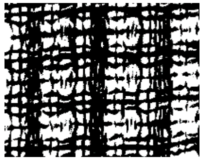


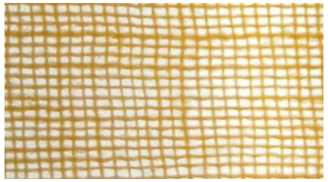
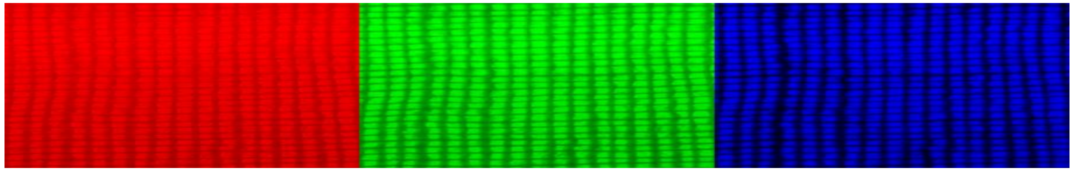
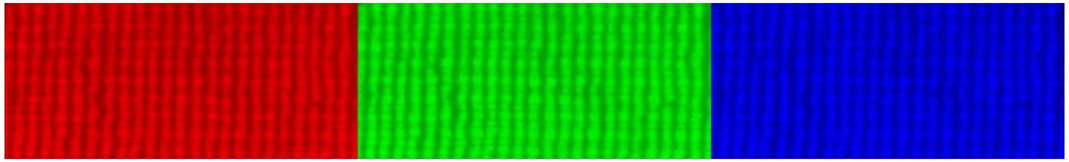
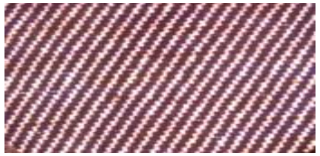
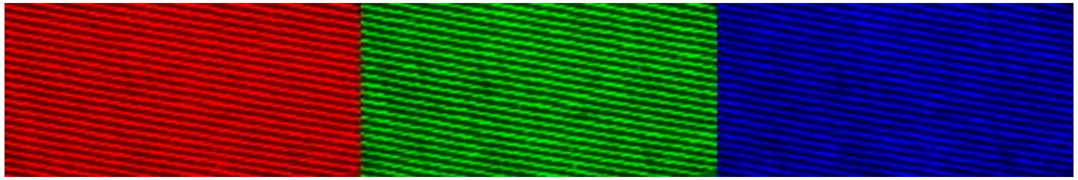
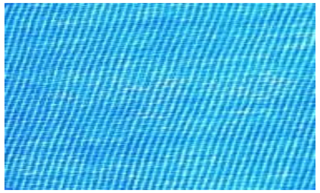
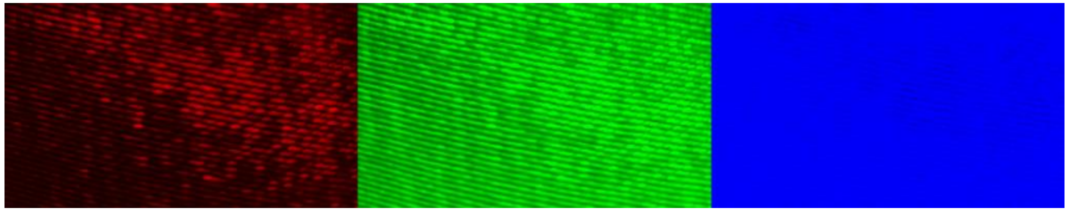
Result and Discussion

1. Total six samples of woven fabric are selected out of which three sample of plain weave with different warp, weft density, GSM, and material.
2. Two sample of twill weave and one sample of combination weave. The particulars of all samples are tabulated in table 3 along with different images after processing through software.
3. We have converted image into grey scale to study the prominence of warp and weft pattern then it was converted into binary image to study the structure of a fabric (structural pattern) and masking of image carried out for the study of reverting binary form.

Table 1: Details of image analysis for woven fabric samples

r. No.	Woven Fabric Structure	Particulars		Original Captured Image (5X)	Grey Scale Image	Mask Image	Binary Image	Original Captured Image Information (5X) 8 bits per pixel
1	**Plain Weave**	CODE GSM(g) EPI / PPI	PW 01 53.9 53 / 33					Weave:- plain Width: 332 pixels, Height: 664 pixels Size: 215K,Pixel size: 1x1 pixel^2
2	**Plain Weave**	CODE GSM(g) EPI / PPI	PW 02 98.59 48/26					weave :- plain , Width: 250 pixels,Height: 181 pixels,Size: 44K, Pixel size: 1x1 pixel^2
3	**Plain Weave**	CODE GSM (g) EPI	PW 03 135.7 48/40					weave :- plain,Width: 183 pixels Height: 182 pixels,Size: 33K Pixel size: 1x1 pixel^2
4	**Twill Weave**	CODE GSM (g) EPI / PPI	TW 01 298.5 54/26					Weave:- Twill (3/1) Width: 149 pixels,Height: 172 pixels Size: 25K,Pixel size: 1x1 pixel^2

5	**Twill Weave**	CODE GSM EPI / PPI	TW 02 68.58 116/67					Weave : Twill (2/2) Width: 451 pixels,Height: 418 pixels Size: 184K,Pixel size: 1x1 pixel^2
6	Combination weave (Plain Weft rib)	CODE GSM EPI / PPI	PR01 231 46/25					Weave:- combination of plain,weft rib Width: 1159 pixels,Height: 694 pixels Size: 785K,Pixel size: 1x1 pixel^2

Sr.No.	Sample code		
1	PW01		
2	PW02		
3	PW03		
4	TW01		
5	TW02		

Conclusion:

1. Image analysis can be used to extract fundamental components of a fabric weave.
2. In plain weave fabric with 100% cotton warp and weft yarn image showing prominent patten after converting in grey, binary and mask format. Also show differentiation in warp and weft pattern after applying filters in RGB montage view.
3. In another plain-woven fabric where warp are cotton yarn and weft is untwisted polyester filament. Shows prominent warp yarn pattern as a continuous line with regular waviness. The thick and thin line pattern shows where the weft is up the line becomes thick and where the warp is down it becomes thin. Same pattern is observed for all warp yarns in both the samples.
4. Twill fabric samples show prominent twill line pattern in all images.
5. In case of mixed plain and warp rib pattern it shows prominent rib pattern in warp direction.

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2.IMPACT OF VARIOUS DENIM FINISHES ON MICROFIBRE RELEASE BEHAVIOR

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S Naveen, Fashion Technology, PSG College of Technology, Tamilnadu, India

ABSTRACT

Microfiber pollution, a subset of microplastic contamination, poses a significant threat to aquatic ecosystems, with synthetic textiles contributing substantially to its proliferation. While the environmental impact of synthetic microfibers is widely recognized, less attention has been given to natural and regenerated cellulose fibers. Among the myriad sources of microfiber pollution, denim manufacturing and laundering processes stand out as significant contributors. Despite the prevalence of denim blue jeans globally, their production and maintenance release substantial amounts of microfibers into the environment. This study addresses the gap in understanding the extent of microfiber emissions from industrial denim manufacturing processes. Through a comprehensive methodology involving fabric selection, domestic washing simulation, fiber shedding analysis, and physical properties examination, the research aims to quantify microfiber release from denim fabrics subjected to various washing conditions. The investigation focuses on different fabric finishes, yarn types, weaves, and washing treatments to discern their impact on microfiber release. Results indicate that fabric construction and finish type play crucial roles in microfiber release during washing, with certain combinations leading to higher or lower fiber shedding. Moreover, the choice of washing treatment significantly influences microfiber release rates. The findings underscore the importance of considering both fabric characteristics and washing techniques in mitigating microfiber pollution in denim manufacturing.This study highlights the urgent need for proactive measures to address microfiber pollution from industrial sources and advocates for sustainable practices in denim manufacturing to safeguard ecosystems and human health. Further research could explore strategies to minimize microfiber release without compromising garment quality and performance, thus contributing to a more sustainable clothing industry.

Keyword: -Microfibres, Microfibre pollution, Cotton, Denim, Denim finishes and Microfibre shedding etc….

1. INTRODUCTION

Microfibers, a subset of microplastics, have emerged as a significant pollutant in aquatic ecosystems, with approximately 20-35% of marine microplastics originating from synthetic textiles. Polyester, acrylic, and nylon fibers, commonly found in apparel, constitute the majority of microplastics in oceans. Recent studies have revealed the ubiquitous presence of microfibers, including natural and regenerated cellulose fibers, in marine sediments and aquatic life. Despite the growing awareness of synthetic microfiber pollution, the potential physiological impacts of natural and regenerated cellulose fibers have often been overlooked in prior research. [1]

Meanwhile, denim blue jeans stand as an iconic and prevalent garment worldwide, with their popularity soaring in recent decades to an anticipated global market value of US$85 billion by 2025. However, the manufacturing and laundering processes of denim jeans contribute significantly to microfiber pollution. Despite manufacturers recommending monthly washing, the average consumer washes their jeans after just two wears, releasing microfibers into wastewater. These microfibers, including indigo-dyed variants, traverse wastewater treatment plants and ultimately contaminate aquatic ecosystems, persisting in marine, freshwater, and terrestrial environments. [2]

While existing research has primarily focused on quantifying microfiber emissions from domestic washing machines, limited attention has been given to industrial sources, such as textile factories and washing procedures in denim manufacturing. Addressing this gap, our study aims to quantify microfiber emissions from industrial washing procedures integral to the production of denim garments, particularly blue jeans. By illuminating the extent of microfiber pollution originating from industrial processes, we seek to provide a comprehensive understanding of the environmental impact of denim manufacturing.

Our research underscores the necessity of quantifying microfiber emissions from industrial manufacturing processes to accurately assess the environmental footprint of the clothing industry. Through this investigation, we aim to shed light on the urgency of mitigating microfiber pollution and advocate for proactive measures to safeguard ecosystems and human health in the face of this pervasive environmental challenge.

2. METHODOLOGY

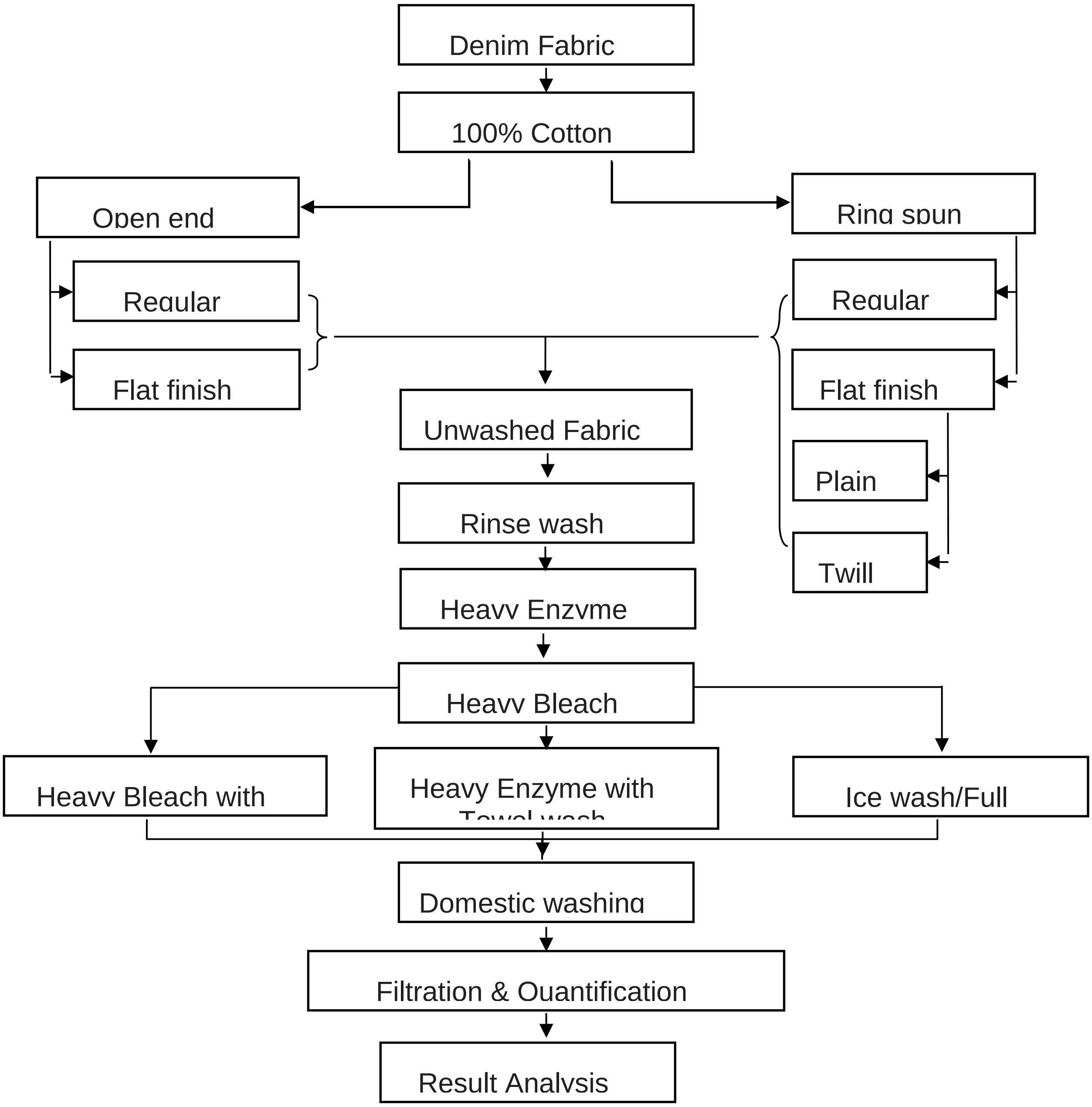

Figure -1 Flow process chart

2.1 Fabric selection and Preparation

Denim fabrics sourced from the industry, composed of 100% cotton, were selected for the study. Two different finishes, a flat finish and a regular finish, were collected for each fabric configuration .Fabric samples were cut into 11x11 square specimens and double-folded at the four sides of the raw edges with 1cm inside. Specimens were then sewn across the four sides to enclose the raw edges neatly and provide strength to prevent fraying or unraveling.

2.2 Domestic washing procedure

Commercially available liquid detergent, with a quantity of 4 grams per liter, was used for washing denim fabrics.Each sample was sequentially noted to identify the fabric wash throughout the process for easy tracking and labelling.

2.3 Washing equipment

Fabric samples were washed using a Launder-o-meter, a laboratory-scale laundry machine designed to mimic a home washer.

2.4 Fiber Shedding analysis

Shed fiber from the textiles were inspected using a 1000x digital microscope.Whatman Grade 1 filter paper, with a pore size of 11µm, was utilized to filter wash effluent and capture shed fiber.Each sample of washing liquid effluent was filtered in individual containers, and sample numbers were noted in the respective beakers.

2.5 Physical properties analysis

The Martindale Abrasion Tester and tensile strength tester were used to analyze physical properties of textiles, including abrasion resistance and tensile strength. GSM and thickness of the fabric samples were analyzed.

2.6 Fiber counting

To determine the average number of fibres per square, 30 squares were randomly selected in the filter papers.Fibres in each square were counted using a microscope, and the total number of fibres was divided by 30 to calculate the average number of fibres per square.

2.7 Data analysis

Data collected from fibre shedding analysis and physical qualities analysis were analyzed to assess the impact of different fabric finishes and washing procedures on fibre shedding and textile properties.By following this comprehensive methodology, we aimed to obtain accurate and reliable data regarding fibre shedding and textile properties of denim fabrics subjected to various washing conditions, thereby contributing to a deeper understanding of the effects of domestic washing on denim garments.

3. RESULTS AND DISCUSSION

The study involved the collection and analysis of five denim samples sourced from an industry, all comprising 100% cotton. Each sample was characterized by distinct combinations of yarn type (open end or ring spun), finish (regular or flat), and weave (twill or plain). The analysis primarily focused on microfiber count, microfiber mass, and various physical properties to elucidate the environmental impact of denim fabric.

3.1 Open end regular finish vs Open end flat finish

Both the Open End yarn, Regular Finish and Open End Flat Finish samples exhibit an increase in microfiber release after washing treatments. (Refer figure 2 and 3) However, the Open End yarn, Regular Finish generally releases fewer microfibers compared to the Open End Flat Finish across most treatments.The Stone Wash treatment results in the highest microfiber release for both samples, with the Open End yarn, Flat Finish sample releasing significantly more microfibers compared to the Regular Finish sample

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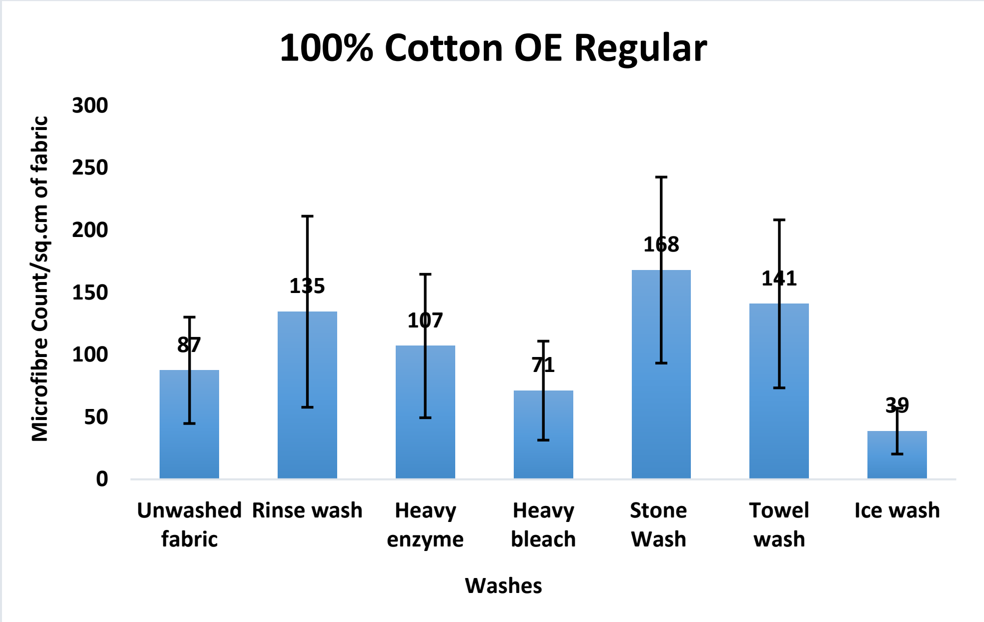


Figure -2: Number of microfibres per square mm released in 100% cotton open end yarns regular finish fabrics for each denim washes

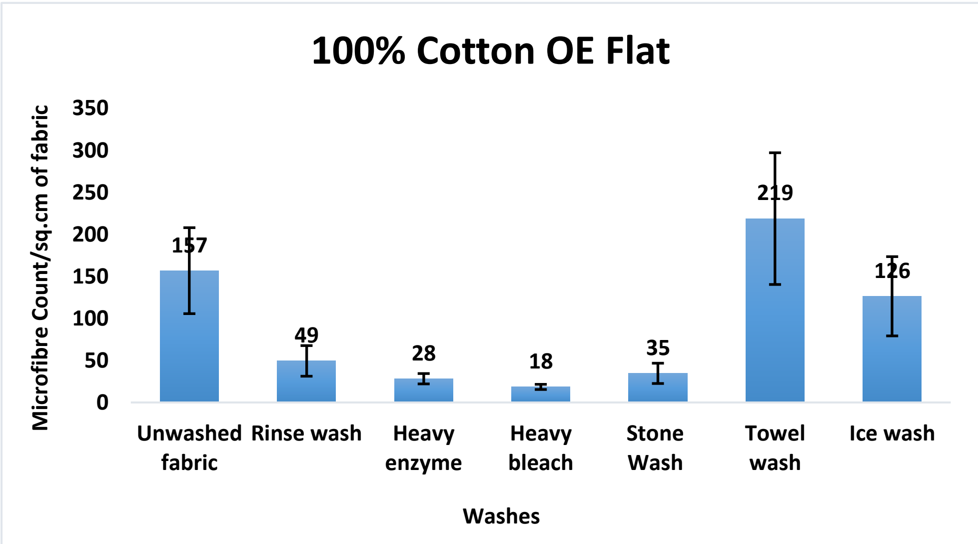
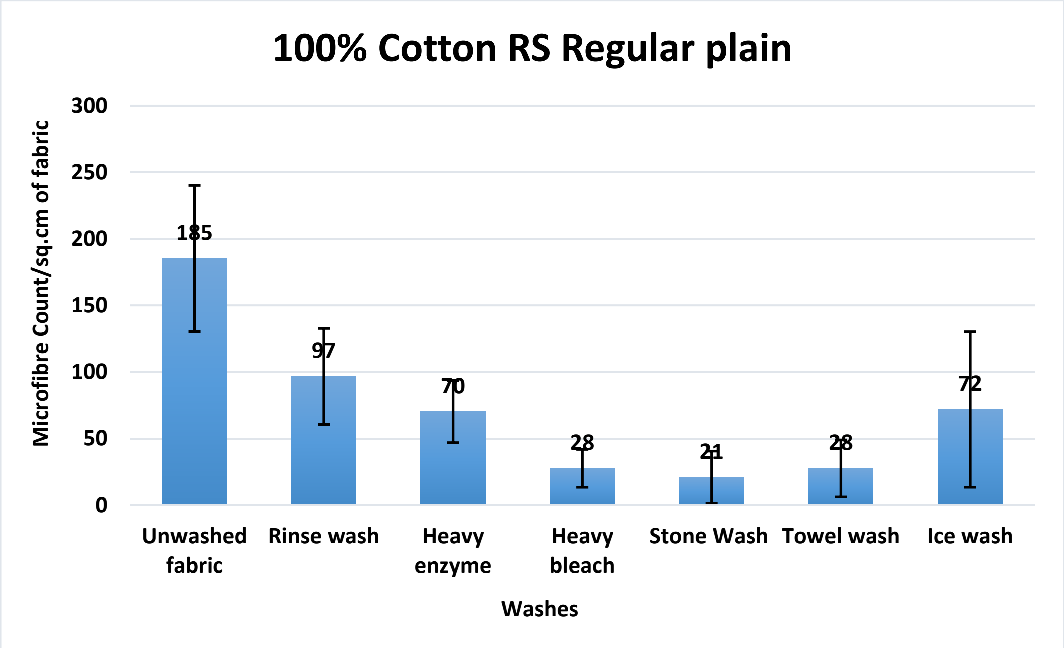


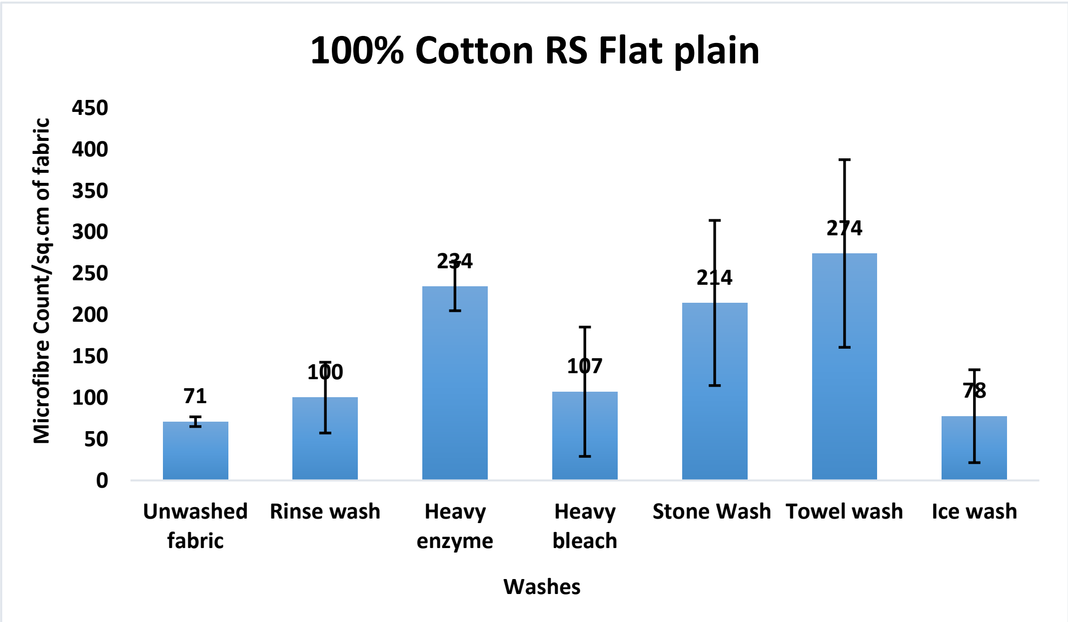
Figure -3: Number of microfibres per square mm released in 100% cotton open end yarns regular finish fabrics for each denim washes

3.2 Ring spun regular finish plain weave vs Ring spun flat finish plain weave

The Ring Spun Regular Finish Plain Weave sample demonstrates relatively low microfiber release across all treatments compared to the Ring Spun Flat Finish Plain Weave sample.Notably, the Towel Wash treatment results in the highest microfiber release for both samples, but the Ring Spun Regular Finish sample releases fewer microfibers compared to the Flat Finish sample. (Refer figure 4 and 5)



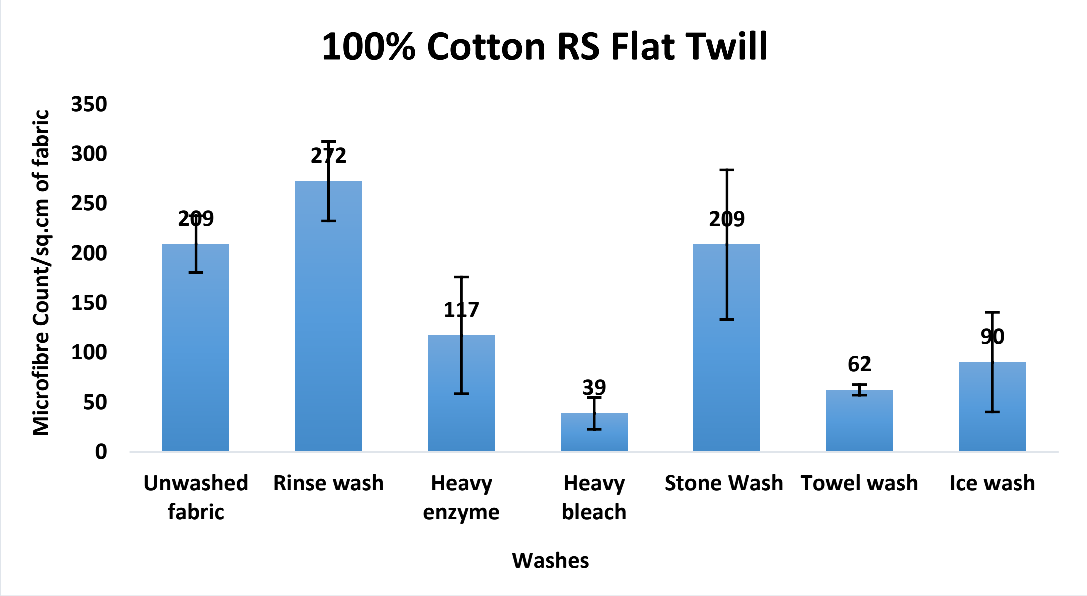
Figure– 4 Number of microfibres per square mm released in 100% cotton ring spun yarns regular finish plain weave fabrics for each denim washes



Figure– 5 Number of microfibres per square mm released in 100% cotton ring spun yarns flat finish plain weave fabrics for each denim washes

3.3 Ring spun flat finish plain weave vs Ring spun flat finish twill weave

The Ring spun flat finish twill weave sample exhibits slightly higher microfiber release compared to the plain weave counterpart across most treatments.The Rinse Wash treatment results in the highest microfiber release for both samples, with the twill weave sample releasing more microfibers compared to the plain weave sample. (Refer figure 5 and 6)



Figure– 6 Number of microfibers per square mm released in 100% cotton ring spun yarns flat finish twill weave fabrics for each denim washes

4. CONCLUSIONS

Overall, the findings suggest that fabric construction (weave type) and finish type significantly influence microfiber release during washing. Ring spun yarns and regular finishes tend to exhibit lower microfiber release compared to open end yarns and flat finishes, respectively. Additionally, the choice of washing treatment can impact microfiber release, with certain treatments leading to higher or lower fiber shedding. These results underscore the importance of considering both fabric characteristics and washing techniques in minimizing microfiber release and promoting sustainable denim manufacturing practices. Further research could explore strategies to mitigate microfiber release while maintaining garment quality and performance.

5. ACKNOWLEDGEMENT

We have great pleasure in conveying our sincere thanks to our project guide Dr. R. Rathinamoorthy, Associate Professor, Department of Fashion Technology, PSG College of Technology for his constructive criticism, guidance and valuable help at all stages to complete this study as successful.

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3.PROMOTING SUSTAINABLE BANANA PRODUCTION AND TRADE THROUGH THE WORLD BANANA FORUM'S DEVELOPMENT

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ABSTRACT

Today's research is focused on environmental sustainability. Natural fiber is being used in different application ranging from textiles to advanced automotive industries. All natural fibers, especially plant fibers, are renewable, biodegradable, lower in health risks, environmentally safe, recyclable, etc. One of the natural plant fiber is Banana fiber. It is a lingo-cellulosic fiber which is obtained from the pseudo stem of the banana plant. After fruit harvesting, the plant is discarded as waste and thrown. From ancient time, banana fiber has been extracted and used for different applications ranging from handicraft to handloom and today in technical textiles. Nowadays Banana fiber is also used for making currency notes. The waste which is obtained after extraction of fiber from the pseudo stem are also used for making scrubs. This paper reviewed the banana fiber extraction, its properties, applications, bleaching of banana fiber, dyeing and its result, and softening process. The aim of this paper is to explore the banana fiber to the textile fraternity and to find out future research possibilities so that more research can be carried out as India is the biggest producer of Banana in world. And every part of banana tree is useful for making different applications after harvesting the fruit.

Keywords: Banana Plant, Banana Fiber, Sustainable fiber, Natural fiber biodegradable fiber.

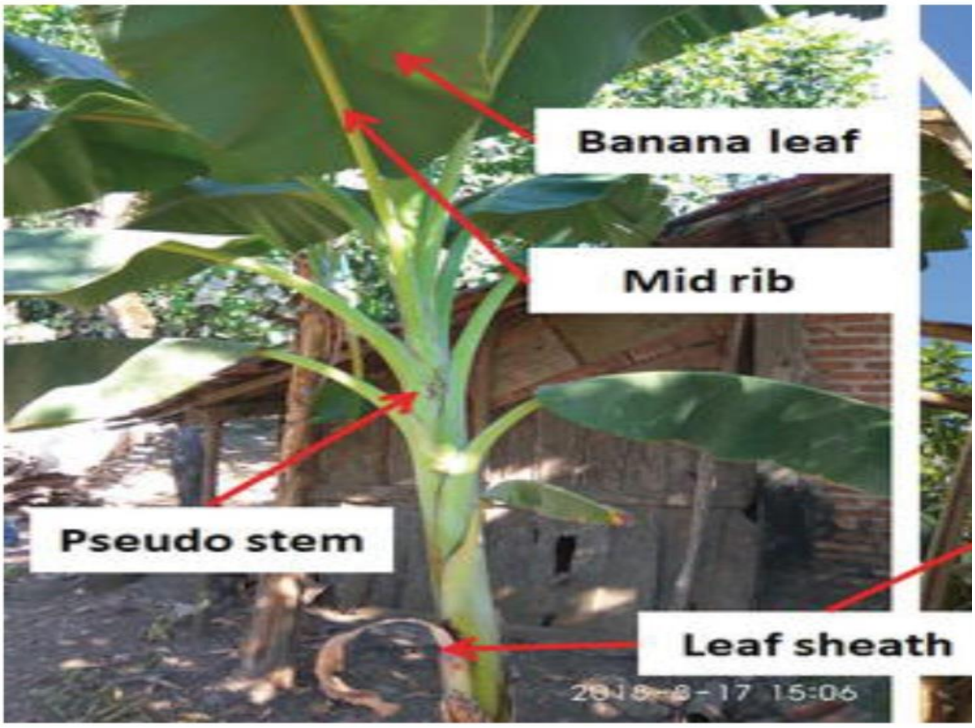
INTRODUCTION

The modern scientific world is moving towards a sustainable research environments for the protection of the ecosystem. Different efforts are going on once of them is the utilization of natural fiber in different ways by extraction from the direct nature. All natural fibers are lower in health risks, environmentally safe, recyclable and non abrasive for quick processing. Natural fibers have many advantages over synthetic fibers, including wide availability, significantly reduced density, low cost, outstanding thermal insulation and many more. (1)

One of the natural fiber is banana fiber. Banana fiber is a ligno-cellulosic fiber which obtained from the pseudo stem of banana plant.After harvesting the banana fruit from banana plant the pseudo stems are generally discarded as waste or burnt after drying thus causes substantial pollution. In few places it is used as a bio fertilizer.(2)

- Banana fiber have highly strength, light weight, smaller elongation, fire resistance quality, strong moisture absorption quality, great potentialities for paper making special demand of handmade paper.

- Banana fiber is making products like filter paper, paper bags, greeting cards, lamp stands, pen stands, decorative papers, rope, mats, currency notes, and composite materials etc. (2)



Properties Of Banana Fiber

- Physical properties :-
- Dia (mm) : 0.080-0.250
- Length (mm) :1000-5000mm
- Aspect ratio (l/d) :150
- Moisture absorbtion(%) : 60

Chemical properties :-

- Cellulose (%) : 60-65
- Hemi cellulose (%) : 6-19
- Lignin (%) : 5-10
- Pectin (%) : 3-5
- Ash(%) : 1-3
- Extractives (%) : 3-6

MATERIAL AND METHODS

Extraction Of Banana Fiber

Fibers from the banana pseudo stem can be extracted by a decorticator machine. It is a machine used to strip bark, skin, wood, stalk, and grain. The extraction process is conducted as soon as the pseudo stems are cut. The common method in practice is a combination of water retting and scraping.

The leaves are stripped from the cut pseudo stems afterward a knife is put at the bult end between the outer and middle layers of the leaf shaft and then the outer part is held firmly and pulled out.

Decorticator machine consists of a rotating drum mounted on a shaft. On the circumference of the drum are mounted several blades which create a beating action as the drum is rotated by an electrical drive. As the drum rotates the pseudo stem is feed between the drum and backing plates or feeding roller.

Owing to the crushing, beating and pulling action the pulpy material is removed when it is half way through. The pseudo stems are slowly pushed from the drum and fall out to the conveyer belt, and eventually the fibers are collected on the bucket. The next step is the degumming process of the fibers to remove foreign matter that are then washed and dried at room temperature of approximately 27-32 degree C. This machine can handle approximately two tons of dry fiber per day.(3)

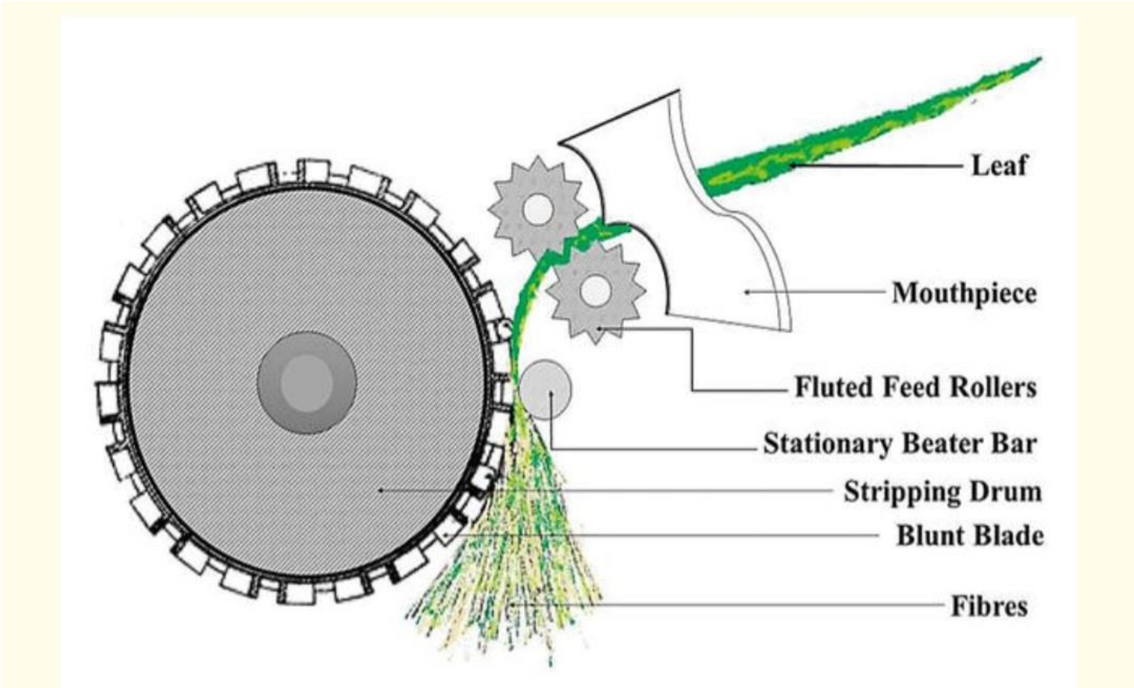


Figure – 1 Extraction Machine of Banana Fiber

The extraction process is done both manually and machine. After fiber extraction we removed the gum from the fibers. The process of removing gum from fibers is known as retting. After that the fibers are washed and dried.

Banana pseudo stem fiber produced by decorticator machine contains a quite large % of gum and non fibrous cell or parenchyma (approx 30-35%). These gums and cells are mostly not soluble in water and must be extracted before the fiber is mechanically spun into fine yarn count. These gums basically consists of arabans and xylons which are soluble in the alkaline solutions.

The basic degumming process steps are –

- Boiling the fibers couple of times in aqueous alkaline solution with or without agitation and pressure and with or reducing agent.
- Washing the fibers with water for neutralizing.(4)

Banana Fiber In Textile

The banana plant contains good quality textile grade fibers popularly known as banana fiber. This fiber is another unexplored natural fiber used for the fashion and technical textile industries for sustainable product development. These fibers are extracted from the pseudo stem of the banana plant. Suitable banana fiber extractors can be used to extract the fibers from the pseudo stems of the banana plant. (5)

Bleaching Of Banana Fiber

The extracted fiber after removing gum is now bleached with the hydrogen peroxide which is used for bleaching the cotton. We used sodium hydroxide, hydrogen peroxide, sodium carbonate, and sulfuric acid for bleaching the banana fiber. (6) After bleaching the we dyed the banana fiber by using natural dye.

Dyeing Of Banana Fiber

Bleached banana fiber is now dyed using natural dye. In dyeing procedure first we prepared a dyeing solution in which we use madder natural dye at 5% shade. There are three pH of dyeing are-

1. Acidic pH
2. Water And
3. Basic

After dyeing the banana fiber we see that the banana fiber gives better result in acidic pH. We dyed the banana fiber in acidic pH of 5-6 for 120 minutes at 80 degree C. After dyeing we washed the fiber with water and dried it.

Fabric Formation

We made a fabric by using banana fiber with help of hand loom. In which we use cotton as a warp and banana fiber as a weft. In which after the formation of fabric we feel that the fabric feels is rough because coarseness of banana fiber so we research about the softening process of banana fiber to make it comfortable for wearing.

Figure -2 Dyed Banana Fiber **Figure – 3** Banana Fabric

Softening Of Banana Fiber

The softening procedure is done for banana fiber after the retting process. The banana fiber have been subjected into chemical treatment to reduce the fineness. In softening process we reduce the fineness of banana fiber by treating with different alkaline treatment. In which we use chemicals like – NaOH and H_2O_2 with different percentages. The treatment is done in two steps. In first step the fiber was bleached with H_2O_2 (4% on weight fibers), NaOH (2% on weight fibers), M:L ratio is 1:20 at 100 degree C for 60 min with some drop of weighting agent. After that the fiber is treated with NaOH at different percentages like 1%,2%,4%,and 8% with 1:20 M:L ratio at 95 degree C for 30 min to reduce the fineness. The softener is prepared with the combination of castor oil (4-6%), Aloe Vera (4-6%), cotton seed oil (4-6%), and emulsifier (2.5%) treated for 60 min. (7)

The fiber weight loss can be calculated by using the formula –(8)

Weight loss (%) = [(IW- AW) / IW] *100

Where, IW is the mass of fiber before treatment and, AW Mass of fiber after treatment.

By using this formula we can calculate the % of weight loss.

Morphological Structure Of Banana Fiber

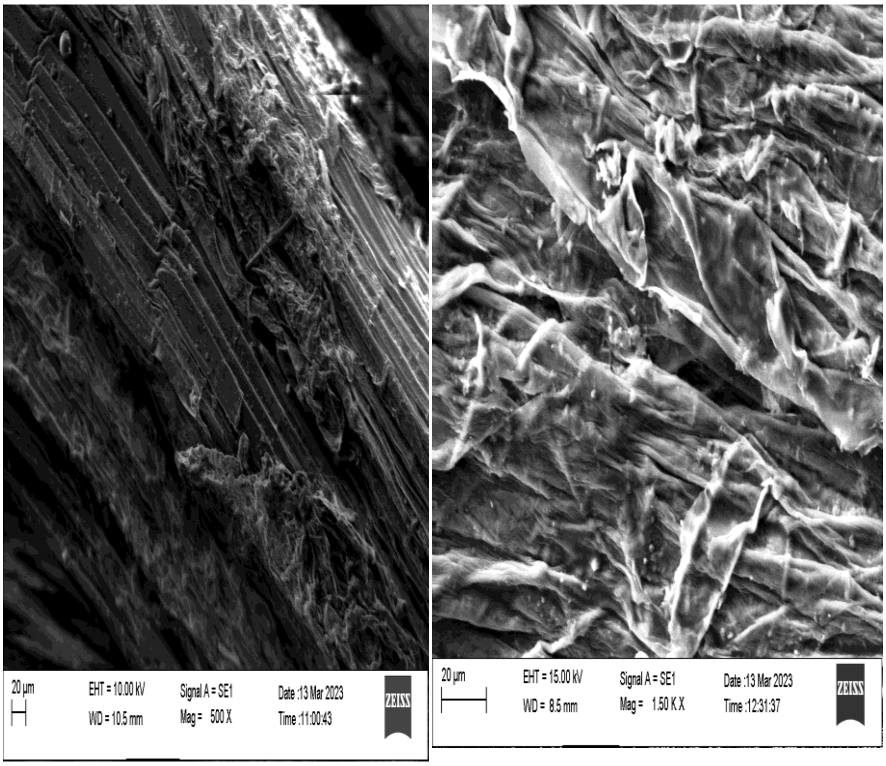


Figure – 4 The morphological structure of banana fiber with the help of SEM analysis.

Uses Of Banana Fiber

Banana fiber used in various application such as for making handicraft, decorative items, paper, currency notes, composite material, disposal items, sanitary napkins, filter paper, paper bags, etc, and its also used for making banana scrub. The banana fiber shows very good antibacterial properties. It can also be used for making ropes and mates.(9) There are many use of banana fiber especially a research say that the paper which is made from banana fiber can be folded 3000 times and its life is over 100 years. The banana plant leaves are used for making serving plates. Every part of banana plant is useful for various applications. (10)

Figure – 5 Application of Banana Fiber

RESULT AND DISCUSSION

S.N No.	Concentration of NaOH	Fiber fineness (Tex)
1	Raw banana fiber	31.2
2	Treated with 2.5 %	8.2
3	Treated with 5 % NaOH	5.46
4	Treated with 10 % NaOH	4.8
5	Treated with 15 % NaOH	3.7
6	Treated with 4 % H_2O_2 & 2% NaOH	5.5
7	Treated with 4 % H_2O_2, 2 % Na_2CO_3 and 4% NaOH	5.8

Table 1 – Fineness of alkali treated banana fiber

SN NO.	NaOH Concentration	Weight before treatment (g)	Weight after treatment (g)	Weight loss(%)	Condition
					M:L = 1:20 Temp = 95 degree C Time = 30min
1	2.5 %	338.16	324.22	4.122	
2	5 %	338.16	306.42	9.386	
3	10 %	126.08	111.99	11.172	
4	15 %	126.08	106.13	15.823	

Table 2 – Weight losses of alkali treated banana fiber

In the result of this experiment we can say that chemical treatment influence the banana fiber fineness. The retting and alkalization treatment improves the fiber surface adhesive characteristics by removing natural and artificial impurities, there by producing a rough surface topography. After chemical treatment the fineness of banana fiber is reduced, and the softening process reduce the fiber roughness and improves the spinability of the fiber because of that fiber can easily pass through different rollers without slippage. (7)

And in dyeing procedure we say that dyeing the banana fiber with natural dye at 5% shade on acidic medium at 5-6 pH is gives more better result. And we can easily dyed the banana fiber by using madder natural dye.

The fabric formation by using banana yarns as a weft is also possible but without softening its feels rough. But it can used in further applications such as curtains, mats, covers ,etc but its not comfortable to wear.

Banana Production In India

As per the research India is a largest banana producer in the world it contribute approx 32.8% .And one hectare of banana plant we can extract 400-600 kg of banana fiber which we can use in various applications.(11) The major state in India which grows the banana plant are mentioned below. (12)

1. Maharashtra
2. Tamil Nadu
3. Karnataka
4. Gujarat
5. Andhra Pradesh

6. Madhya Pradesh
7. Assam
8. Bihar
9. Kerala

CONCLUSION

In the above article we can conclude that banana is a biodegradable, sustainable, and renewable fiber. And India is the largest banana producer in the world, So we can make India largest producer of banana fiber also.We can utilized this fiber in various applications. And after softening treatment it can use for making cloth also which are comfortable to wear. We can replace the synthetic fiber with this banana fiber. It is a natural fiber with wide ability. And the main thing which is highlight that every part of banana tree is useful. After fiber extraction the waste is also use for making banana scrub. Proper research can help for proper utilization of this fiber. And for reducing the pollution in the environment we can replace this natural banana fiber with the other harmful products. Still now further research can be carried out for proper utilization of these banana fiber.

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4.SANITARY NAPKINS: SYNCHRONIZATION OF SUSTAINABILITY WITH SUITABILITY

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ABSTRACT

Menstruation, a natural occurring process, is considered and taken into account as something which shouldn't be talked about so casually. Still being taboo in some parts of the country, it is of utmost significance in the context of health of females, from the point of view of normalising it as a genuine part of the lifecycle of females and in accordance with Menstruation Awareness Programmes which literally do put in efforts so as to educate the underprivileged sections of the society. Although Literacy paved way so as to make amendments in the mindsets of the people regarding menstruation in the females and menstruation products, yet there is much more left to conquer in order to make the living of the females more tranquil and soothing during their "those days of the month". Menstruation products such as Sanitary Napkins, Tampons, Menstrual Cups, which females do use during their menstrual cycle are to be bestowed the whole limelight of discussion whenever something about Menstruation is talked about, since these products, to some extent makes the whole process soothing and tensionless. However, proper usage of these products and ultimately their safe disposal is something which should be taught to the girls at the early age itself. At the outskirts of the cities and towns, in socially backward societies of mankind, the issues and problems related with the natural process of the female bodies needs to be taken into consideration. Moreover, the use of toxic chemicals and additives in the formulation of menstrual products hampers the health of the females and certain alternatives for such concerns, gradually, needs to be adopted by the giant players of this category in the market. Switching over to Eco-friendly possibilities would come at the cost of money and adaptive mindset of the menstruating female part of the population of 141.72 crores Indians (as of 2022).

Keywords: *Menstruation, Sanitary Napkins, Waste generation due to improper disposal of sanitary napkins, Health Concerns and Environmental Concerns.*

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1. WASTE GENERATED BY SANITARY PADS AND ITS EFFECTS ON THE ENVIRONMENT

Global population of females generates is nearly 250 to 300 million tons of waste which is a multitude and requires the utmost attention to be eliminated from this planet [1]. As per the National Family Health Survey, 77.5% of urban and 48.2% of rural Indian female population use disposable sanitary pads. This much consumption of sanitary napkins will generate around 16180 tons of waste per month which are non-decomposable and generate harmful gases in the atmosphere. As per the report of the Karcha Project, an average woman throws around 150 kg of non-biodegradable absorbents on land or other water bodies per year that are not decomposable [9].

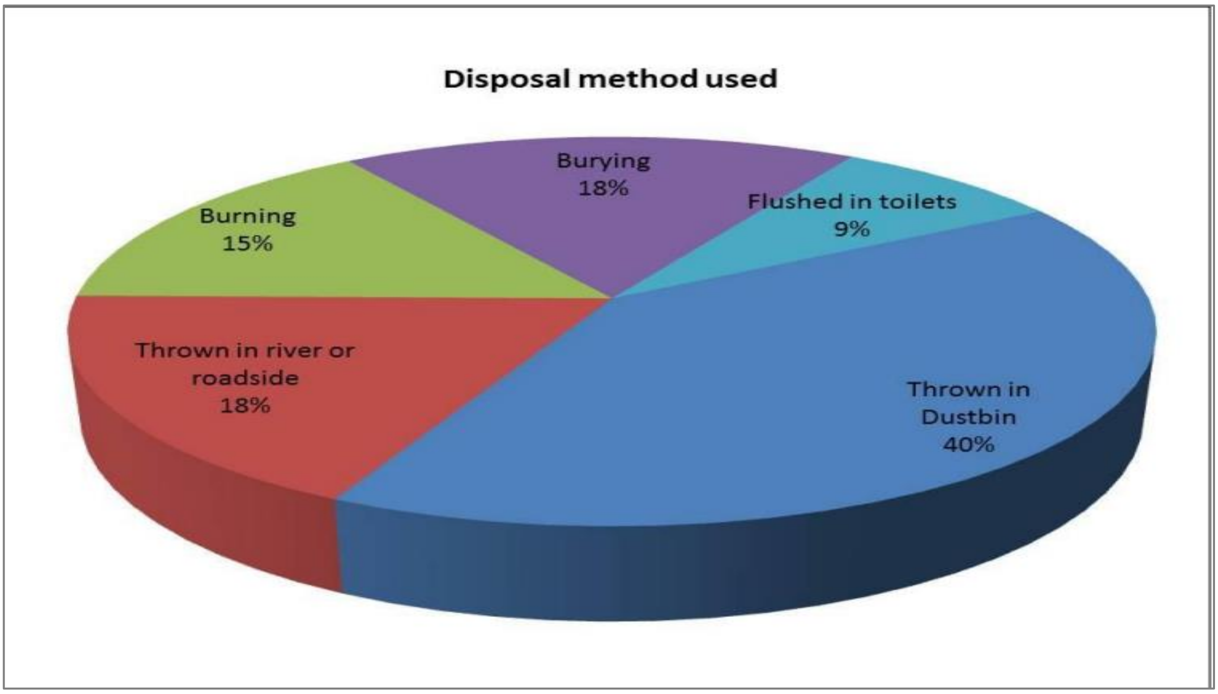

Figure-1:*Different sanitary waste disposal methods followed in India*

Conventional sanitary napkins are made up of 90% plastic, which goes to landfills and remains there for centuries leading to an increased carbon footprint in the soil in the end contributing to a heavy amount of soil pollution. Hepatitis and HIV viruses that can remain contagious in soil for almost up to 6 months are also found in sanitary goods that have been soaked in the blood of an infected woman or girl. Conservancy personnel without protective gear or instruments have to physically unblock and clean the stopped drainage caused by the use of napkins even leads to a huge source of water pollution.Although burning pads create hazardous fumes that are bad for the environment and human health, and result in air pollution it is still preferred to incinerate menstrual waste [5]. A PATH study analysed that the annual solid waste load of disposable sanitary napkins was higher than any other menstrual hygiene products which is around 44,254 cm3/female/year [2]. The average sanitary napkin comprises 48% fluff pulp, 36% PE, PP, and PET, 7% adhesives, 6% superabsorbent and 3% release paper [3]. meta-analysis study in India suggests that unsafe disposal practices such as throwing absorbents in open spaces and burning in open burning, not incineration are significantly higher inrural and slum settings than in school-based studies, and that reliable that solid waste disposal was more common in urban areas than in rural areas [4]. Menstrual hygiene products often contain residual solvents like volatile organic compounds which can be a major threat to the environment mainly resulting in air, water, and soil pollution when such menstrual hygiene waste is disposed of even affects the female intimate area [6]. Raw materials like polyethylene and polyester take nearly 500 to 800 years to completely degrade with nearly no trace. In rural areas, due to a lack of facilities, women dispose of used menstrual clothes and sanitary pads in landfills after wrapping them in polythene bags which eventually slows down the degradation time, and the menstrual hygiene waste is thrown in the soil for many years. Polyacrylate is a super absorptive polymer used as raw material in sanitary pads which when flushed in the toilets can lead to large amounts of water consequently blocking the sewage system which leads to backflow. Bleaching chemicals such as organic chlorines are used in the production of deodorized sanitary pads which can disrupt the pH of soil and increase the degradation time [7]. acrylate polymers used as raw material for sanitary pads release certain toxic monomers or additives when the polymeric network degrades [8]. leaching of enough chemicals makes their way to groundwater leading to contamination of huge sources of drinkable water pollution even when this polluted groundwater used for irrigation leads to soil pollution increases the alkalinity of soil. An increase in the disposal of sanitary pads using burning at low temperatures leads to the release of toxic greenhouse gases which have severe effects on health as well as the environment [5]. Over a billion non-compostable sanitary pads are making their way into sewerage systems, landfills, fields, and water bodies in India every month, posing huge environmental and health risks [9]. P&G has a high share percentage of the women's hygiene goods market at a lower price Whisper Choice Sanitary Napkins Ultra with Wings pack of 7 Pads of regular size cost nearly 27 rupees. but it leads to negative effects on the environment as it consists of non-decomposable materials like polyethylene and polymeric fibres as raw materials which are harmful to women's health as well as degrading soil fertility and polluting water bodies. The lower price of whisper implies that it has ignored the external cost in the form of degradation of the environment which is beard by the society [9].

2. HEALTH HAZARDS CAUSED BY THE SANITARY NAPKINS

Everyday exposure to sanitary pads and picking and segregating them manually, leads the waste pickers to experience headaches, stomach churn, put off their food and when they don't feed their tired body at the end of the day, weakness and restlessness. Redness in the eye, respiratory or breathing problems, skin irritation, and vulnerability to gastrointestinal and musculoskeletal ailments are some of the very common problems experienced while handling waste, especially diapers and sanitary pads. Conventional disposable menstrual products mainly sanitary pads are bleached white using chemicals like chemical dioxin, which are linked to immune system suppression, reproductive issues, cancer, natural pH imbalance of the vagina, and leads to redness in the intimate area, which leads to discomfort, itching, rashes, and infections. Even nowadays sanitary pads are made of plastic to ensure desired elasticity and absorbency, discrete plasticizers are present in them causing grave damage to the organs. Some menstrual pads contain chemicals like Bisphenol A and Bisphenol S which hinder embryonic development and pose difficulties [11]. If cloth pads were not managed properly, then the human papillomavirus (HPV) would cause critical health. Dioxin used for whitening is a pollutant and a carcinogen by the WHO [12]. The use of dioxin, even in smaller amounts, would occupy the fat tissues of the human body and cause several health disorders, including cervical cancer and ovarian cancer. Since the vaginal mucous membrane is extremely permeable, it could absorb the dioxin directly into the bloodstream. Dioxin is an immunosuppressant that leads to an imbalance in the hormonal regulatory mechanism. Endocrine imbalance is the ratio of estrogen and androgen in the body, resulting in reproductive problems. The unavailability, unaffordability, and issues in disposing of the sanitary pads were the reasons for the long-term usage of the napkins [13]. The volatile organic compounds are studied in terms of safety, as their toxicity easily affects the reproductive function. This leads to minor dysfunction in the reproductive system caused by their toxicity can greatly affect reproductive disorders and further lead to pregnancy complications [14]. The volatile organic compounds result in irritation or allergic reactions accompanied by the use of sanitary pads [15].

Recently a case of a 49-year-old Australian nurse was stricken with dermatitis surrounding her genital parts caused by MDBGN which was a component of the adhesive patch of the sanitary pad she used. After she changed her pad to an eco-friendly product and began wearing inner products made of nylon and synthetic fibres cloths, she stopped complaining about those symptoms. The patching test results turned out to be positive for her sanitary pad, specifically for the adhesive part in the pad where MDBGN was used as a biocide in the manufacturing process. After this incident, the MDBGN allergy dermatitis review was carried out from 1993 to 2004 at the Skin and Cancer Foundation, Australia. The findings showed that these symptoms were quite infrequent, with only 20 cases of allergy to MDBGN being diagnosed among 2,837 patients tested during this period (0.7%) [13]. Organic solvents may also affect the health system that is not directly related to the reproductive organs, and cause health disorders such as autoimmune diseases, cardiovascular diseases, and neurodevelopmental defects. It has been investigated that exposure to organic solvents brings hazardous effects on pregnancy in terms of premature infant delivery, spontaneous abortion and subfertility, congenital malformations, and infertility Prolonged exposure leads to such symptoms. parental exposure to organic solvents affects circulatory systems and genital organs. Exposure to organic solvent in the vagina exerts influence on autoimmune diseases including multiple sclerosis, and cardiovascular diseases including complications and even malformation of newborns [14].

3. ENVIRONMENT-FRIENDLY ALTERNATIVES OF SANITARY NAPKINS

Ever since the disposal pads came into picture, earlier the women used old pieces of clothes, leaves, grass, paper, or other absorbent entities which they thought were apt for the very purpose. Better said then experienced, those practices were indeed associated with serious problems like rashes, vaginal and rectal infections. The first disposal pad was made available in the market in the year 1888 and around [16]. Superabsorbent Polymers (SAPs) tend to be the widely used material for the sanitary pads. SAPs refer to the class of polymers which incorporates high water uptake capability and the capacity to imbibe enormous quantities of fluid despite being under pressure because of the presence of a hydrophilic network in its very structure which helps in the formation of hydrogen bonds with the molecules of water, thereby keeping the skin dry and particularly isolated from the menstrual discharge [17]. SAPs could be most commonly characterised as the synthetic (petrochemical based) and natural (polysaccharide and polypeptide based). Majority of the marketed sanitary napkins are petrochemical based and derivatives of acrylic acid, its salt, and acrylamide which can't easily decompose, thereby leaving imprints of carbon footprint in the environment [18]. Hence, Natural plant fibres have been used extensively as a substitute of SAPs and some of the environment-friendly alternatives of sanitary napkins are as shown in the table given.

Table: *Marketed Biodegradable Alternatives of Sanitary Napkins*

Brand Name of the Biodegradable Sanitary Napkin	Natural Plant Fibers used as a substitute of SAPs
Saathi	*Banana fibres, bamboo fibre*
Carmesi	*Corn fibre*
Heyday	*Bamboo fibres and corn starch*
Anandi	*Organic cotton*
The Woman's Company	*Organic cotton*
Pee Safe	*Bamboo fibres and organic cotton*
Laado	*Organic cotton*
Purganics	*Organic cotton*
Vivanion	*Herbal extracts and anion strips*
Noraa Sanitary	*Organic cotton, corn starch, virgin pulp, and bamboo*
Eco Femme	*Organic cotton*

4. CONCLUSION

As per the discussions stated above, sanitary napkins and their waste disposal if not done in the most adequate way possible is detrimental for the human race as well as the ecosystem. The problems associated with the disposal of sanitary napkins could be traced back to the fact that there are stances of reluctance of people to get upon the fact that menstruation need not be taken or considered as a taboo in this twenty first century. The inclusion of toxic chemicals and variants in sanitary napkins adds to the fact that these are a source of threat for the female population. Therefore, biodegradable versions of sanitary napkins need to be taken into account and grassroots research should be opted for so as to increase the accessibility of the eco-friendly alternatives for the wider strata of the population. Awareness Programmes/Campaigns in Schools, Pictorial Representation of Menstrual Cycle including the ways to be opted for so as to safely discard/dispose the used sanitary napkins and Initiatives by the Major Business Players of the market in shifting the concern to "Less is More" could aid in educating and informing the social beings to truly reflect upon their undertakings from the lessons of life in the school of obstacles and dilemmas amidst a sea of opportunities.

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5.Comfort Properties of Denim Woven Fabrics Made from Different Spandex Percentage

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Abstract

Denim is cotton and twill fabric that uses colored warp and white weft yarn and used for jeans, work clothes and casual wear and considered as one of the most traditional and fashionable fabrics. In this study, stretchable denim fabrics for active sportswear was produced on Toyota® air jet loom with five different twill denim fabrics containing various percentages of elastane and comfort performance characteristics were studied . Different fabric constructions were woven by changing the amount of weft yarn Lycra percentage. Fabric used to conduct this work has the following specifications 64 EPI, 46 PPI, 12s Ne warp and 12s Ne weft yarn and fabric width 180cm ..Vat (Sulfur) dyed cotton warp yarn and undyed weft yarn of (12sNe) for both warp and weft were used for producing denim fabrics. Weft yarn Lycra percentage were changed up to five different values. A 98.5%c/1.5 Lycra,97,5%c/2.5Lycra , 96.5%c/3.5lycra, 95.5%c/4,5%Lycra and 94.5%c/5.5% for each fabric and their air permeability, drape ability, stretch ability and pilling rate were assessed. The influence of various elastane percentages on the above denim fabric performance parameters are investigated by employing a one-way Analysis of Variance (ANOVA) statistical software package. This would help commercial stretch denim manufacturer to understand the effect of elastane percentage on fabric properties. The obtained results showed that Lycra proportion in the fabric has an effect on fabric air permeability, stretch ability, pilling and drape ability. Air permeability was higher at low elastane percentage while drape ability, fabric stretch properties and pilling are good at higher elastane percentage.

Keywords:- *Denim fabrics; Lycra; Air permeability; Elastane yarn; Weaving Etc*

1. Introduction

Denim fabric is hard-wearing and has high density with a highmass per unit area and a 3/1 or 2/1-twill weaves construction.It is comfortable, fashionable, affordable, durable and a popular clothing material. Nowadays, the stretchable denims are in fashion due to its comfort fit and flexibility. These fabrics possess elasticity so that garments made out of stretchable denim fabric closely fit to body without restricting body movement. Clothes are mostly under strain in some parts of the body, such as the knee, elbow and lower back areas. Therefore, stretching is very important for the comfort of the wearer. Generally, fabrics are required to stretch comfortably in accordance with body movements, and also after -stretching, to retain their original shape without any deformation. However, if clothes don't have such great flexibility,deformation occurs which is dubbed as fabric bagging Ambedkar BR [2].The percentage of spandex used in the weaving industry depends on the fabric stretch required and fabric properties. Sincethe elasticity of these types varies up to 300%, this is reflected on the final characteristics of knitted and woven fabrics Mona MA [1].

2. *Materials and Methods -*

2.1 Techniques of merging cotton and spandex

A core spun spandex yarn is a compound structure consistingof a spandex core surrounded by staple sheath fibers. The stretchin a core spun yarn is derived from the contraction of the elastomerfrom the extension to which it is subjected during textile mill spinning. There are many methods for merging spandex with other textile fibers, such as core spinning, rotor spinning, siro spinning,and air entangling. Core spinning is one of these methods, and can be applied by the ring, Murata vortex, friction spinning, and rotor twister techniques Mourad MM.

Yet, to introduce various elastane's proportions for each yarn, the core's draft is modified as DuPont de Nemours [6] (Equation (1)):

$$DElastane = \frac{tElastane}{TYarn \times P} \quad \ldots\ldots\ldots..[1]$$

Where D Elastane, T Yarn (tex), t Elastane (tex) and P (%) are, elastane's draft, yarn's count, elastane count and fixed percentage of the elastane filament respectively.

2.2 Materials

The Toyota® air jet looms are used to produce a 3/1 warp faced fabric made from dyed warp yarn and undyed weft yarn.*A 98.5%c/1.5 Lycra,97,5%c/2.5Lycra , 96.5%c/3.5lycra, 95.5%c/4,5%Lycra and 94.5%c/5.5%* 3/1 twill denim produced fabric are used to conduct this work with the following particulars 64 EPI, 46 PPI, 12s Ne warp and 12s Ne weft yarn and fabric width 180cm.Weft yarns were produced from modified ring spinning system using elastane fibers of 70Dtex at five spandex percentage level as a filament and sheath consists of staple cotton fibers (Table 1-3).

Table 1: Warp Specifications.

Parameters	Specifications
Yarn count	12 Ne
Yarn type	100% cotton (rotor)
Yarn appearance	Even / normal
Yarn status	Dyed
Dye type	Vat (sulfur)
Ends per width	4608

Table 2: Weft yarn production specifications.

Parameters	Specification
Lycra yarn count	70 Dtex
Lycra draft	2.15- 6.2
Roving cotton draft	1.16
Yarn appearance	Normal/ even
Yarn status	White
Yarn type	Core spun yarn

Table 3: Yarn properties :

Yarn Sample	Breaking Strength, (cN/tex)	Breaking Elongation, (%)	U %	Unevenness, (CVm %)	Thin Places ,(-50%/ km)	Thick Places, (+50% /km)	Neps , (+200 %/ km)	Hairiness, (Uster® H)	Sh
Warp yarn									
	13.64	7.68	8.95	11.26	0	5	0	5.12	1.06

Weft yarn									
C1	13.55	8.84	8.85	11.21	0	13.8	12.5	8.2	1.95
C2	13.84	9.22	9.76	12.37	0	40	30.6	8.66	1.99
C3	13.22	9.45	8.66	10.99	1.3	70	65	7.47	1.83
C4	12.79	10.32	8.99	10.23	0.5	45	60	8.1	1.92
C5	11.83	10.64	8.52	10.21	2.5	25	40	7.12	1.72

3. Comfort properties –

Air permeability

Table 4 Analysis of variance (ANOVA) was performed to determine the statistical significance of the effects of elastane percentage on fabric air permeability. The Air permeability performance of those samples with different stretchable fabrics was illustrated in Figure 1 and observed that the Lycra percentage has a profound effect on fabric air permeability. As the percentage of spandex in weft yarns increases, the air permeability decreases. The statistical analysis proved that the maximum air permeability was associated with the fabric sample C1, while the lowest air permeability was noticed for the sample C5. The higher value of air permeability is observed in the fabric with lower value of Lycra percentage and it decreased as the Lycra percentages were increased. As Lycra percentage increased in the fabric, contraction, of the woven fabric were more, which made the fabric more compact, bulk and thicker, resulting in higher resistance to air flow. Hence, the higher amount of Lycra content can help in achieving higher stretch ability, with reduced air permeability. From statistical analysis it was observed that there is a significant difference in fabric air permeability of the five denim fabrics having different Lycra content ($F=94.675$, $p = 0.000$) (Figure 1).

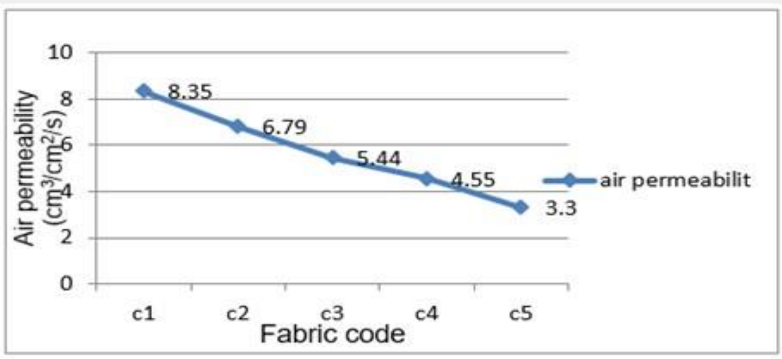


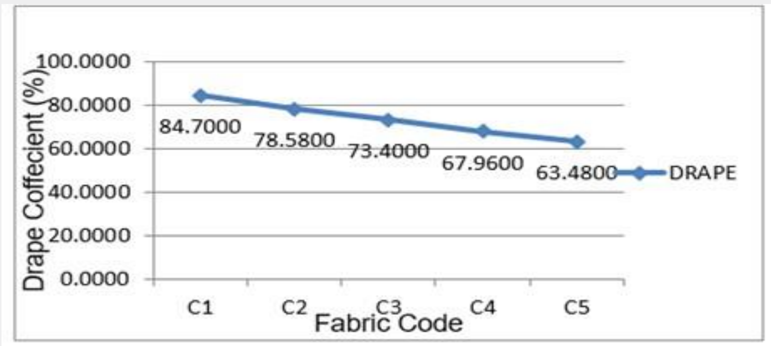
Table 4: ANOVA table for air permeability.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	76.903	4	19.226	94.675	0
Within Groups	4.061	20	0.203		
Total	80.965	24			

Table 5 A fabric with higher drape coefficient will be stiffer. The stiffness affects the fabric drape and tactile comfort. The fabric with very low drape ability is not comfortable to wear and cannot bend as per the body contours. The effect of Lycra percentage on fabric drape of the stretchable denim fabric is shown in Figure 2 and observed that as the percentage of elastane increases the drape coefficient of the denim fabric decreases meaning that fabric drape ability becomes good. From statistical analysis (one-way ANOVA) it can be observed that there is a significant difference between the fabric drape ability of the denim fabric samples having different Lycra percentage (F=98.826, p = 0.000) (Figure 2).

Table 5: ANOVA table for drape ability.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1420.244	4	355.061	98.826	0
Within Groups	71.856	20	3.593		
Total	1492.1	24			



Fabric Stretch

Table 6 A fabric with higher stretch may follow the body movement easily. However, once the force is being removed, the fabric should return to its original dimensions. The fabric containing Lycra are well known for their good stretch ability and stretch recovery characteristics. The interactive relation between spandex percentage and fabric stretch ability of denim fabrics are shown in Figure 3. It can be observed that the stretch ability was increased with the Lycra percentage since elastane makes the structure more compact. From the Figure 3, it can be noticed that as the applied load increases the percentage of stretch ability also increases. From ANOVA analysis it was observed that there is a significant difference in fabric stretch properties of the five denim fabrics having different

Lycra percentage (F=194.333, p=0.000) (figure 3)

Table 6: ANOVA table for fabric stretch property.

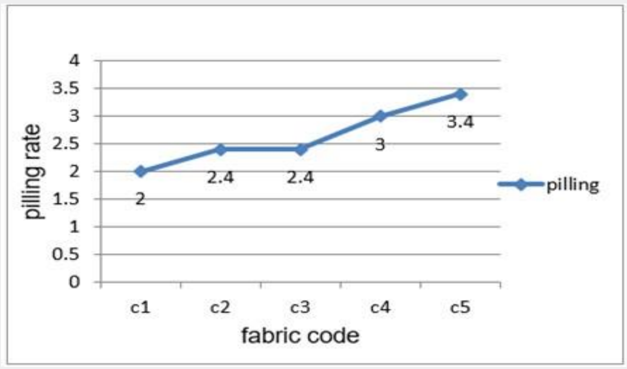
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2360.046	4	590.012	194.333	0
Within Groups	212.526	70	3.036		
Total	2572.572	74			

Pilling property

Table 7 & Figure 4 illustrates the relationship between the amount of elastane percentage and the pilling rating for the tested samples produced from 3/1 twill denim fabric at five different variations. From the statistical analysis of pilling rate, it is clearly seen that amount of elastane percentage has a significance effect on pilling rating for all tested fabrics. As percentage of elastane increase the pilling rate increases, because the greater amount of Lycra the tighter the fabric (Figure 4).

Table 7: ANOVA table for pilling rate.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.16	4	1.54	4.053	0.014
Within Groups	7.6	20	0.38		
Total	13.76	24			



Conclusion

The results obtained in the study work indicates that percentage of elastane has a significant effect on the comfort properties of cotton/elastane woven denim fabric. It is observed that air permeability performance of the denim fabric decreases as spandex percentage increase since less space for the passage of air. As spandex percentage increased the fabric contraction of the woven fabric were more, which made the fabric more compact, bulk and thicker, resulting in higher resistance to air flow. Hence, the higher amount of spandex content can help in achieving higher stretch ability, with reduced air permeability.

Drape ability of the denim fabric increases as spandex percentage increases. Fabric stretch ability increases with spandex percentage sine elastane has higher stretch and makes the structure more compact, It is also apparent that pilling resistance of the denim fabric becomes good as spandex percentage increases because of spandex is more resistant to abrasion than cotton fiber and the greater percentage of spandex the tighter the fabric.

Statistical analysis proved that the difference between the results for the three fabric were significant for all the properties. Comparing the fabrics analyzed, it can be concluded that they have a wider field of variation in performance characteristics (comfort) of denim fabric as the percentage of elastane content in the yarn starts to change.

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6.Design and Development of Conductive Knitted Fabric using Core Spun Conductive Yarn

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Abstract:

In recent years, the integration of electronics into textiles, known as e-textiles, has gained significant attention due to their potential applications in various fields, such as healthcare, sports, fashion, and smart textiles. This research focuses on the design and development of conductive knitted fabric using core spun conductive yarn, presenting a novel approach in textile electronics. The study investigates the fabrication process, electrical conductivity, mechanical properties, and potential applications of the developed conductive knitted fabric. Results indicate that the core spun conductive yarn-based fabric exhibits promising electrical conductivity, flexibility, and wash durability, making it suitable for diverse e-textile applications.

Keywords: Conductive Knitted Fabric, Core Spun Conductive Yarn, E-textiles, Textile Electronics, Electrical Conductivity,

Introduction:

The emergence of smart textiles has opened new possibilities for integrating advanced functionalities into conventional clothing. Conductive knitted fabric has gained attention due to its ability to combine the properties of traditional textiles with electronic components. Incorporating conductive yarns or fibers into knitted structures makes it possible to create fabrics that can sense, actuate, or generate electrical signals [1-3].

Smart textiles, also known as e-textiles or textiles, refer to fabrics that incorporate electronic components or functionalities. These textiles have gained significant attention in various fields, including fashion, healthcare, sports, and military applications. Smart textiles offer numerous advantages, such as sensing capabilities, data transmission, energy harvesting, and aesthetic enhancement. Conductive materials play a crucial role in the development of smart textiles [4]. These materials exhibit electrical conductivity, allowing them to conduct electricity and interact with electronic devices. Common conductive materials include conductive yarns, conductive polymers, metal fibers, and conductive coatings. These materials can be integrated into textiles through various techniques such as weaving, knitting, printing, or coating. Knitted fabrics offer several advantages over woven fabrics, particularly in terms of stretchability, flexibility, and breathability [5]. Knitted structures can be engineered to provide targeted compression, ventilation, and insulation properties. Additionally, knitting allows for the integration of conductive elements directly into the fabric during manufacturing. Several studies have investigated using conductive knitted fabric in various applications, including healthcare monitoring, wearable electronics, and sports apparel. These studies have demonstrated the feasibility of using conductive knitted fabric to create garments with embedded sensors, actuators, or communication capabilities [6-8].

This research focuses on using core spun conductive yarn to design and develop conductive knitted fabric, aiming to explore its electrical conductivity, mechanical properties, and potential applications.

Materials and Methods

Core Spun Conductive Yarn:

The core-spun conductive yarn used in this study, procured from HPT Pvt. Ltd. Panipat, comprises a conductive core material encased within a protective insulating sheath. These yarns are meticulously crafted using ultra-high molecular weight polyethylene fibers reinforced with metal and other multifibre components in the core/sheath structure, boasting a yarn count of 170 Dn. The selection of materials for both the core and sheath significantly influences the resulting fabric's electrical conductivity, flexibility, and wash durability. By integrating conductive materials into the core, this yarn facilitates the seamless transmission of electrical signals throughout the fabric structure, ensuring optimal performance in electronic applications.

Fabrication Process:

The conductive knitted fabric was meticulously crafted using flatbed and circular knitting machines, each tailored to specific fabric designs and structures. Various knitting structures were explored to optimize the fabric's electrical conductivity, with the core-spun conductive yarn seamlessly incorporated into the knitted structure to ensure uniform distribution and maximum conductivity. Figure 1 illustrates the intricate weft-knitted structure of the fabric, showcasing its geometrical parameters and the meticulous attention to detail in its fabrication.

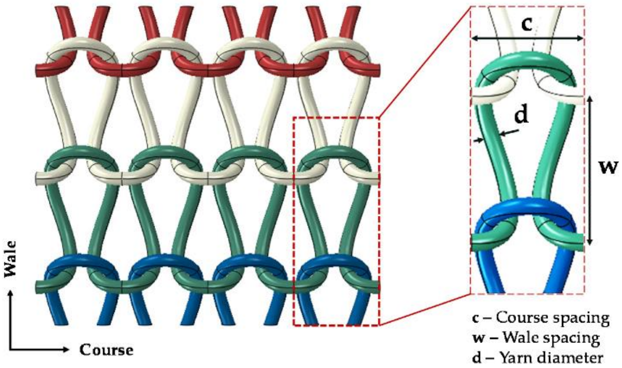

Figure 1. Knitting pattern of the plain weft-knitted fabric and its geometrical parameters.

The computerized flatbed knitting machine *utilized in this study features a gauge of 14 and a width of 22 inches, enabling precise and efficient fabrication of knitted fabrics. The fabric specification entails a width of 18 inches, with a specific 1x1 rib design or weave pattern employed. The loop length of the fabric measures 35mm, contributing to its desired texture and stretchability. The resulting fabric achieves the desired weight and density with a targeted GSM (grams per square meter) 250. The fabric structure is also characterized by 19 wales per inch and 17 courses per inch, ensuring uniformity and consistency in the knitted pattern. This combination of machine and fabric specifications provides a reliable foundation for producing high-quality knitted textiles with tailored characteristics. Figure 2a shows knitted fabric developed using a flatbed machine.*

The circular knitting machine *employed in this study is characterized by a gauge of 6, indicating the number of needles per inch along the circumference of the machine cylinder. With a wales density of 14 wales per inch and a course density of 13 courses per inch, this machine can produce knitted fabrics with a balanced and uniform structure. The yarn count utilized in the knitting process is 170 Dn, denoting the fineness or thickness of the yarn. The chosen weave pattern is a rib, contributing to the fabric's elasticity and texture. These specifications enable the circular knitting machine to produce rib-knitted fabrics with consistent quality efficiently and with the desired characteristics for various applications in the textile industry. Figure 2b shows knitted fabric developed using a circular knitting machine.*

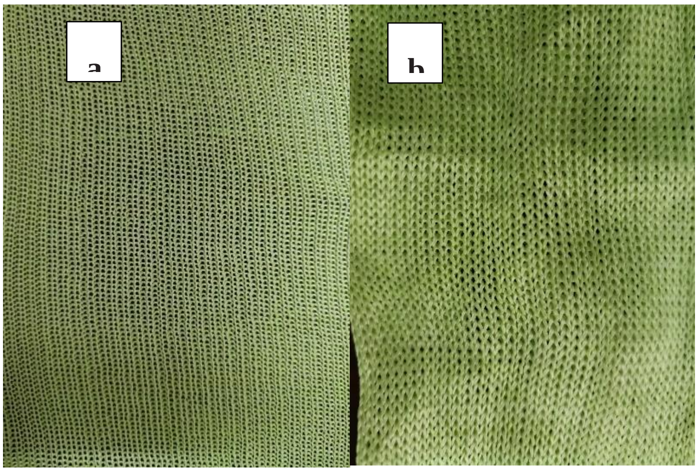

Figure 2: a). Flatbed knitted fabric b). Circular bed knitted fabric.

Characterization:

The electrical conductivity of the conductive knitted fabric was assessed using a Multimeter method, as shown in Figure 3. First, the multimeter was set to measure resistance in ohms. Then, two ends of the knitted fabric sample were securely connected to the multimeter probes, ensuring good contact. The multimeter's display was observed to record the resistance value of 70 Ω. A lower resistance value indicates higher electrical conductivity, while a higher resistance value indicates lower conductivity. Multiple measurements were taken across different areas of the fabric to ensure consistency and accuracy [9,10]. This method provided quantitative data on the electrical conductivity of the conductive knitted fabric, which is crucial for evaluating its performance in electronic applications.

Figure 3: Multimeter to assess the electrical conductivity of the knitted fabric

Discussion:

The results obtained from this study highlight the efficacy of core-spun conductive yarn in fabricating knitted fabrics with exceptional electrical conductivity and structural integrity. The meticulous fabrication process and the utilization of advanced knitting machines enabled the production of fabrics with tailored characteristics suited for diverse applications. The demonstrated electrical conductivity of the fabric underscores its potential for integration into wearable sensors, smart garments, and functional textiles, offering innovative solutions in healthcare, sports, fashion, and beyond.

Prototype Development:

A prototype jacket was successfully developed based on the promising results obtained from the design and development of conductive knitted fabric using core-spun conductive yarn, as shown in Figure 4. This jacket is a tangible application of the fabric's capabilities in wearable electronics and smart textiles [11].

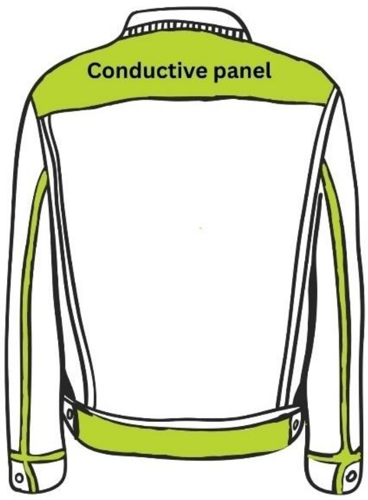

Figure 4: Conductive Jacket Prototype

Prototype Description:

The prototype jacket features a sleek and modern design, seamlessly incorporating the conductive knitted fabric into its structure. The fabric's exceptional electrical conductivity, flexibility, and durability make it an ideal choice for integrating electronic components into the jacket's functionality.

Key Features:

- *Embedded Sensors: The conductive knitted fabric is a platform for embedding various sensors throughout the jacket. These sensors can monitor vital signs such as heart rate, body temperature, and movement, providing valuable data for healthcare monitoring and sports performance tracking.*
- *Interactive Controls: The jacket has interactive controls, allowing users to adjust temperature settings, control music playback, and receive notifications through touch-sensitive panels integrated into the fabric. This feature enhances user experience and convenience.*
- *Integrated Lighting: LED lights are seamlessly integrated into the fabric, providing illumination for enhanced visibility during nighttime activities or outdoor adventures. The conductive nature of the fabric ensures reliable power distribution to the lights, enhancing safety and visibility.*
- *Wireless Connectivity: The jacket has wireless connectivity capabilities, enabling seamless communication with smartphones, smartwatches, and other electronic devices. This connectivity allows users to access additional functionalities and receive real-time device updates.*

Applications:

The prototype jacket holds immense potential for a wide range of applications in various fields [12]:

- *Healthcare: The embedded sensors can monitor vital signs and detect anomalies, providing early warnings for potential health issues.*
- *Sports and Fitness: Athletes and fitness enthusiasts can use the jacket to track performance metrics and optimize training routines.*
- *Outdoor Activities: The integrated lighting and interactive controls make the jacket suitable for outdoor activities such as hiking, cycling, and running, enhancing safety and convenience.*
- *Fashion and Lifestyle: The sleek design and advanced functionalities of the jacket cater to fashion-forward individuals seeking style and functionality in their clothing choices.*

Conclusion:

In conclusion, the research on the design and development of conductive knitted fabric using core spun conductive yarn has yielded promising results and opened avenues for innovation in textile electronics. The meticulous selection of materials and fabrication techniques has created a fabric with exceptional electrical conductivity, flexibility, and durability. By integrating advanced knitting machines and precise design parameters, fabrics with tailored characteristics suitable for various applications have been achieved.

The successful evaluation of the fabric's electrical conductivity using the Multimeter method reaffirms its potential for integration into wearable electronics and smart textiles. Developing a prototype jacket demonstrates the fabric's capabilities, showcasing its versatility and applicability in real-world scenarios.

Overall, the design and development of conductive knitted fabric represent a significant advancement in textile technology, offering a platform for creating intelligent and functional textiles that enhance comfort, convenience, and safety in various aspects of everyday life. As technology continues to evolve, conductive knitted fabrics hold immense potential for revolutionizing industries and shaping the future of wearable electronics.

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7.EFFECTIVE REMOVAL OF MICROFIBRES FROM LAUNDRY WASTE WATER

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ABSTRACT

Microfibres in laundry water is one of the major contributors to microfibre pollution. Environmental pollution caused by domestic laundering processes of synthetic clothes has been reported as the major cause of primary microplastics in the marine system. Around 35% of microplastics found in the ocean resembles the fibres that are being used in the apparel. These microfibres are potential enough to affect living organisms in the sea and they can transfer to the human being through the food chain. The main objective of this project is to remove the microfibres in the laundry wastewater to mitigate their potential environmental and human health impacts. Adsorption of microfibres from laundry water by using bio char, magnetic separation method and luffa sponge is found to have a positive impact to reduce the microfibres. In this study, we aim to develop an efficient method to filter the laundry wastewater using modified Luffa sponge which has more efficiency compared to other processes.

Keyword: -*Microfibres, Luffa, Laundry, Alkali Concentration, Duration, Temperature and Efficiency*

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1. INTRODUCTION

The widespread use of textile and consumer goods has led to several environmental and human health challenges including environmental pollution, wildlife and ecosystem impact, water quality degradation, etc. Microplastics and microfibres are the emerging contaminants and it is necessary to remove the impurities at the earliest to protect our environment. These microfibres are very fine, ultra-thin synthetic fibres typically made from materials like polyester, nylon or acrylic. The textile industry has seen a significant rise in the use of synthetic fabrics due to their cost-effectiveness and widespread availability. As of 2023, over 60% of global clothing comprises synthetics like polyester, acrylic, and nylon [1]. On average, washing a kilogram of cloth load releases 150,000 fiber particlesand about 12.8 × 106 microfibers per cubicmeter of water are released during the washing process [2].

Studies reveal that domestic laundry wastewater is a primary source of microfibre pollution. The release of microfibres (up to 7 million) into the environment primarily from laundry activities has emerged as a significant environmental issue of our time and have become a notable pollutant. Despite efforts to mitigate microfibre release during laundry, such as controlling factors like temperature and agitation, effectiveness has been limited. Consequently, attention has shifted towards removing microfibres from effluent [3].

Innovations like Cora-ball and laundry bags have shown promise in reducing microfibre release during washing [4]. Additionally, external filters attached to washing machines' outlet pipes have been developed to effectively capture microfibres from wastewater. Researchers reported that these filters are effective in removing the microfibres from 80 – 98% based on the technology adopted. The filters were noted to be effective up to 20 washes, after that a replacement of a new filter or cleaning by the manufacturer is essential [5]. Studies also reported that the clogging of the mesh-type filters is one of the major problems of the filters due to the use of detergents in the laundry. Though these filters are quite effective at limiting the discharge of microfibres from laundry their application is largely limited by problems with disposal and long-term effectiveness.

However, these methods can cause secondary pollution after being involved.In this study, inspired by the natural phenomenon, a type of biodegradable sponges derived from the luffa plant were fabricated to deal with these contaminants. Luffa is a niche vegetable for food and eco-sponges and is very popular in Europe and Asia. It consists of crisscrossed fibres and presents a three-dimensional reticular structure. The luffa sponge is a low-density, eco-friendly resource that is non-toxic, biodegradable, and has stable physical and chemical properties. The 3D structure of the sponges provided affluent active areas, as well as the capillary force of porous sponge, which can help to adsorb microfibres tightly on the surfaces [6].

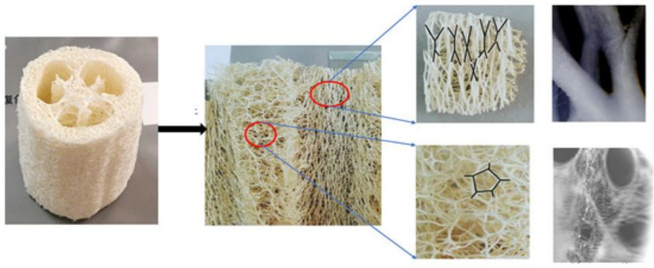


Figure -1: Fibrous structure of Luffa

2. METHODOLOGY

When utilizing untreated luffa for microfibre filtration, several limitations are observed. These include reduced surface roughness, inadequate mechanical bonding strength, heightened presence of impurities (such as wax or gummy substances), and overall decreased filtration efficiency. So, Luffa is pretreated with Sodium Hydroxide (NaOH) where it removes the waxy and gummy substances and also removes lignin and hemicellulose thus, formation of scratches. This process offers several advantages. Firstly, it effectively removes impurities from the luffa material. Secondly, it enhances surface roughness, thereby optimizing filtration performance [7]. Additionally, the treatment fosters improved adhesion between fibres and particles, resulting in enhanced overall efficiency.

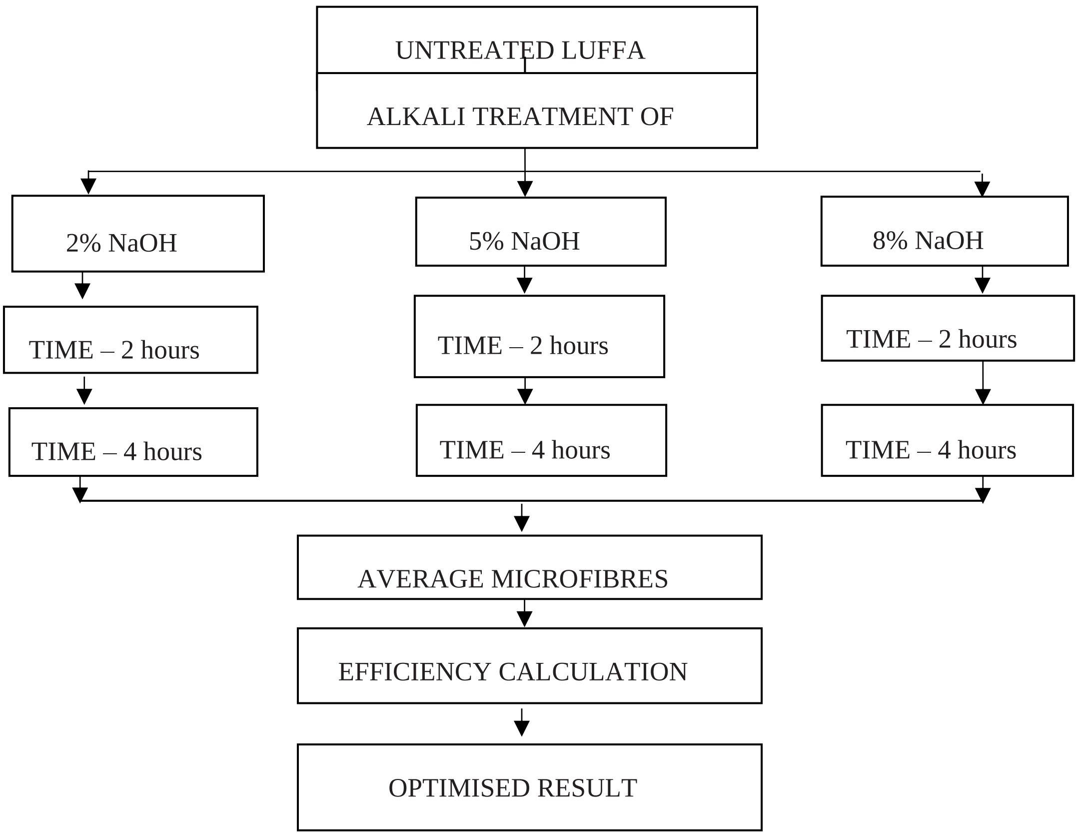


Figure -2: Flow process chart

2.1 Product development

We developed an external filter attached to washing machines' outlet pipes to effectively capture microfibres from wastewater. In this filtration system, alkali-treated luffa sponge will be arranged in layers as a luffa disc within the pipe. As the laundry water traverses through the luffa, it effectively captures microfibres on its surface, facilitating the removal of impurities from the water stream and it is found that 98% efficiency through luffa filter for about 7 wash cycles.

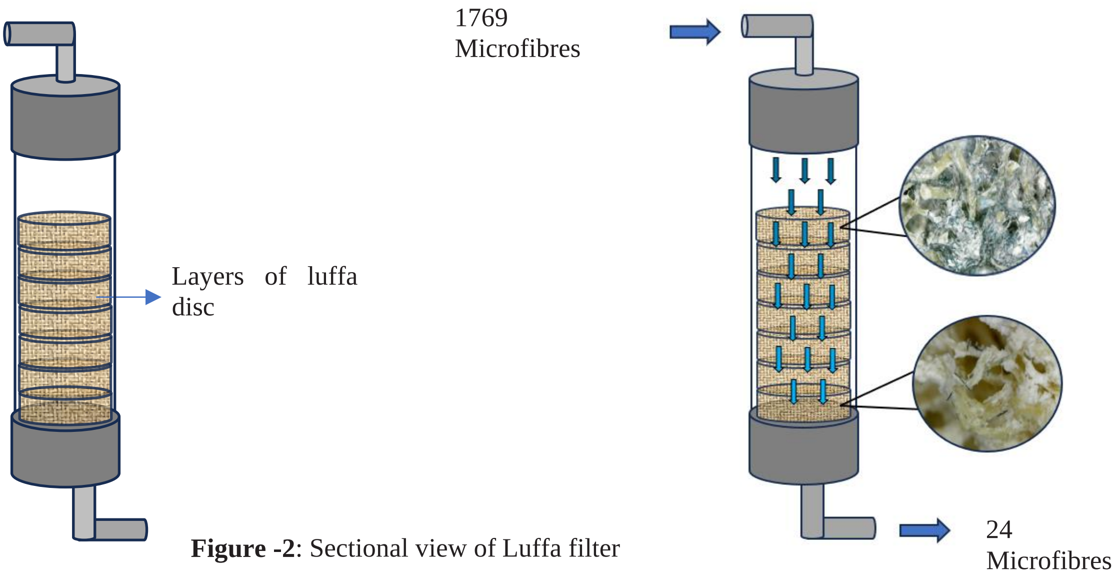


Figure -2: Sectional view of Luffa filter

2.2 Filtration efficiency

The determination of filtration efficiency employs a counting method, with the corresponding formula provided as follows:

$$\text{Efficiency } \% = \frac{\text{A} - \text{B}}{\text{A}} * 100$$

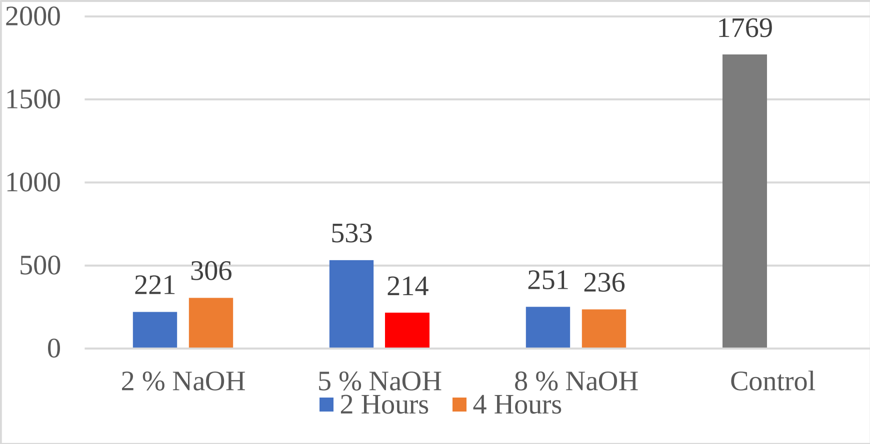
A = No. of microfibres when directly filtered through filter paper.

B = No. of microfibres when filtered using luffa setup.

The predetermined quantity of microfibres captured when directly filtered through filter paper was found to be 1769 microfibres.The filtration efficiency data for the initial 100 litres when passed through the luffa filter was documented.

3. RESULTS AND DISCUSSION

Numerous trials and experiments were conducted during the alkali treatment of luffa to achieve more optimized results aimed at enhancing efficiency. These experiments involved varying concentrations of NaOH, durations, and temperatures. The efficiency of the treatment process was assessed using a counting method to measure its effectiveness. Initially, three different concentrations of NaOH, namely 2%, 5%, and 8%, were utilized to treat luffa at two distinct durations: 2 hours and 4 hours. Four trials were conducted for each combination to obtain an average efficiency. Subsequently, the results were compared and visualized in the graph provided below for comprehensive analysis and interpretation.



24 microfibes

A graphical representation illustrating the efficiency data was generated and is presented below:

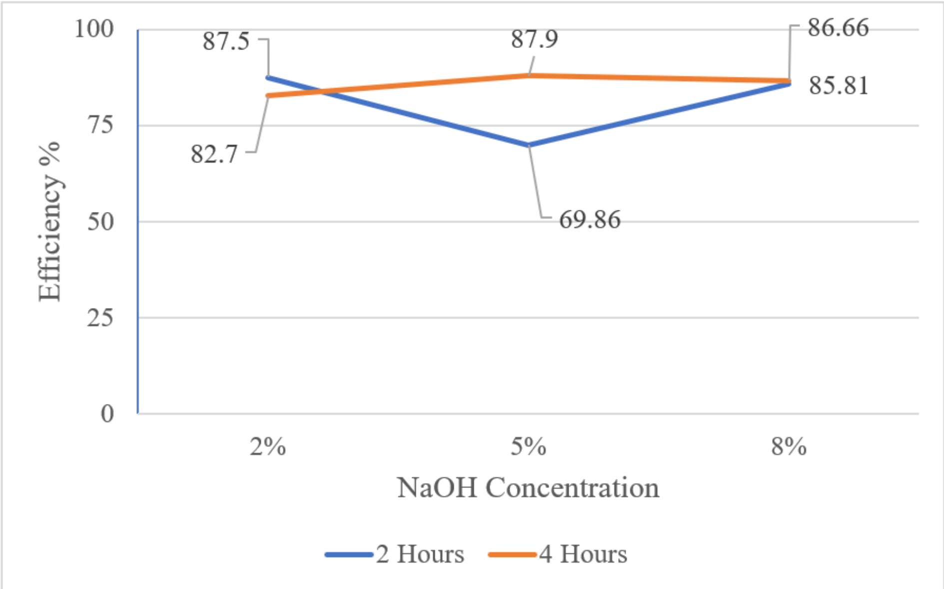


Figure -4*: Microfibres filtration efficiency*

Subsequent trials were conducted by varying the temperature parameters, specifically at 40°C, 60°C, and 80°C, to explore the effect of temperature on filtration efficiency and graphical representation illustrating the efficiency data was generated and is presented below:

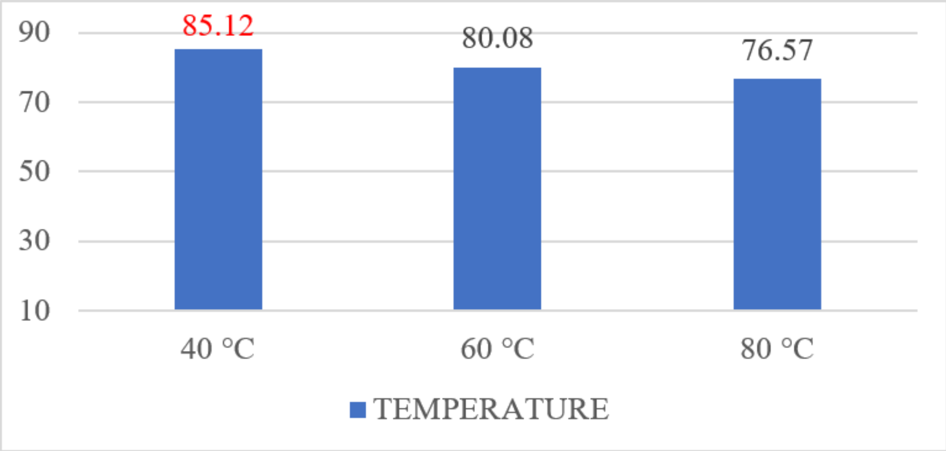


Figure -5*: Effect of temperature on filtration efficiency*

Ultimately, the optimized parameters for the luffa treatment process were determined as follows: a temperature of 32°C (room temperature), a concentration of 5% NaOH, and a treatment duration of 4 hours. Following the establishment of these optimal conditions, the luffa material was pretreated accordingly, dried, and subsequently arranged into discs to be stacked within the pipe assembly. This configured setup was then connected to the outlet pipe of a washing machine, wherein the filtration efficiency would be evaluated. Following the setup establishment, the filtration efficiency data for theinitial 100 litres when passed through the luffa filter is presented below:

Table -1: *Number of microfibres after each trial*

Experiment	***Microfibres count***	***Efficiency %***
10L 1	*24*	*98.64*
10L 2	*22*	*98.76*
10L 3	*27*	*98.47*
10L 4	*24*	*98.64*
10L 5	*39*	*97.80*
10L 6	*33*	*98.13*
10L 7	*30*	*98.30*
10L 8	*267*	*84.91*
10L 9	*236*	*86.66*
10L 10	*284*	*83.95*
	Average efficiency %	*94.43 %*

It is evident that the luffa filtration system exhibits varying degrees of efficiency across multiple experiments. The majority of experiments demonstrate consistently high filtration efficiency, and has the average efficiency of 94.43%. However, outliers are observed in experiments 8, 9, and 10, where significantly lower efficiency rates are recorded (ranging from 83.95% to 86.66%) and this deviation is due to detergent powder occupying the surface area of the luffa and leaving no space for the microfibres to get attracted the luffa surface.

4. CONCLUSIONS

In conclusion, the experimentation and optimization process regarding the filtration efficiency of luffa as a microfibre filter yielded valuable insights. Through systematic variations in parameters such as NaOH concentration, treatment duration, and temperature, the ideal conditions were identified. These optimized conditions were found to significantly enhance the filtration efficiency of the luffa material. The establishment of such parameters not only contributes to improved microfibre filtration efficacy but also provides a practical and sustainable solution for addressing microfibre pollution in laundry wastewater. In addition to achieving high filtration efficiency, another notable aspect of this optimized luffa filtration system is its sustainability in terms of disposal. The natural and biodegradable properties of luffa make it an environmentally friendly choice for microfibre filtration. Once the luffa material has reached the end of its lifecycle as a filter, it can be easily disposed of in a sustainable manner, further enhancing the eco-friendliness of the filtration process.

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8.VERTICAL FARMING USING AGRO-TEXTILES

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ABSTRACT

The idea is to develop a system to cultivate plants in a soilless Agro-textile bed. Here Hydrogel, a superabsorbent chemical will be introduced within the textile fabric to make root support to grow plants. fertilizer will be used to provide the required nutrients (micro and macronutrients) and integrated with the beds. Agro-textile beds (Nonwoven and Spacer Fabric) will be used to grow medicinal plants initially with zero soil consumption on all of the beds. This process is a successful medium to grow plants without soil, also a proven eco-friendly approach with optimum water and chemicals consumption, besides the implementation soil-less farming.

Keywords : *Soilless agro-textile bed[1] , Root support[2] , Nutrient (micro and macronutrients)[3] , Agro-textile beds (Nonwoven and Spacer Fabric)[4] , Eco-friendly approach[5] , Optimum water and chemical consumption[6] .*

1. INTRODUCTION

With the rapid growth of population and requirement of land for cultivation the agriculturists find it very difficult to continue cultivation for crop production . Moreover the impact of food safety requirements , artificial pesticides , inorganic fertilizers are also of great concern in the context of ecological balance . The increase in crop production was not possible without any modern days technology and with the advent of modern technology , agriculture was very much developed with new systems that have reduce the energy , water and chemical wastes . Again the fertilization in the fields are causing adverse effect on thr environment with a high impact by polluting and creating human hazards . Preservative which was used at the time of storage are also not congenial for preservation vegetables , fruits etc, So if , there is any scope of cultivation without the help of soil would be a great approach to soilless farming integrated with the capability of multiple productivities has been presented in this paper with the help of agriculture and textile technology .

1.1Agrotextiles

Textile used in agriculture , horticulture , animal husbandry etc. are terms as Agrotextiles . Agrotextiles are specialized textiles used in agriculture for various purposes. The Agro-textiles help regulate temperature, protect crops from pests and adverse weather, conserve moisture, and control weed growth, contributing to more efficient and sustainable farming practices.

1.2 Vertical Farming

Even though India's agriculture is food-sufficient, the country is still home to a quarter of the world's hungry. Horizontal farming in India is resource-intensive, as the agriculture practices overuse water, fertilizers, and pesticides . Vertical farming is a modern agricultural technique where crops are grown in vertically stacked layers, often in urban areas. It allows for high-density cultivation and efficient use of space, making it possible to grow food in areas with limited land availability.

2. PROJECT METHODOLOGY

2.1 Material used for Plants

2.1.1.Lettuce,is known for its hydrating properties due to its high water content. It is also a good source of vitamins A and K, which are important for maintaining healthy bones and promoting blood clotting. Lettuce is often used in salads and can be a refreshing addition to your diet.

2.1.2.Coriander is a wonderful source of dietary fiber, manganese, iron and magnesium as well. Inaddition; coriander leaves are rich in vitamin C, K and protein. They also contain small amount of calcium, phosphorous, potassium, thiamin, niacin and carotene. Coriander is rich in immune- boosting antioxidants, helps to lower blood pressure, benefits heart health, protects brain health, promotes digestion and gut health, fights infections and protects our skin.

2.1.3. Spinachis packed with nutrients and is known for its high iron content, which helps in promoting healthy blood circulation. It also contains antioxidants that can support eye health and protect against age-related macular degeneration. Additionally, spinach is a good source of vitamins A and C, which are essential for a

strong immune system.

2.2 Agro textile used

2.2.1 Coir absorbent material

Coir pith or dust is a biomass residue that decomposes very slowly due to its lignocelluloses nature. It is one of the largest agro wastes in tropical countries. Hillocks of coir pith accumulate in the vicinities of coir fiber extraction units. A byproduct obtained during the extraction of Coir Fiber from the husk of Coconut. It has been found that to have superior and equivalent properties on being used as a growing media by commercial horticulture, floriculture and amateur home garden enthusiasts.

2.2.2. Warp knitted spacer fabric

Spacer fabrics are three dimensional knitted fabric consisting of two separate knitted substrates which are joined together or kept apart by spacer yarns. First layer-hydrophilic by nature, Second layer-hygroscopic by nature and Spacer layer-mono or multifilament. This three-dimensional fabric is comprised of an initial layer for moisture release, an interior layer for airflow, and at third outer layer for heat dissipation. According to the end uses the spacer ends of mono- filaments may be polyester, polyamide, or polypropylene.Spacer fabrics (3D fabrics) are produced through knitting and weaving technologies, among these technologies, knitting is the most common manufacturingprocess for the production of spacerfabrics. There are two types of spacer fabrics: warp-knitted spacer fabric and weft-knitted spacer fabric

2.2.3 Nonwoven stitch boned jute / coir fabric (Geo textile)

Coir Geo textile products is more than two decades old. A wide range of standard and tailor made products meeting various specific site conditions arepresent. Coir Fiber which is extracted from the outer cover of Coconuts is 100% degradable and ecofriendly with strong cellulose and property to absorb water. The fiber is spun to yarn and then woven to make Coir Geo Textiles.

3. PROCESS WORK

First, the micrograins are placed in cubes made of coirpith. These cubes are then kept in a dark room for 2-3 days to promote initial sprouting. Once they start to sprout, they are moved to a location where they can receive indirect sunlight for about 7-8 days. This helps them continue their growth. Once they reach a suitable stage, they are carefully transplanted into the NFT system, which is a specialized system for growing plants. Finally, after approximately 55 days, the micrograins are ready to be harvested. It's quite a precise and well-planned process to ensure optimal growth and yield.

4. CONCLUSION

This project on the design and development of agro-textile materials and their application in vertical farming showcases the potential for sustainable agriculture practices. By utilizing coirpith cubes for germination and carefully transitioning the micrograins to an environment with indirect sunlight, the project demonstrates an effective method for promoting growth. The successful transplantation into the NFT system further emphasizes the importance of providing the right conditions for optimal plant development. With a total timeline of approximately 55 days, this project highlights the potential of agro-textiles and vertical farming as viable solutions for maximizing crop yields, conserving resources, and reducing reliance on traditional soil farming methods. It opens up new possibilities for sustainable agriculture and contributes to the ongoing advancements in this field.

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9.INSTRUMENT FOR SPUN LONG STAPLE BAST FIBRE

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ABSTRACT

Bast fibers are available everywhere, though their quantity may vary with location but making them into yarn is not available everywhere. So, they are not utilized locally due to the unavailability of proper spinning machines. The local weavers or artisans are not able to buy these advanced spinning machine as they are very costly and widely used in industries. Also, they don't have that much skilled to operate these automatic machines, therefore, they are dependent on others for bast fiber yarn manufacturing.By seeing this situation, the idea to make handy instrumentwas emerged.By using this instrument, they will not depend on others for yarn. They will spun fibres into yarn easily as per their requirement. The design of handy instrument has been developed for spun long staple bast fiberby which a weaver can easily spun available bast fiber in best possible count without using electricity. There are different mechanical and electrical instruments available in the market but either they are costlier or able to spun fibres in only coarser count. In this paper, only idea of design of this instrumenthas been presented.

Keywords:*Bast fiber, Rural artisan, Banana fiber, Handy instrument.*

1. INTRODUTION

The modern scientific world is moving towards a sustainable research environment for the protection of the ecosystem. Different efforts are going on to utilize natural fiber in different ways. All natural fibers are safer to health and environment, recyclable and sustainable. Natural fibers have many advantages over synthetic fibers, including wide availability, low cost, outstanding thermal insulation and many more. One of the bast fiber is Banana. After harvesting the banana fruit from banana plant, the pseudo stems are generally discarded as waste or burnt after drying thus causing substantial pollution. In few places it is used as a bio fertilizer. One hectare of banana farm is estimated to contribute approximately 220 tons of bio-mas as waste containing pseudo stems, and leaves. A fully matured banana pseudo stems has 20-25 layer of flesh sheaths.

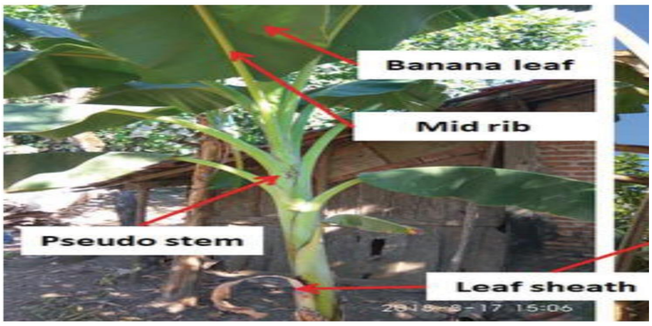

Figure 1- Banana Plant [1]

The banana plant contains good quality textile grade fibers popularly known as banana fiber. This fiber is another unexplored natural fiber used for the fashion and technical textile industries for sustainable product development. Research contributed by Sinha (1974) discloses a suitable process to spin in banana fiber in a jute spinning system. They made lot of effort for blending banana-based fibers and further different products development. This work also elaborated on the use of white jute, jute, and kenaf which were blended with banana fiber at different proportions to develop different sustainable product[2]. In hand spinning the fibers are spun into yarn by hand without any complicated machineries but it is time consuming process as well as the count of yarn is not defined, the yarn is uneven, the TPI is also not equal along the length. The production rate is also slow. In machine spinning process the machines are very costly and the weaver can not afford that, and they do not have much skilled to operate such kind of machine. These machines also required huge amount of electricity and very big space to set up. So, it is needed from the point of rural artisan to develop a machine that is simple, easy to operate and cheap. So an idea was explored here to design the machine suitable for rural area along with its comparison with available spinning systems.

2.BAST FIBRE SPINNING METHODS

2.1 Traditional Hand Spinning

In this method the fibers are spun into yarn by hand. No machineries are used but this is time consuming process.The count of yarn is not defined so the yarn is uneven and the TPI is also not equal.

Figure 2. Charkha [3]

Raw fibers are usually cleaned and combed to align the fibers and remove natural gum. The spinner sets up a spinning wheel, which consists of a wheel and a spindle. The wheel is turned by hand, which in turn rotates the spindle. The spinner pulls a small amount of fiber from the prepared supply and holds it lightly between their fingers. This action is called drafting. As the spinner drafts the fiber, they use their other hand to rotate the spindle, which twists the drafted fiber into yarn. The amount of twist applied depends on the desired characteristics of the yarn. Once enough yarn has been spun, it is wound onto the spindle or a separate tool called a nostepinne.

2.2 Flyer Spinning

From the back of the spinning frame, crimped sliver is fed from the finisher drawing. After entering the spinning frame’s drafting zone, the sliver is then pressed into the front pair of aprons by the retaining and pressing roller. As a result, the original drafting of the sliver is organized here. Because aprons can easily control all fibers. As a result, the production of high-quality yarn from low-quality fibre can only be achieved by using an apron draft frame. All fibers are controlled by the apron and sent to the drawing roller. Deliveries are made by touching the draft lightweight sliver with help of yarn detector. The sliver is then twisted and turned into yarn. As the flyer spins at its own speed, the bobbin yarn tension is set on the bobbin carrier. The difference in circumference between the flyer and the bobbin creates yarn on the button. When the bobbin yarn is full, then the machine is turned off and the full bobbin is removed. Finally the machine is restarted again with an empty bobbin. [4]

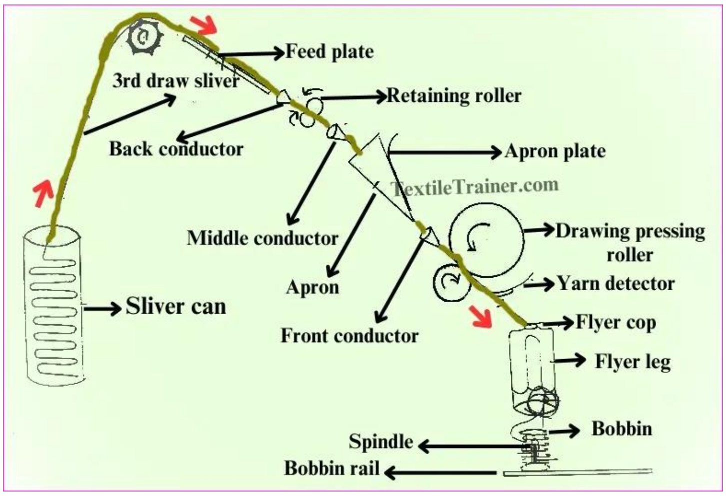

Figure 3- Bast fibre Spinning [4]

2.3 Proposed solution already available

2.3.1 Foot operated spinning machine

Waste Agro Ltd. has developed a foot operated spinning machine in which a number of fibres are fed into the machine by hand. Flyer twisting mechanism was used here to twist the fiber and wound on the bobbin, but the feeding is not in control, and courser count will only be possible.

Figure 4- Waste Agro Spinning Model [5]

2.3.2 iSPIN

iSPINis an electric spinning wheel solution that simply fits to your electric sewing machine. And by this we can spin natural soft fibre and wool fibre but for this we required sewing machine and electricity. [6]

Figure 5 - ISPIN Spinning Attachment [6]

3. Proposed Design

In this design, the drive to the main machine pully is transferred through belt from the pedal. The power will transfer to three different zones such as feeding zone, twisting zone and winding zone by gear arrangement. In feeding zone there are two seprate sections in which required number of fibres are feed.In twisting zone, the twist are imparted through a noble twisting method. After getting twist the twisted yarn is wound on the winding roller upto required amount. This proposed instruments will be very cheaper, easy to handle, can able to produce fine count as well as doubling can be possible. No electricity is requied as well as twisting and winding zones are sepeate so higher productivity can be achieved. As well as contant delivery rate will be achived.

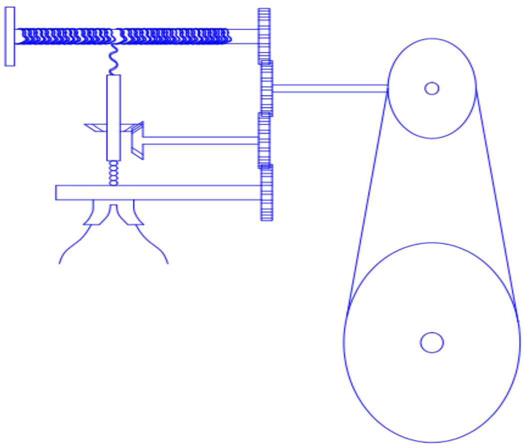

Figure 6- Proposed Design of Instrument

4. CONCLUSION

There are many bast fibre spinning techniques available but either they are electrically operated or spun courser count yarn. The new proposed design can be the appropriate solution for rural artisans for bast fiber yarn spinning. It will be cost effective so weaver can afford this instrument and should not depend on others for yarn.

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10.THE CONVERTIBLE SHELTER-JACKET

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ABSTRACT

Human beings have 3 basic needs. We must have food, clothing and shelter to survive. If any one of these basic needs is not met, then humans cannot survive.

- ***Food:*** *Adequate nutrition to sustain energy and health.*
- ***Shelter:*** *Protection from harsh weather conditions and environmental elements.*
- ***Clothing:*** *Appropriate attire to maintain body temperature and protect against the elements.*

What if a piece of clothing can serve as a shelter for when we are in an emergency situation? that way the device provides a user with an easy to carry, non-cumbersome water resistant, heat resistant piece of clothing that protects the user from the outdoors and cold environments.

***Target customer base: The homeless living in the cold region, mountaineers, refugees,* people living around the cold areas, travelers.**

This innovative wearable blanket seamlessly combines the warmth of a full-body sleeping bag with the functionality of a cozy jacket. When the night calls for rest, effortlessly transform it into a snug sleeping bag blanket with a retractable foot compartment, all while basking in the continued warmth of the coat. this jacket strikes the perfect balance between breathability, warmth, and protection from the elements.

These devices offer:

- thermal protection.
- a shield from insects and a lightly padded surface to sleep on to increase comfort
- provide users with protection from environmental elements such as cold, rain and wind.
- Water resistance
- A shelter/place to sleep in.
- Easy access inbuilt storage space

Traditional sleeping bags:

Typical sleeping bags are formed in an elongated pouch having a u-shaped cross section with a zipper along one side to permit the user to enter and exit the bag, and allow the bag to be closed around his or her body while therein. While in use, the shape of these bags can consume a sizeable amount of space within a tent or sleeping area.

When the bag is not in use, it is rolled up and secured in the rolled state. The shape and size of these bags when stowed and placed in a backpack can result in a considerable amount of lost volume that can otherwise be utilized for carrying necessary camping gear. Depending on the size and material construction, the sleeping bag can add substantial weight and bulk to the gear carried by a user.

1.1 What it provides :

- Water resistance
- Heat resistance
- Protection against adverse weather conditions
- Full-body cushioning
- Easy-access storage for valuables
- Protection from pests and insects

1.2 The problem homeless in the cold region, mountaineers, refugees, people living around the cold areas & travelers face:

1. **Homeless**: Homeless individuals in cold regions struggle with finding adequate shelter to protect themselves from the harsh weather conditions. Access to warm clothing, blankets, and hot meals becomes critical for survival.

2. **Mountaineers**: Mountaineers face a multitude of challenges in cold regions, including extreme weather and altitude sickness. They must be well-prepared with appropriate gear, such as insulated clothing, high-quality tents, and specialized equipment for navigating icy terrain. Mountaineers also need to be skilled in cold-weather survival techniques and be prepared for emergencies.

3. **Refugees**: Refugees fleeing conflict or persecution often find themselves in cold regions without adequate shelter or resources. They may lack proper clothing and shelter to protect themselves and their families from the cold. In refugee camps, overcrowding and limited access to heating facilities can exacerbate the harsh living conditions.

4. **Residents of Cold Areas**: People living in cold regions year-round face challenges related to maintaining infrastructure, transportation, and daily activities in extreme weather conditions. Cold climates also present challenges for agriculture and livestock management.

5. **Travelers**: Travelers venturing into cold regions need to be prepared for sudden changes in weather and temperature. They should pack appropriate clothing, gear, and emergency supplies, such as food, water, and communication devices

How it helps the target customer/people and how it helps their situation:

They should pack appropriate clothing, gear, and emergency supplies, such as food, water, and communication devices. But they also can’t carry all the weight with them because of the lack of storage, traveling and relocation. Outdoor enthusiasts are often faced with the dilemma of balancing how much gear to carry on hiking or camping trips. Some items are necessary for the commencement of particular activities. While these backpacks are voluminous and offer ample storage, users must be careful not to overload the backpack lest it become unmanageable or difficult to carry. To reduce the weight and bulk of the gear they must carry, outdoor enthusiasts are constantly seeking items that are more compact, and serve multiple purposes.

So, I came up with an idea so you can merge two of the essentials for living into one piece of clothing.

2.2 How it works:

A wearable garment that converts into a sleeping bag for insulating a user from environmental elements. The garment comprises a hooded jacket having two side portions covering a user's chest, a rear portion covering a user's back, two arm portions and a jacket hood. A lower pouch is removably secured at the bottom of the jacket and folds up to lie flat against the interior of the rear portion and jacket hood. This lower pouch is a recess contoured to fit the shape of a human lower body and having two feet shaped recesses at the bottom. By contouring the lower body enclosure to fit the shape of the legs and feet, excess air space is eliminated and overall insulation is improved. In this way the device provides a user with an easy to carry, non-cumbersome sleeping bag that protects the user from the outdoors and cold environments.

Other basic difficulties include:

1.Personal security, quiet, and privacy, especially for sleeping

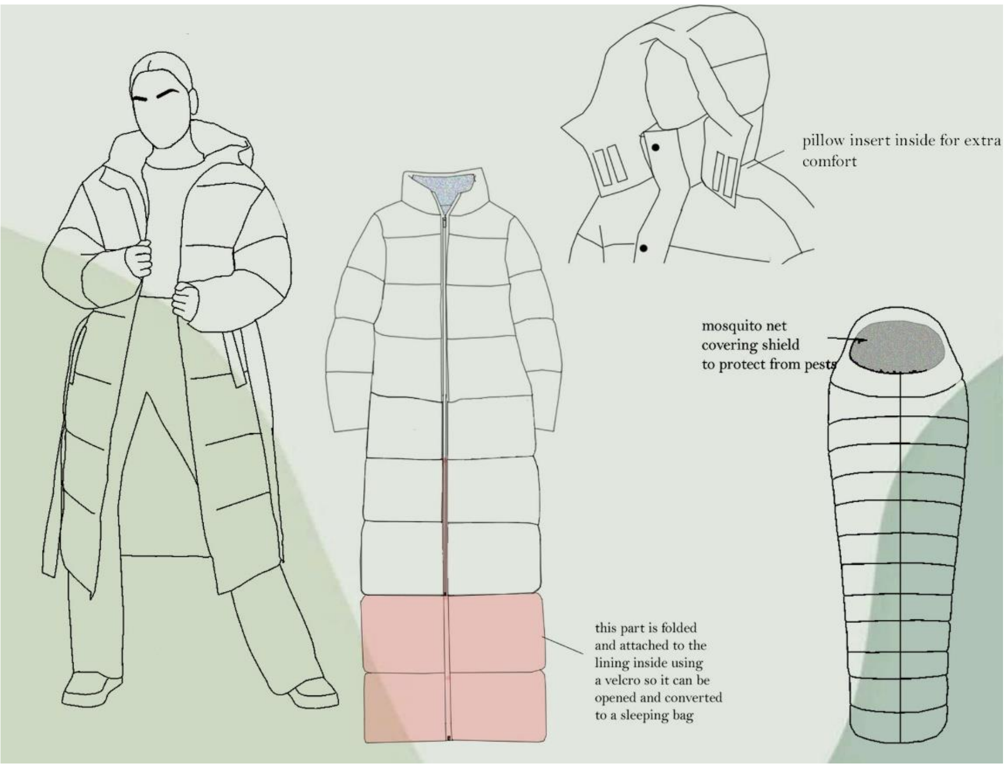
2.safekeeping of bedding, clothing and possessions, which may have to be carried at all times

3.adverse weather conditions like snow or rain

4.Lack of clean and hygienic environment (insects and animals)

5.Constant displacement and carrying belongings

- Inability to afford clothing (need for warm, dry clothes that are not damaged or torn and can protect them)
- lack of shelter



2.3 The garment construction

- The jacket comprises a rear portion, two side portions, a pair of arm portions, a jacket hood and a lower pouch. The device is unfolded and extended to show the various elements in a “ready for use” state. Each of the two side portions covers a corresponding portion of the front of a user's chest. A removable Velcro securement fastener is used to join the two side portions together near the middle of the chest area to extending vertically from an upper edge of the pouch to allow ease of entrance of a user's legs
- Arm portions are secured to an upper area at each side of the jacket to receive and retain a user's arms. Along the top of the jacket a hood is secured, which covers a substantial portion of the user's head while leaving the facial area open to allow proper respiration.
- When the lower pouch is attached to the jacket but not in use, the pouch is folded upwards and secured with a Velcro along the interior of the rear portion and hood. The lower pouch can be folded into a neat and compact shape for storage. After the pouch is compacted, it is folded upward towards the jacket hood. The bottom of the pouch, which is contoured to fit a user's feet, folds into the jacket hood. The lower pouch can be accessed through grasping the pouch bottom, pulling it away from the jacket.
- The user's lower body is enclosed within the lower pouch, which is fully extended to allow the legs to stretch. The sides of the pouch taper inward near the area corresponding to a user's knees and calves. Conversely, the bottom of the pouch expands outward and has pleats, thus a one size fits all. The contour results in less empty air space between a user's body and the pouch walls, The lower pouch thus insulates a user's lower body and keeps him warm throughout the night. The jacket and hood may be worn as normal, to keep the upper body and head warm. The pouch and jacket are adapted to be connectable.
- The lower pouch is folded up into a stowed position and the jacket garment is worn as a coat. The hood may be placed up or down according to the user's preference. When the lower pouch is in a stored position the device can be used as a regular outer layer. It thus provides protection from cold, wind, precipitation and the like while a user is enjoying outdoors activities.

3. Design concept

- a thigh length puffer jacket with inner foam padding for heat resistance and comfort while sleeping.
- This jacket can be unfolded and converted into a sleeping bag or a full-size bed (for one person) with pillow cushioning insert in the head area.
- This also comes with a set of easy access pockets and storage area for safekeeping belongings.
- The face region can be covered with a Velcro net cover for prevention from insects and other animals
- The jacket is a one size fits all so it fits everyone and makes them comfortable
- This jacket can be folded and can be buckled into a little bag
- The jacket is made up of a water proof material to protect them from adverse weather conditions

Inspiration board

3.1 Construction and textile materials

A fabric made for special occasions; Waterproof taffeta (the fabric used to make umbrellas) has been growing in popularity.

It is a 100% poly fabric and thanks to its water-resistant nature, it can be used for many purposes.

It is generally used for making reusable bags, high-end bag linings, medical gowns, and bedsheets and umbrellas


Foam batting


water-proof taffeta


white satin lining

4. CONCLUSION

The sleeping bag is stored along the interior of the rear portion of the jacket for easy transport and can be easily unfolded and extended when a user is ready to sleep or needs protection from environmental elements along his or her entire body length.

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11.Design and development of Transdermal Vitamin D3 patches

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ABSTRACT

This critical review explores the advancements in transdermal drug delivery fabric patches, focusing on textile materials and manufacturing methods. Various textile materials, such as biocompatible polymers and microfibers, are examined for their suitability in patch fabrication. The manufacturing process involves techniques like electrospinning and melt extrusion, aiming to enhance drug release kinetics. The integration of multifunctional and intelligent materials is analyzed from different perspectives. Smart polymers and responsive fabrics enable controlled drug release in response to physiological cues. Additionally, the review delves into assumptions surrounding the potential of these materials for personalized and targeted drug delivery.Major companies in the transdermal patch market, including medical companies and textile manufacturers, are identified. Their contributions to research, development, and commercialization shape the evolving landscape of transdermal drug delivery. The competitive dynamics among these stakeholders drive innovation and market growth.Various types of transdermal drug delivery patches, such as reservoir patches and matrix patches, are evaluated for their efficacy and applications. The market study provides insights into current trends, challenges, and future prospects, offering a comprehensive understanding of the transdermal skin patch landscape.

Keyword: *-Application, Market study, Textile material, Transdermal Drug delivery patch.*

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1. Introduction :

The Drug Delivery System (DDS) is a standard term for a physicochemical series development that have some control over the movement and appearance of pharmacological substances from cells, tissues, and organs, with the objective that these powerful substances can have constructive outcomes.[1,2,3]Today around 74% of medications are taken orally once more seen to be lacking. Getting to the powerful medication transport game plan ofsuch an individual emerged. The medicine is used in an exceptionally fairly high dosage in the patch, which is applied on the first layer of epidermis for about a prescribed amount of time. TDDS are estimation structures that contain drugs, and when applied to responsive first layer of skin, convey the prescription, throughout the layers of skin with a degree of control over the progression of the framework [1, 4].In 1965 StoughtonRecently viewed as percutaneous medicine ingestion. The Food & Drug Administration promoted the first ever Transdermal-SCOP program in 1979. The FDA embraced this to hinder queasiness andregurgitating [1, 5].

Fabric materials used for medical programs and plans are things that are utilised in medical treatment, and in clinical and sterile operations. This use in different designs follow as far as possible back to bygone eras. For example, ordinary materials like silk, cotton, fabric, etc., have been used as dressings for injuries. In the 20th hundred years, the recently developed, in VIVO use of medical and biological substances was spread out in the CVDs, stomach-related, eliminatory, etc., structures just after the launch of phony and designed fibres. Now a days, recent troubles are taking part in the branch of regenerative and tissue planning, in structures for the movement of organically powerful particles and in the development of smart materials for checking and cure of uncountable illnesses [6, 7, 8].different factors connected with the change of well- being status [6, 9].

1.1 Consequences of deficiency of vitamin d3

M. Dhage, V. Wamane, and M. Sherkar [10] studied the characteristics and mechanism of vitamin D3. They stated that Young to middle-aged adults begin to lose an average of 0.5% of their bone mass per year and can lose up to 5% to 10% of their bone mass over a period of 10 to 20 years, increasing the risk of osteoporosis and fractures. After menopause, women begin to rapidly lose 3-5% of their bone mass due to the loss of estrogenic stimulation in the skeleton, and vitamin D deficiency exacerbates this loss and increases the risk of developing osteoporosis. earlier in life, putting him at greater risk for fractures. The main source of vitamin D for children and adults is exposure to natural sunlight. Therefore, the main cause of vitamin D deficiency is insufficient sun exposure. Wearing sunscreen with an SPF of 30 reduces vitamin D synthesis in the skin by more than 95%. Dark-skinned people naturally have sun protection and need at least three to five times more sun exposure to produce the same amount of vitamin D as a white-skinned person. Vitamin D deficiency causes abnormalities in calcium, phosphorus, and bone metabolism. Vitamin D deficiency decreases the absorption of dietary calcium and phosphorus, leading to elevated PTH levels. The path-mediated increase in osteoclast activity creates local foci of bone weakness and causes a general decrease in bone mineral density (BMD), leading to osteopenia and osteoporosis. Improper calcium phosphate product causes defects in skeletal mineralization. In young children, whose skeleton is mineral deficient, this defect causes various skeletal deformities, classically called rickets. Vitamin D deficiency also causes muscle weakness; affected children have difficulty standing and walking, while older adults sway and fall more, increasing their risk of fractures.

1.2 Vitamin d3 deficiency in India

P Aparna, S Muthathal, Baridalyne Nongkynrih, and Sanjeev Kumar Gupta [11] study the causes of deficiency of vitamin D3 in India. They stated that the prevalence of Vitamin D deficiency ranged from 40% to 99%, with most of the studies reporting a prevalence of 80%–90%. It was prevalent in all age groups and high-risk groups alike. With the consequences of Vitamin D deficiency, namely, autoimmune diseases, cardiovascular diseases, cancer, and tuberculosis being explored, imagine the burden it would cause in our country. To create awareness among the public and healthcare providers about the importance of Vitamin D and the consequences of deficiency. The Indian diet generally fails to satisfy the daily requirement of Vitamin D for a normal adult. This stresses the need for fortifying various food with Vitamin D, through national programs. This silent epidemic should be addressed appropriately with concrete public health action.

2. Transdermal Drug Delivery System Patches

R. Dubey and U. Pothuvan [12] studied TDDS patches and stated that transdermal Patches have been contributing an important part to the pharmaceutical industry and medical practice by providing advances in the delivery of treatment with existing and novel drugs. The transdermal drug delivery system has made a great contribution to medical practices but many researchers are undergoing to achieve its full potential. A transdermal drug delivery system was coming into existence to overcome the difficulties of drug delivery, especially the oral route. Transdermal drug delivery refers to the means of delivering drugs through the surface of the skin for local or systemic treatment. The drug functions after absorption through the skin into the systemic circulation via capillary action at a certain rate. Transdermal patches are now widely used as topical and transdermal delivery systems. These patches are a significant result of advancements in skin science, technology, and knowledge, which have been created via trial and error, clinical observation, and evidence-based investigations dating back to the earliest human records. A transdermal patch is a medicated adhesive patch that is applied to the skin and used to deliver a precise amount of medicine into the bloodstream via the skin. A benefit of transdermal medication administration over other forms of delivery systems such as oral, topical, intravenous (i.v.), intramuscular (i.m.), and so on is that it is non-invasive. Transdermal patches provide medication to the patient in a regulated manner, either by a porous membrane covering a reservoir of medication or by body heat melting tiny layers of drug contained in the adhesive. This review article covers the basics of transdermal patches, such as the many types of patches, how they're made, and what factors influence them, among other things.

2.1 Types of TDDS patches

O. A. Al Hanbali, H. M. S. Khan, M. Sarfraz, M. Arafat, S. Ijaz, and A. Hameed [13] studied Transdermal drug delivery patches and stated five common types of Transdermal patches.

1. Single-layer drug-in-adhesive patches, a single layer of polymer with adhesive properties is used as a reservoir for drug dispersion.

2. Multilayer drug-in-adhesive patches Multilayer transdermal patches consist of a drug reservoir layer and an adhesive layer where drug release is controlled over some time

3. Vapor transdermal patches consist of a single layer of adhesive polymer with a vapor release property where vapor can be released . Several vapor dermal patches are available on the market and are used for different purposes.

4. Membrane-moderated transdermal reservoir patches: a transdermal patch containing a drug reservoir, a backing layer made of impermeable metallic plastic laminate, and a porous polymeric membrane that controls drug release over time. The membrane is made of polymeric materials.

5. Micro reservoir transdermal patches: Micro reservoir transdermal patches combine matrix dispersion with a drug reservoir.

2.2 Advantages of TDDS patches over oral treatments

V**.** Rastogi & P. Yadav [14] studied Transdermal Drug Delivery System and stated the following advantages of TDDS over oral treatment.

1.Self-administration is possible and continuous, sustained release of drugs.

2.Avoids peak and trough drug levels and longer and multiday dosing intervals.

3.Avoids first-pass hepatic metabolism and enzymatic degradation by the gastrointestinal tract and also avoids gastrointestinal irritation Less frequent dosing improves patient compliance.

4.An alternate route for patients who are unable to take oral medications.

5.Dose delivery is unaffected by vomiting or diarrhea Drug administration stops with patch removal.

3. Transdermalskin patch market study

Transdermal patches have evolved from traditional repository/film designs to innovative lattice patches, offering improved comfort, flexibility, and drug delivery efficiency. These patches utilize dynamic patching responses within a cushion, combining drug and adhesive into a single layer. Despite advancements, challenges like skin irritation, allergic reactions, and improper usage persist, necessitating ongoing improvements in formulation and application technologies.

The market for transdermal skin patches is poised for substantial growth, with a projected compound annual growth rate (CAGR) of 4.87% from 2023 to 2028. Factors such as the COVID-19 pandemic have influenced market dynamics, highlighting the importance of transdermal patches in delivering drugs safely and reliably to specific skin microenvironments. Additionally, advancements in microneedle technology have enabled the development of novel delivery systems for combating diseases like the novel coronavirus, showcasing the versatility and potential of transdermal patches in addressing evolving healthcare needs.

Increasing awareness of healthcare, coupled with rising disposable incomes, has fueled demand for medical treatments worldwide. Governments are actively supporting pharmaceutical research, evident from initiatives like the USFDA's grants for rare disease treatments and private sector contributions to pharmaceutical development. These efforts are expected to further drive the adoption and innovation of transdermal medication delivery systems, fostering market expansion and improving patient outcomes [6,15].

4.Methodology :

We adopt following methology steps to prepare Transdermal Vitamin D3 Patches:-

1. Procure Raw material
2. Testing of Raw material
3. Microencapsulation of Vitamin D3
4. Pad and cure the fabric with Microcapsulation chemical
5. Final testing
6. Result and discussion
7. Conclusion

4.1Raw material

Based on the precise needs of the finished product, the materials for this study were chosen. The required fabric characteristics were determined, and the fabric selection was made following them.

- Nonwoven viscous
- Adhesive- Polyisobutylene adhesive
- Chemicals- Cholecalciferol (vitamin d3)
  Triglycerides
  Transcutol

5. CONCLUSIONS

In conclusion, this critical review delves into the multifaceted landscape of transdermal drug delivery fabric patches. Through a meticulous examination of existing literature, it becomes evident that these patches offer a promising avenue for drug administration, characterized by advantages such as improved patient compliance and reduced side effects. However, challenges like variable drug permeation and patch adhesion pose hurdles. Advancements in nanotechnology and material science hold potential solutions. While acknowledging the substantial progress made, further research is essential to address limitations and optimize these patches for diverse therapeutic applications. This review underscores the dynamic nature of transdermal drug delivery fabric patches, encouraging continued exploration and innovation in this field.

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12.DESIGN AND DEVELOPMENT OF PROTECTIVE WEAR FOR MANUAL SCAVENGERS

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ABSTRACT

"Manual scavenging" refers to the manual removal of human waste from an unsanitary latrine, septic tank, pit, open drain, or sewer using hand tools such as shovels, buckets, and brooms. Scavengers who work by hand run the risk of suffering from respiratory diseases, typhoid, and cholera, which makes their job hazardous and dehumanizing. Due to the abundance of bacteria that reside in sewers, other common health problems include blood and skin infections, respiratory infections from pollution exposure, skeletal disorders from lifting heavy storage containers, burns from contact with hazardous chemicals mixed with waste, and infections from the sewer itself. The workers are put in danger since the labor is typically performed without clothing or protective gear. For the current study, questionnaires are administered in person. The prototype will be distributed among workers to ask for feedback on the design features that will be implemented, and adjustments will be made to enhance each prototype as needed. Based on the feedback received on prototypes, the final product will be designed and developed.

Keywords: Manual scavengers, Protective wear, Waterproof, Antimicrobial, Diseases.

1. Introduction

By utilizing hand tools like buckets, brooms, and shovels, one can manually clean, move, dispose of, or handle human excreta in an unhygienic latrine, open drain or sewer, septic tank, or pit. This process is known as manual scavenging. Scavengers who work by hand run the risk of contracting cholera, typhoid, and respiratory illnesses, making it an extremely dangerous and dehumanizing profession. Additionally, scavengers may get blood or skin infections, respiratory infections from pollutants they breathe in, a skeletal disorder from lifting heavy storage containers, burns from coming into contact with hazardous chemicals mixed with waste, and infections from the many bacteria that live in sewers. The task is frequently done without safety gear or clothing, which puts the employees in danger.

1.1 Objectives

The current research work is carried out with the following objectives,

1.To analyze various issues manual scavengers experience while using their everyday attire.

2.To analyze the various health problems related to manual scavengers in India.

3.To design and develop protective gear for manual scavengers in India.

1.2 Scope

The outcome of the current research will be to create protective wear for manual scavengers which will be used while cleaning dry latrines, open drains, and sewers that will protect them from different influenza diseases and keep them from experiencing Nausea, Tuberculosis, Asthma, infections, and Typhoid like various diseases.

2. Study of Manual Scavenging

The International Labour Organization describes three forms of manual scavenging in India:

1. Elimination of human waste from common spaces and "dry latrines" (basic pit latrines without a water seal, not dry toilets in general)

2. Septic tank cleaning.

3. Gutter and sewer cleaning.

They have a higher risk of getting infected. Before beginning to clear underground drains, almost all of them drink alcohol. People in the community still remove human waste by hand from toilet tanks, whether they are in their houses or somewhere else. Sanitary staff feel obligated to clear up night dirt every day. [1]

2.1 Health-related Issues of Manual Scavengers

Manual Scavengers face health issues i.e., manual contact with excreta exposes them to various diseases, skin infections, rotting of fingers and limbs, tuberculosis, hepatitis, leptospirosis, helicobacter, and nausea. Some manual scavengers complain about not being able to eat due to exposure to excreta. Most women from the manual scavenging communities tend to be addicted to tobacco (Gutka) and men to liquor, to diminish the repulsive nature of their work and beat back their state of hopelessness.[1]

Ninety percent of allmanual scavengers have not been provided with proper equipment to protect them from face-borne illness. This includes safety equipment like gloves, masks, boots, and brooms. The use of hand by women manual scavengers certainly will have direct skin contact with human waste, which is a very dangerous combination that is contributing to serious health conditions. Chronic skin diseases are very common among women manual scavengers.[5]

2.2 Manual Scavenging Death

Manual scavenging particularly the cleaning of sewers and septic tanks is an intrinsically dangerous occupation with risks that include drowning in sewage or asphyxiation from inert gases such as methane or carbon dioxide. Between 2016 and 2020 there were 472 such fatalities recorded with the highest number (110 deaths) occurring in 2019. [10]

According to the official data on manual scavenger deaths, about 920 people died between January 1993 and 2010 while cleaning sewers and septic tanks in India. Based on the number of cases, the state of Tamil Nadu had the highest number of sewer deaths.[17]

3. PLANOF WORK

3.1 Introduction

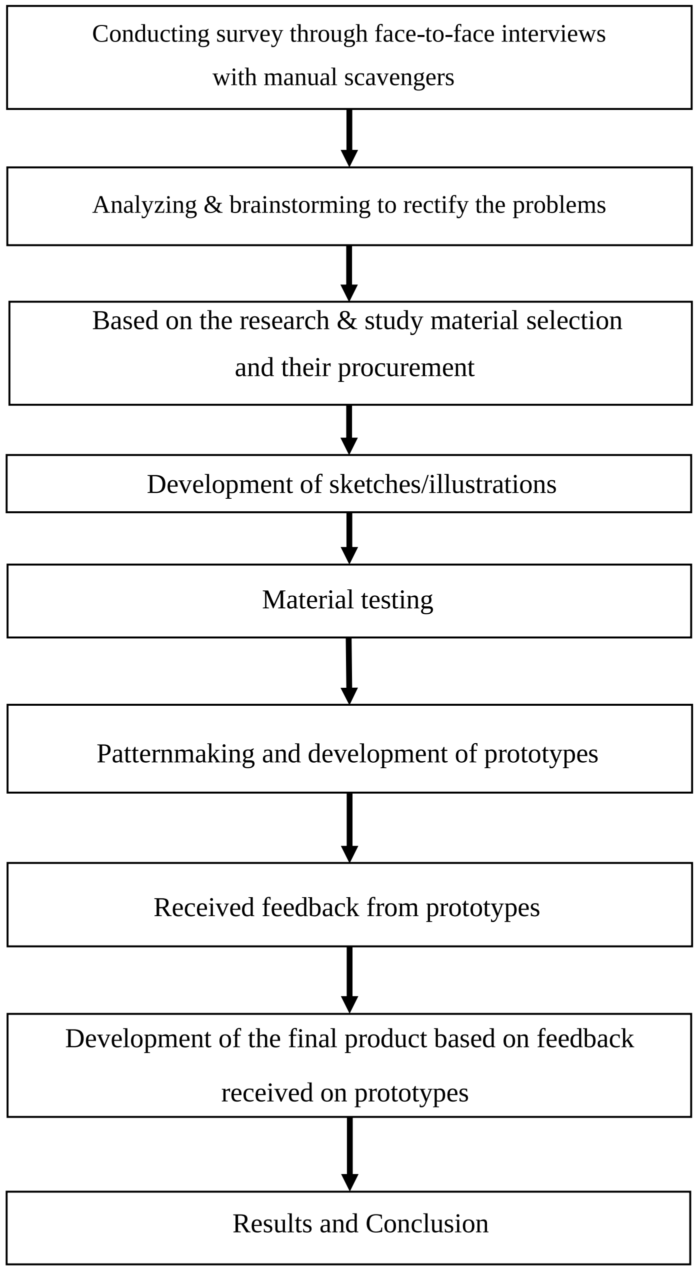
This chapter outlines the materials and methodology used in the development of protective wear for manual scavengers; the different tests conducted on raw materials; and the overall process that was followed in the manufacturing of theprotective wear.

3.2 Materials

The selection of materials for this study was based on the specific requirements of the product. The required fabric characteristics were determined, and the selection of fabric was made according to those criteria. The protective clothing worn by manual scavengers is made of polyester fabric with a 150 to 250 GSM weight and an antibacterial treatment. After that, a water-repellent coating will be applied. A polyester fabric with an antibacterial treatment is utilized for the protective clothes worn by manual scavengers. A further step involves applying a water-repellent coating. Polyester with an antimicrobial finish that has been water-repellently coated is favored because it prevents water from penetrating the fabric and the antimicrobial treatment protects against non-allergenic, non-toxic, and other harmful gases.

3.3 Methodology

The current research involves the approach involved conducting surveys through interviews to understand the problems, develop a product, including necessary prototyping, and obtain feedback for each prototype to improve product quality.



Flow Chart 1: Comprising various steps involved in carrying out the research.

3.4 Prototype Illustrations

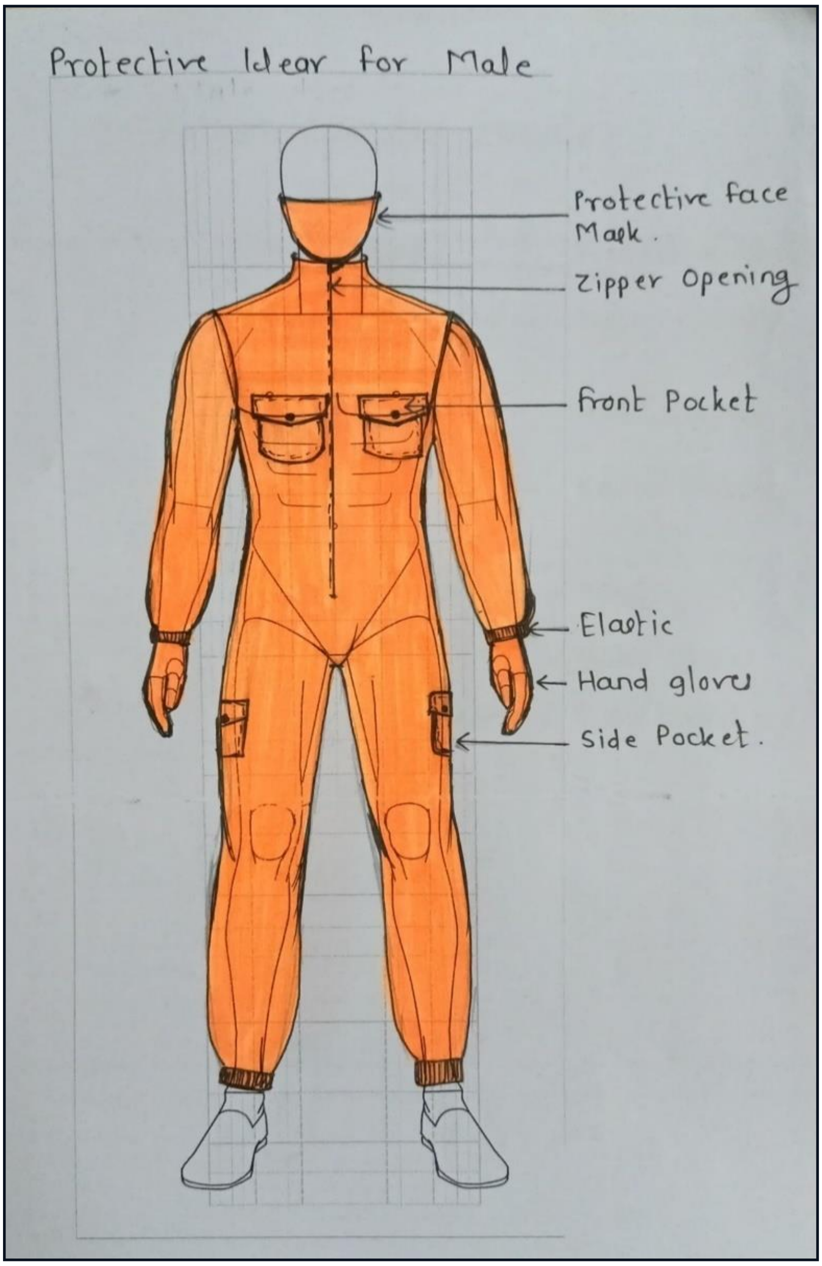


Figure 2: Men's prototype illustrations.

3.4 Technical flat sketch

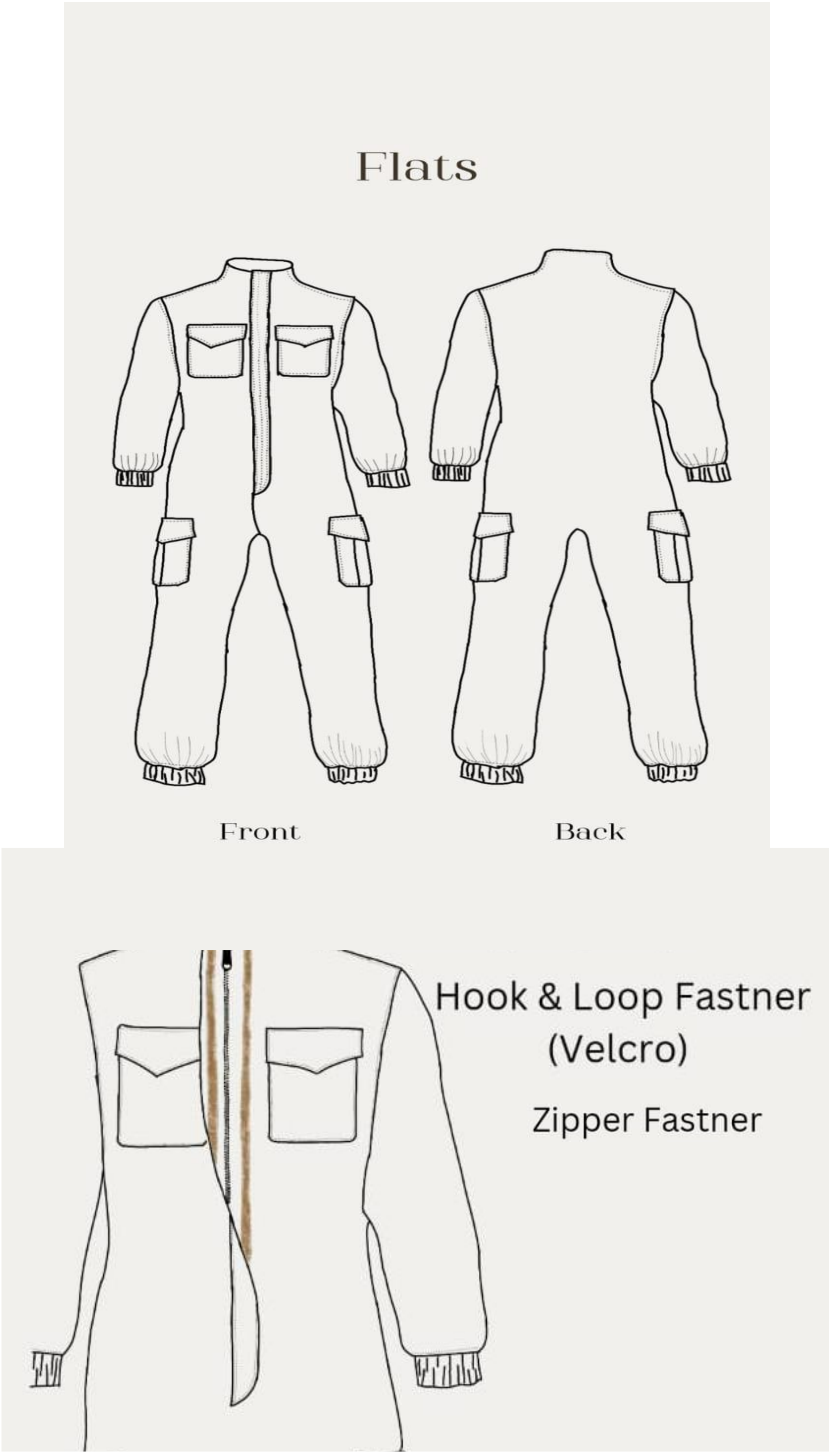


Figure 3: Technical flat sketch.

3.5 Patterns

Figure 4 : Patterns for prototype

__3.6 Prototype images__

Figure 5: Front and back side of the prototype

4.Conclusion:

The design and development of protective wear for manual scavengers represent a crucial step toward addressing the long-standing issues associated with this hazardous occupation. Beyond the

physical protection provided, these innovations aim to restore dignity to the individuals engaged in manual scavenging, fostering a safer and more inclusive working environment. By combining technological advancements with community engagement, we can aspire to eliminate the perils of manual scavenging and move towards a society that values the health, safety, and dignity of all its members.

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13.A SYSTEM TO EVALUATE CREASE RECOVERY ANGLE USING IMAGE PROCESSING

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ABSTRACT

The folds or ridges that result from folding, compressing, and crumpling garments while they are being worn, washed, and dried are known as wrinkles. Crease recovery is the term used to describe a textile fabric's capacity to recover or withstand wrinkling distortion. Thus, the most significant aesthetic attribute is the crease or wrinkle in the fabric, which may be assessed using a variety of objective and subjective analysis methods. Accurate assessment of wrinkles is necessary to produce textile products of the desired quality. Standard test procedures for evaluating fabric wrinkles have been developed by the International Organisation for Standardisation (ISO) and the American Association of Textile Chemists and Colorists (AATCC).The wrinkle recovery angle (WRA) of the warp and weft directions is used to characterise the wrinkling behaviour of the fabric in the AATCC TM 66-2003 test procedure. Wrinkles are created by folding and compressing the cloth. Human error may occur during this typical test procedure.

This project introduces a new automated approach for crease recovery assessment, taking into account the demands of the modern textile industry. METLAB is a potent programme that is frequently used for image processing and analysis. It offers a complete image processing toolbox that has many features and algorithms created especially for image processing jobs. A wide range of functions for image enhancement, filtering, segmentation, feature extraction, and other tasks are included in this toolbox. For academics and developers, it expedites the process of implementing intricate image processing algorithms. In order to quantify the wrinkle recovery angle of the fabric specimen wrinkled by the created device, an angle measuring programme is developed utilising image processing in MATLAB. By eliminating human intervention during the entire crease assessment process, the technology helps to prevent human errors.

Keyword: -Creases Recovery Angle,METLAB, Image Processing

1. INTRODUCTION

The assessment of a fabric's resistance to or recovery from wrinkling has been the focus of numerous studies over the years. Actually, wrinkly fabrics are routinely assessed in the textile business using both objective and subjective analysis. The International Organisation for Standardisation (ISO) 2313:1972 and the American Association of Textile Chemists & Colorists (AATCC) 66-2003 both standardised the test procedure. To use these conventional techniques, the Shirley crease recovery tester (SDL-M003) and the Monsanto wrinkle recovery tester were created; nonetheless, they are time-consuming and susceptible to human error. In (AATCC) TM 66-2003 method [1], wrinkles are caused by folding and compressing the fabric and the wrinkle recovery angle (WRA) of warp and weft directions is used to characterize the wrinkling behavior of the fabric.

An efficient method of doing away with human intervention is image analysis. Thus, the purpose of this project work is to create and construct instruments based on the principles of image analysis and compare the outcomes of the newly produced instrument with the Shirley crease recovery tester that is already in use. The instrument that has been designed removes the subjective inaccuracies, present in the assessments of fabric wrinkles, currently utilised in the textile sector.

2. Experimental

Shirley Crease recover tester is being used to measure crease/wrinkle recovery angle, using AATCC TM 66 -2003. This method may include personal error in measurement of recovery angle. These errors may be during sample preparation or may be during measurement of crease recovery angle. Referring the drawbacks of existing instrument to measure crease recovery angle, using AATCC TM 66 -2003, the system was designed and developed. The work was planned as shown in the flowchart below,

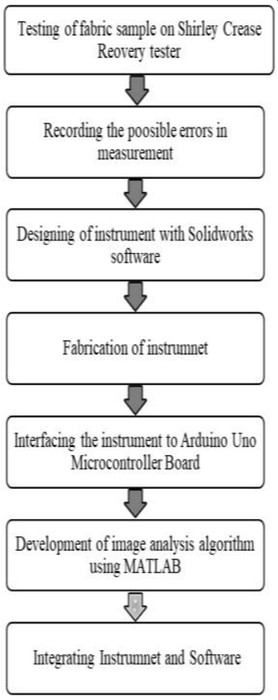


Figure -1: Work Flow diagram

2.1Design of Instrument

The design of instrument is finalized after referring all the standard specifications provided by AATCC (American Association of Textile Chemists and Colorist) which are used in conventional crease recovery measurement methods. The main component of the designed instrument are Knife, Pressing Block, Machine Frame, Stepper motor, Loadcell, and Arduino Uno microcontroller board. The instrument design is as shown below,

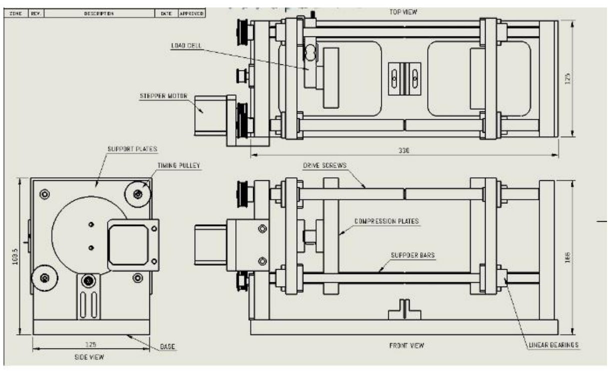


Figure -2: Line Diagram of developed instrument

2.2 Development of Instrument

Referring the design illustrated in above figures the instrument was fabricated. The instrument consists of a knife edge and pressing blocks; Straight bar type load cell YZC-133 is installed at one of the pressing blocks, these pressing blocks are driven by the stepper motor (Nema 23). The entire assembly is then interfaced to Arduino UNO microcontroller.

In the existing wrinkle recovery tester based on (AATCC) TM 66-2003 standard, wrinkles are caused by folding and compressing the fabric either in warp or weft direction under a specified pressure for a particular duration using separate loading device, after removing the creased specimen from the loading device it is allowed to recover for specified time before transferring it to the wrinkle recovery tester for measurement of recovery angle. The wrinkle recovery angle (WRA) of warp and weft directions is used to characterize the wrinkling behavior of the fabric.

To eliminate human intervention and personal errors in above method, an instrument was developed comprising of knife edge, pressing blocks containing Loadcell and wrinkle recovery measuring unit. In order to overcome manual errors in measurement of Wrinkle Recovery Angle on conventional instrument the MATLAB code is designed which aims to measure angle within an image by utilizing user interaction and image processing techniques.Fig.3 depicts the developed instrument for wrinkling the fabric specimen, midway, for measurement of wrinkle recovery angle.

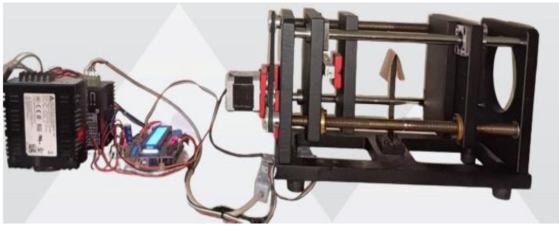
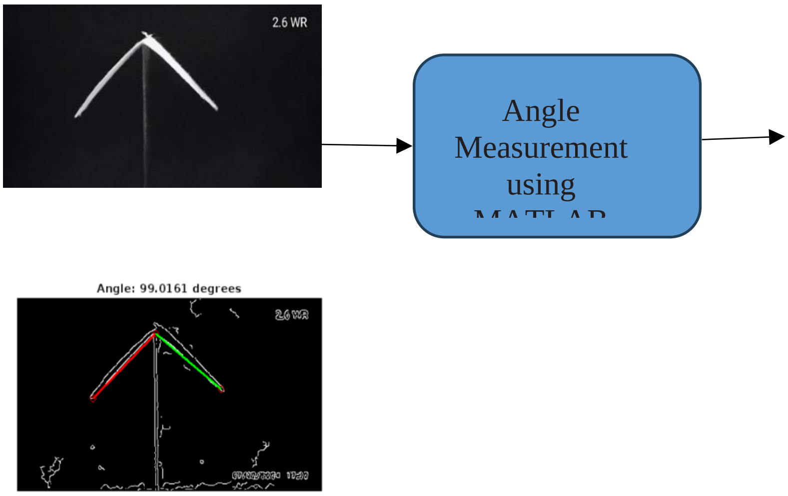


Figure -3: Actual image of developed instrument

The fabric sample of size 2 by 1 inch is taken and folded it from the center then it is placed over the knife edge. After folding the fabric its size become 1 by 1 inch. Then the sample is pressed from both sides using pressing blocks, standard load is accurately applied and monitored with the help of Loadcell. Stepper motor is used to drive the pressing blocks. The load of 1 kg is applied for 2 minutes. After 2minute pressing blocks are released to go back to their original position. Whole assembly is interfaced to Arduino Uno controller which is programmed to monitor and control applied load and duration. The sample is then allowed to recover for 2 minutes and finally image is captured using digital camera which is placed in front of the knife i.e. sample.



Input image

mage Processing Operation

The designed MATLAB code performs image processing operations on input image viz. conversion of RGB image to grayscale image and then detection of edges using Canny edge detection algorithm.The edge detected image is displayed in figure window and asks user to select three points : center point and then two end points. Once the user select three points further selection is disabled and then two lines are drawn from the selected center point and two endpoints followed by measurement of an angle between these two lines. The angle in degrees is displayed in the title bar of figure window.

2.4Testing of Crease Recovery Angle

To confirm the reliability of results obtained from newly developed instrument, hundred different fabric samples were collected, randomly, from various industries and market. All these sample were evaluated on both conventional Shirley Crease Recovery tester and the newly developed wrinkle recovery measurement tester.

Further the results obtained from both of these instruments were compared statistically, using T test, to confirm trustworthiness.Following table depicts warp and weft wise mean values of wrinkle revovery angle obtained from Shirley crease recovery tester & the developed crease recovery tester,

Table -1: Mean Values of Crease Recovery angle

		Shirley Crease Recovery Tester		Newly Developed Instrument	
Sample No.	**MATERIAL**	**Warp way Crease Recovery Angle**	**Weft way Crease Recovery Angle**	**Warp way Crease Recovery Angle**	**Weft way Crease Recovery Angle**
1.	**POLYESTER - COTTON**	94.8	70	94.586	68.2
2.	**POLYESTER - COTTON**	78.6	78.7	73.6	74.8
3.	**POLYESTER - COTTON**	74.2	74.1	75.7	70.8
4.	**POLYESTER - COTTON**	77.2	69.4	77.9	68
5.	**POLYESTER - COTTON**	89.7	48.3	91.7	49.3
6.	**POLYESTER - COTTON**	84.4	88.1	84.3	87.2
7.	**POLYESTER - COTTON**	75.3	72.3	70.5	73.5
8.	**POLYESTER - COTTON**	73.6	49.1	71.4	50.5
9.	**POLYESTER - COTTON**	81.5	90.0	79.0	86.0
10.	**POLYESTER - COTTON**	99.9	94.9	98.8	89.9
11.	**POLYESTER - COTTON**	97.1	93.1	94.4	88.6
12.	**POLYESTER - COTTON**	80.2	79.0	76.0	75.1
13.	**Cotton**	55.4	49.2	52.7	52
14.	**Cotton**	52.1	59.3	53.8	60.7
15.	**Cotton**	44.7	30.3	48.8	30.5
16.	**Cotton**	47.9	36	43.9	44.2
17.	**Cotton**	69.7	67	66.28	68.1
18.	**Cotton**	63.3	63.7	64.8	64.2
19.	**Cotton**	55.7	49	52.6	49
20.	**Cotton**	44.4	45.2	45.7	47.3
21.	**Cotton**	29.1	22.9	30.4	24.5
22.	**Cotton**	41.8	35.8	44.7	37.3

23.	**Cotton**	45.4	38.7	49	40.3
24.	**Cotton**	74.1	58.7	77.5	55.2
25.	**Cotton**	52.2	76.4	59.3	70.5
26.	**Cotton**	45.4	70.6	40.9	70.8
27.	**Cotton**	79.3	89.9	78.2	87.3
28.	**Cotton**	43.5	40.2	41.8	43.2
29.	**Cotton**	41.1	46.7	44	47.1
30.	**Cotton**	56.2	27.8	53.2	30.2
31.	**Cotton**	48.5	42.5	50	44.8
32.	**Cotton**	37.6	42.9	37.1	45.5
33.	**Cotton**	85.8	95.0	89.0	97.8
34.	**Cotton**	45.0	43.8	48.3	48.1
35.	**Cotton**	29.9	38.0	31.0	38.2
36.	**Cotton**	56.5	63.3	54.3	65.0
37.	**Cotton**	72.2	72.3	75.6	68.9
38.	**Cotton**	78.9	77.7	76.3	74.5
39.	**Cotton**	51.8	54.4	50.1	56.4
40.	**Cotton**	59.3	61.6	60.6	63.3
41.	**Cotton**	76.7	67.0	78.3	66.3
42.	**Cotton**	48.2	52.8	47.0	51.1
43.	**Cotton**	59.0	52.0	55.3	51.5
44.	**Cotton**	61.7	57.0	59.2	53.3
45.	**Cotton**	43.1	50.9	44.8	48.4
46.	**Cotton**	57.7	51.8	53.0	47.2
47.	**Cotton**	81.2	72.6	80.0	70.1
48.	**Cotton**	80.6	63.5	83.9	65.6
49.	**Cotton**	69.6	58.6	66.9	56.8
50.	**Cotton**	60.5	65.5	62.9	66.1
51.	**Cotton**	44.9	57.0	44.3	61.4
52.	**Cotton**	51.0	48.8	56.3	51.5
53.	**Cotton**	59.7	59.5	64.4	66.2
54.	**Cotton**	42.7	55.5	46.3	52.8
55.	**Cotton**	59.5	59.1	57.2	63.6
56.	**Cotton**	67.8	64.4	72.5	67.9
57.	**Cotton**	56.8	64.7	59.5	63.7
58.	**Cotton**	49.6	56.8	49.8	58.4
59.	**Cotton**	61.5	68.1	63.3	69.9
60.	**Cotton**	57.5	64.9	57.9	61.9
61.	**Cotton**	65.5	52.0	62.5	52.8
62.	**Cotton**	88.5	92.0	87.3	90.9
63.	**Cotton**	40.8	43.9	36.9	48.1
64.	**Cotton**	51.4	41	53.9	39.1
65.	**Cotton**	46.3	39.9	42	36.2

66.	**Cotton**	38.1	42.8	42.7	37.6
67.	**Cotton**	49.3	32.3	46.9	33.8
68.	**Cotton**	49.9	50.1	45.1	43
69.	**Cotton**	34.6	33.2	39.1	29.8
70.	**Cotton**	34.1	40	37.5	37.5
71.	**Cotton**	50.1	53.1	56.7	52.1
72.	**Cotton**	55.6	46.3	51.1	42.3
73.	**Cotton**	52.8	46	57.1	50.2
74.	**Cotton**	54.7	46.2	59	41.8
75.	**Cotton**	50.9	46.1	44	42.3
76.	**Cotton**	48.9	45	49.9	41.8
77.	**Cotton**	62.1	48.7	58	44.3
78.	**Cotton**	50.6	46	44.9	47.7
79.	**Cotton**	37.1	43.7	40.7	37.9
80.	**Cotton**	60.9	54.4	46.1	41.4
81.	**Cotton**	67.2	53.4	67.5	58.7
82.	**Cotton**	59.6	51.8	53.5	47
83.	**Cotton**	67.9	67.7	64.1	60.8
84.	**Cotton**	69.8	75.3	64.3	73.7
85.	**Cotton**	71.6	74.6	63.5	74
86.	**Cotton**	73	75.5	62.5	70.4
87.	**Cotton**	76.7	71.1	71.4	71
88.	**Cotton**	84.9	80.8	80.9	80.4
89.	**Cotton**	83.3	84.1	77.9	84.6
90.	**Cotton**	73.2	69.4	79.1	67.4
91.	**Cotton**	70.1	68.1	70	71.5
92.	**Cotton**	75	70	70.9	66.9
93.	**Viscose**	90.5	105.2	94.5	100.8
94.	**Viscose**	109.5	112.1	105.5	115.8
95.	**Viscose**	96.2	109.3	98.2	105.2
96.	**Viscose**	108.9	99.2	103.2	101.3
97.	**Viscose**	88.2	118.6	91.2	114.2
98.	**Viscose**	108.9	124.1	106.1	118.8
99.	**Viscose**	89.3	102.3	78.9	102.9
100.	**Viscose**	103.4	110.1	99.3	105.8

The following graphs shows that, the values of crease recovery angle, obtained from conventional and developed instruments are almost same.

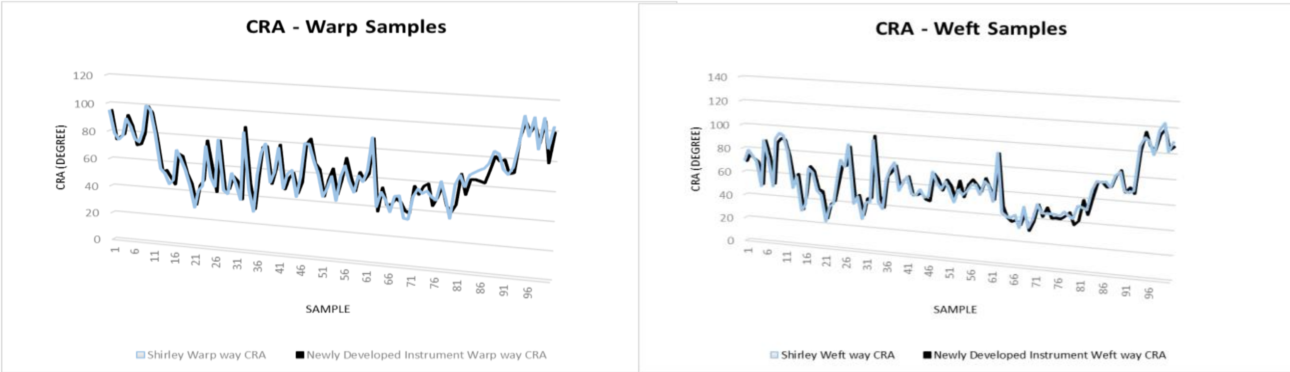


Figure -5: Crease Recovery Angle

It was found that there is no significant difference (P Value : 0.791 for warp samples and P Value : 0.781 for weft samples) between the results obtained from these two instrument, at both the level of significance, viz. 5% as well as 1%.

Further, the Pearson correlation coefficient of CRA from these two instruments is 0.978 and 0.987, for warp and weft samples respectively, which confirms that the conventional subjective measurement on Shirley Crease recovery tester can be replaced by newly developed instrument with image processing technique, since there is positive correlation between the results of two instruments, with correlation coefficient is almost one.

4. CONCLUSIONS

Currently, the crease recovery of fabric samples is assessed in terms of crease recovery angle by AATCC TM 66-2003 test method, which is having certain limitations and potential drawbacks when interpreting and applying the results. The measurement of fabric wrinkle recovery angle, in this method relies on visual assessment, which introduces subjectivity. To eliminate these errors, an automated system, a technology or software designed to evaluate the ability of fabrics or materials to recover from creases or wrinkles, is used for the assessment of crease recovery. From the test results, it is concluded that, the results obtained from the new developed system don't differ significantly from the results obtained from Shirley crease recovery tester, The Pearson correlation coefficient of crease recovery angle obtained from these two instruments is 0.98, which confirms that the subjective assessment and relative errors associated with Shirley crease recovery tester can be eliminated by the new developed system.

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14.Cold pad batch dyeing of cotton fabric with reactive dyes by using ultrasonic energy.

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ABSTRACT

Nowadays use of ultrasonic energy is being carried out in textile industries. It accelerates both physical and chemical reactions which are used for improvement in textile processing methods. Cold Pad Batch dyeing will give us convenient and most economical dyeing of cotton with reactive dyes. This process will require less consumption of energy and water and salt addition is neglected. Thus, this becomes an eco-friendlier process and dye fixation is also high in case of every shade. The CPB procedure is very simple which involves passage of fabric through dye bath and squeezing it through the dyeing padder followed by batching for twelve – sixteen hours. Effective management of ultrasonic energy can improve productivity along with reduction in energy cost. Also, it can be helpful to improve dye productivity as well as fastness properties.

The study will reveal how it may become beneficial in terms of reduction in salt requirements, reduction in dyeing temperature and time for a comparable or even higher color yield, fastness properties, shade across the fabric, etc.

Keyword: -Cold pad batch, Conservation, Reactive dyes, Sustainability, Ultrasonication.

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1. INTRODUCTION

Now a days use of ultrasonic energy is being carried out in textile industries. It can be helpful to clean and homogenize the material. It accelerates both physical and chemical reactions which is used for improvement in textile processing methods. The use of ultrasonic energy is widely studied in terms of improvement of washing fastness. High energy costs, rapid technological changes and the faster delivery time are the major factors regarding textile processing. Effective management of ultrasonic energy can improve productivity along with reduction in energy cost. Also, it can be helpful to improve dyes productivity as well as fastness properties. Dyeing of different fibres with different dyes have been studied earlier.

In dyeing process, the main object is to diffuse the dye and chemical into the fibre. It can be environment friendly aspect of dyeing of textile material. In case of dyeing of cotton using direct dyes, amount of dye required, dyeing time, temperature and concentration of electrolyte required are considerably reduces using ultrasonic energy. In case of dyeing of polyester using disperse dye, ultrasonic energy will improve dye uptake and enhances the dyeing rate. Use of ultrasonic energy in dyeing of acrylic fabric will results into improvement in depth of shade and accelerates the rate with various temperatures.

Cold Pad Batch dyeing will give us convenient and most economical dyeing of cotton with reactive dyes. This process will require less consumption of energy and water and salt addition is neglected. Thus, this becomes a more ecofriendly process and dye fixation is also high in case of every shade. CPB procedure is very simple which involves passage of fabric through dye bath and squeezing it through the dyeing padder followed by batching for twelve – sixteen hours. This higher batching time makes the CPB procedure less attractive to many processers seeking high production rate. It is necessary to reduce batching time to enhance the productivity of CPB. The proposed study involves the use of ultrasonic energy at room temperature during batching stage with aim to reduce batching time and auxiliary concentration. Thus, it will ultimately lead to minimize the waste effluent. The alternative methods of dyeing like Pad dry – Pad steam, E-control and batchwise are comparatively costly due to due to need of thermal energy for fixation of dye. This study presents the CPB dyeing of cotton fabric with reactive dyes using ultrasonic energy and its comparison with conventional method.

1.1 Objective

1. To carry out dyeing of cotton fabric using ultrasonic waves.
2. To study the effect of ultrasonic waves on depth of dyes.
3. To carry out comparative analysis of fastness properties of US dyed fabric and conventionally dyed fabric.

1.2 Scope

1. Presented study will help us to understand effect of ultrasonic energy on reactive dyeing of cotton fabric.
2. This study will help us to minimize the auxiliary concentration required in dyeing process.
3. Presented study consists of comparative study of fastness properties of both Ultra Sonic dyed and conventionally dyed fabric.

2.DYEING OF COTTON BY CPB

Reactive dyes are vastly used in dyeing and printing of cotton fibre. These dyes have a distinctive reactive nature due to active groups which form covalent bonds with -OH groups of cotton through substitution and/or addition mechanism. Among many methods used for dyeing cotton with reactive dyes, the Cold Pad Batch (CPB) method is relatively more environment friendly due to high dye fixation and no requirement of thermal energy. The dyed fabric production rate is low due to requirement of at least twelve hours batching time for dye fixation.[8] Reactive dyes are the family of dyes generally used to dye cotton, viscose, and other cellulosic fibres. However, reactive dyeing requires vast amounts of salt, water and energy. The process is also quite inefficient, leading to low fixation rates (approximately 75 %). This means that repeated rinses are needed to remove the unfixed dye, increasing both water and energy use (as rinse water is often heated) Wastewater produced from reactive dyeing contains high levels of both salt and dye, which is difficult to treat.[9] It is primarily a cold method where the dyeing temperature is 20-25°C and use Cold to Medium Brand Reactive Dyes, and so it is called Cold Pad Batch (CPB) Dyeing. A cooling system is used for cooling the Dye liquid and bath also.[10]Cold pad batch (CPB) is a method of dyeing textiles, typically cellulosic fibres such as cotton, in which the textile is impregnated with dye in a cold state, rather than being heated. High dye fixation and no thermal energy are the advantages of the CPB process. CPB-dyed fabrics are less expensive, have a softer hand feel, and have a cleaner surface than exhaust dyed materials. The process may take up to 12 hours in the batching process, depending on the depth of the shade. During the dyeing process, the dye must become close and even with the material in order to produce a uniform color that is fast to moisture, heat, and light. Due to their superior fastness properties and simple application, reactive dyes are currently the most common type of dye for cotton dyeing. The CPB technique uses less water and energy. This approach completely eliminates the typical salt used to exhaust reactive dyes and provides good dye fixing.[11]

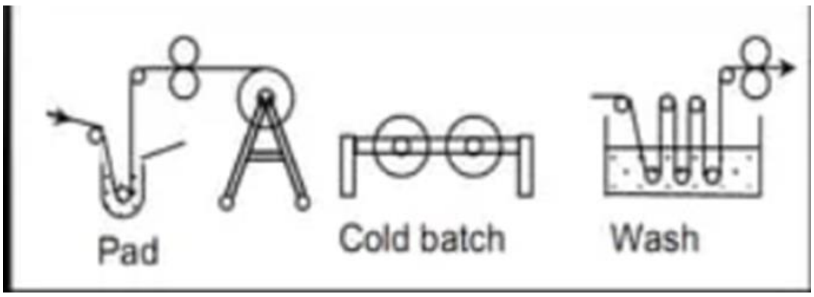

Figure 6- CPB process line diagram

For a successful pad-batch dyeing operation, the following equipment is necessary:

1. A good quality dye padder with supporting equipment for batching fabric onto perforated beams.
2. Dye/alkali mixing and metering equipment.
3. Motorized rotating A-frames or storage racks.
4. Beam wash-off stations, wash-off basins or suitable washing equipment.
5. Perforated beams for beam wash-off. Otherwise, non-perforated.[12]

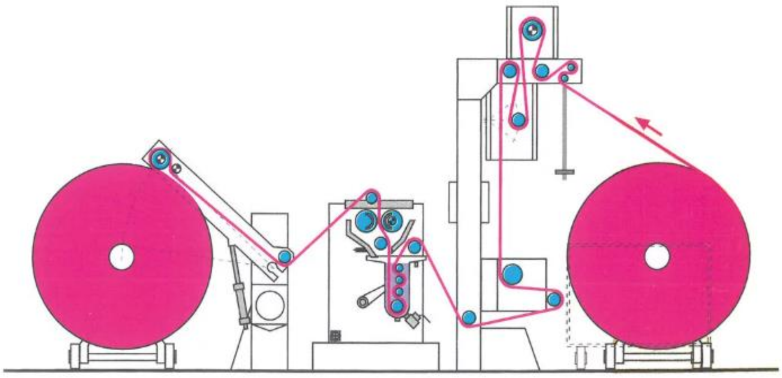

Figure 7 - CPB dyeing machine

Parameter:

- Machine Speed = 40-50 m/min
- Padder Pressure (N/mm or Bar) L-M-R = 20-30-20 or 1.2-1.5-1.2
- Dye Bath Level= 25 Ltr or 50 Ltr
- Immersion time= 1.5 sec
- Machine Utility= 5.5 KW
- Pick Up %= for Cotton 55-70% & for Viscose 85-95% or more, varies depend on Fabric GSM.[9]

2.1Major Drawback

The dyed fabric production rate is low. It requires least 12 hours batching time for dye fixation. Since batching time is too long, it becomes unattractive. Due to which many organizations have to compromise in production.

Therefore, it is must to reduce batching time and improve the production capacity of the process. Now a days there are different trials are going in to reduce batching time. One of them, using ultrasonic energy at the time of padding is best practice. So, we are going to try this practice in our laboratory. Carrying out padding by using ultrasonic energy and kept the batch for the batching purpose. This will reduce batching time along with reducing the required concentration of auxiliaries.

3. EFFECTS OF ULTRASONIC WAVES DURING DYEING

3.1 Wetting & Mass Transfer

Ultrasonic cavitation and micro-streaming improve the penetration of the dye into the fibre and yarn pores of the material. Ultrasonic cavitation accelerates the rate of dye diffusion inside the fibre by perforating the external layer of the fibre, so that the dye can enter the fibre pores. Simultaneously, sonication speeds up the chemical reaction between dye and fibre.

3.2 Dispersion

Sonication breaks up droplets, agglomerates and aggregates preparing a uniform dispersion in the dye.

3.3 Degassing

Ultrasound waves release dissolved or entrapped gas molecules from the fibre into liquid so that the gas can cavitation, thus facilitating dye-fibre contact and penetration for a fast and complete fibre coloration. Tissera et al. (2016) demonstrated that sonication is able to achieve good colour strength on cotton fabric at very low temperature such as 30ºC, which was approximately 230% more than the colour strength achieved in normal heating method of dyeing. Mild sonication of 0.7 W/cm^2 with the UP400St under mild temperature conditions at approx. 30ºC gave significantly improved results for colour strength and a deep penetration of the dye into the cotton fabric. A particle size analysis of the dye revealed that ultrasonication deagglomerates and disperses the hydrolyzed dye molecules during dyeing and helps the dye to penetrate deeper into the fabric. At the same time, the fibre surface and fibre morphology remain unchanged and fully intact after sonication.

3.4 Benefits of Ultrasound waves

- Energy savings by dyeing at lower temperatures and reduced processing times.
- Environmental improvements by reduced consumption of auxiliary chemicals.
- Increased colour yields.
- Enzymatic treatments supplemented with ultrasonic waves resulted in shorter processing times, less consumption of expensive enzymes, less fibre damage, and better uniformity treatment to the fabric.

4. MATERIALS AND METHODS

4.1 Materials

Bleached 100% Cotton fabric

Reactive dyes

Auxiliaries required – Caustic, soda, wetting agent

Lab. Padding mangle

Ultrasonic probe sonicator

4.2 Commercial Cold Pad-Batch Process:

The cotton fabric samples will simultaneously dye with vinyl sulphone reactive dyes. The amount of dye used will be 40 - 100 g/l. The following dyeing auxiliaries will add to the dye liquor, wetting agent (5 g/l), sodium hydroxide (varied between 10–25 ml/l, 38°Be) and sodium carbonate (varied between 15–35 g/l). The dyeing of fabric by Cold Pad Batch (CPB) method will be carried out following the procedure of fabric passage through the trough, squeezing through the nip rolls leaving 70% pick up. The bath temperature is maintained at 25°. Two dips-two nips principle will be followed throughout the work. The padded fabric then immediately wrapped in polyethylene bag to avoid any air exposure and then batched at 25–30°C for maximum 12 - 16 h. The washing-off then carried out by exhaust method followed by (cold rinse - warm rinse - soaping-off - warm rinse - cold rinse). The soaping-off is carried out for 15 min at boil; the liquor-to-material ratio will be 50:1, the soaping bath contained 2 g/l Non-ionic detergent.

4.1 Modified Cold Pad-Batch Process

The US method of dyeing will be same as that of the above conventional procedure. The ultrasonic probe sonicator will be keeping in padding bath and then fabric will be padded. Ultrasonic frequencies of 25 or 40 kHz at temperature range between 25–30°C for minimum 4 h and maximum 12 - 16 h. The washing-off procedure is also same as the above-mentioned conventional procedure.

5. TESTING

Table 1 - Process parameters

Sr. No.	Parameters	Variables
1	No. of Dyes	1,2,3,
2	Concentration of Dyes (gpl)	20, 40, 60
3	Time (sec)	30, 60, 90

5.1 Total colour difference DE (CCM)

Total colour difference was assessed by using –where,

- DE (CCM) is the total colour difference with l:c ratio of 2:1, keeping commercial factor 1.2,
- DL = lightness difference,
- DC = saturation or chroma difference,
- DH = hue difference,
- l = luminosity factor, c = chroma factor, SL = semi sphere of lightness,
- Sc = semi sphere of chroma and SH = semi sphere of hue

Table 2- CCM reports for 20gpl samples

Dyes	Process	CCM Reports for 20 gpl concentration											
		L*	a*	b*	C*	h	DL*	Da*	Db*	DC*	DH*	DEcmc	%STR
Red	Conv.	38.16	50.09	15.31	52.38	17							
	US-30 sec	37.8	50.05	16.04	52.56	17.76	-0.36D	-0.04G	0.72Y	0.18B	0.7Y	0.49	104.41
	US-60 sec	35.47	49.94	16.59	52.62	18.37	-2.69D	-0.15G	1.27Y	0.24B	1.26Y	1.64	129.74
	US-90 sec	34.84	94.74	17.26	52.65	19.13	-3.32D	-0.35G	1.94Y	0.27B	1.96Y	2.16	138.47
Yellow	Conv.	65.4	33.62	64.65	72.87	62.52							
	US-30 sec	65.8	34.28	65.22	73.68	62.27	0.41L	0.66R	0.57Y	0.81B	-0.32R	0.4	99.35
	US-60 sec	65.49	33.23	64.87	72.89	62.88	0.09L	-0.39G	0.22Y	0.02	0.45Y	0.36	100.26
	US-90 sec	64.43	35.04	65.51	74.29	61.86	-0.97D	1.41R	0.86Y	1.42B	-0.85R	0.92	111.97
Blue	Conv.	27.4	-4.72	-15.66	16.36	253.22							
	US-30 sec	25.49	-4.23	-15.48	16.05	254.73	-1.91D	0.50R	0.18Y	-0.31D	0.43R	1.35	115.94
	US-60 sec	24.15	-3.26	-14.61	14.97	257.44	-3.25D	1.47R	1.05Y	-1.39D	1.15R	2.61	126.53
	US-90 sec	23.32	-2.51	-13.62	13.85	259.57	-4.09D	2.22R	2.04Y	-2.51D	1.67R	3.6	133.1

Table 3 - CCM reports for 40gpl samples

Dyes	Process	CCM Reports for 40 gpl concentration											
		L*	a*	b*	C*	h	DL*	Da*	Db*	DC*	DH*	DEcmc	%STR
Red	Conv.	39.57	55.07	6.77	55.49	7.01							
	US-30 sec	38.57	54.46	6.92	54.9	7.24	-1.00D	-0.61G	0.15Y	-0.59D	0.22Y	0.58	107.92
	US-60 sec	37.37	53.75	8.12	54.36	8.59	-2.20D	-1.32G	1.35Y	-1.13D	1.51Y	1.5	118.8
	US-90 sec	37.77	54.09	8	54.68	8.41	-1.80D	-0.98G	1.23Y	-0.81D	1.35Y	1.25	115.71
Yellow	Conv.	65.56	35.57	75.05	83.06	64.64							
	US-30 sec	64.27	39.36	75.9	85.5	62.59	-1.29D	3.79R	0.84Y	2.44B	-3.02R	2.41	116.58
	US-60 sec	65.37	38.86	76.82	86.09	63.17	-0.19D	3.29R	1.77Y	3.03B	-2.18R	1.87	110.86
	US-90 sec	64.89	38.51	76.32	85.49	63.17	-0.19D	2.94R	1.27Y	2.44B	-2.09R	1.74	112.75
Blue	Conv.	22.49	-1.97	-12.97	13.12	261.36							
	US-30 sec	21.01	-1.29	-11	11.07	63.29	-1.48D	0.68R	1.97Y	-2.04D	0.41R	1.94	111.72
	US-60 sec	20.74	-0.78	-10.63	10.66	265.92	-1.75D	1.19R	2.34Y	-2.46D	0.92R	2.49	113.59
	US-90 sec	19.75	-0.99	-11.18	11.22	264.92	-2.75D	0.98R	1.79Y	-1.79Y	0.75R	2.65	124.71

Table 4 - CCM reports for 60gpl samples

Dyes	Process	CCM Reports for 40 gpl concentration											
		L*	a*	b*	C*	h	DL*	Da*	Db*	DC*	DH*	DEcmc	%STR
Red	Conv.	37.31	54.8	8.52	55.46	8.84							
	US-30 sec	36.43	53.67	9.64	54.53	10.18	-0.87D	-1.13G	1.12Y	-0.93D	1.29Y	0.94	105.36
	US-60 sec	35.87	54.11	10.65	55.15	11.14	-1.44D	-0.69G	2.13Y	-0.31D	2.22Y	1.5	113.71
	US-90 sec	35.97	54.04	10.72	55.09	11.22	-1.34D	-0.76G	2.20Y	-0.36D	2.30Y	1.51	115.38
Yellow	Conv.	62.85	39.46	75.4	85.1	62.38							
	US-30 sec	62.28	38.51	74.26	83.65	62.59	-0.57D	-0.97G	-1.14B	-1.45D	0.31Y	0.56	99.25
	US-60 sec	61.61	40.87	74.61	85.07	61.29	-1.24D	1.42R	-0.79B	-0.03D	1.62R	1.33	106.93
	US-90 sec	61.42	40.7	74.18	84.61	61.25	-1.43D	1.25R	-1.22B	-0.49D	-1.68R	1.41	107.53
Blue	Conv.	18.46	-0.16	-9.97	9.97	269.1							
	US-30 sec	17.82	0.49	-7.84	7.85	273.56	-0.64D	0.64R	2.13Y	-2.12D	0.69R	2.03	105.61
	US-60 sec	17.23	0.41	-8.58	8.59	272.74	-1.23D	0.57R	1.39Y	-1.38D	0.59R	1.75	111.53
	US-90 sec	17.09	0.94	-7.05	7.12	277.61	-1.37D	1.10R	2.92Y	-2.86D	1.25R	3.13	113.01

6. CONCLUSION

This article gives you a brief knowledge about CPB dyeing of cotton by using ultrasonic waves. Ultrasonic energy enhances the depth of dye by improving fastness properties of dyes. During the practical we found that as you increase the contact time of reactive dye with ultrasonic dye, you will find drastic increase in the depth of the dye than conventional dyeing. Therefore % strength of the dyes also improves. As % strength of the dye increases, fastness properties of the dyes also increase. This article gives the idea about at minimum batching time we will get same shade as conventional process by using of ultrasonic energy. Thus, overall productivity of the process increases. This method will reduce the energy consumption as well as alkali concentration. Hence by all point of view ultrasonic energy will impact positively on the dyeing of cotton.

7. ACKNOWLEDGEMENT

We would like to express our sincere gratitude to a Department of Technology, Kumaraguru college of Technology for providing chance to participate at National Level Technical Project Display Contest. It will instrumental in Achievement.

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15.BAMBOO SMART SOCKS: A POTENTIAL GAME-CHANGER FOR DIABETIC PATIENTS.

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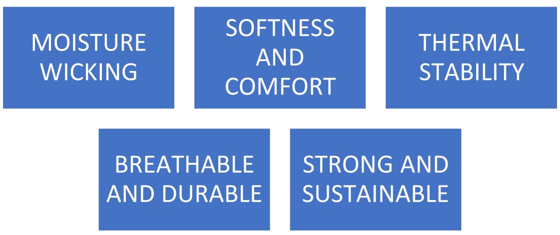
ABSTRACT

Diabetes is a chronic condition characterized by high levels of blood sugar (glucose) either due to insulin deficiency .disorder can have serious implications for foot health, primarily due to two main factors: neuropathy and like bamboo smart socks have emerged to address these challenges. These socks utilize advanced sensor technology embedded within bamboo fabric to monitor foot temperature, moisture levels, and pressure points in real-time. Through continuous monitoring, they provide early detection of potential ulcers or injuries, allowing for timely intervention and prevention of serious complications. Moreover, the breathable and hypoallergenic nature of bamboo fibres enhances comfort and reduces the risk of skin irritation. This abstract explores the potential of bamboo smart socks as a non-invasive, convenient, and effective tool in diabetic foot care, highlighting their role in improving patient outcomes and quality of life.

INTRODUCTION

Recently, there is increasing interest in utilising technology, to reduce the development of a diabetic foot ulcer. Poor circulation. So small injury become gangrene , foot ulcer and another complications . 400 million peoples who have diabetics, 40% of peoples are unable to feel the pain. Bamboo smart socks product is an injury detecting socks which are helps in preventing the diabetic's foot ulcer and amputation. Preventive measures Foot care and regular foot health monitoring is more important. So detection is more important to maintain foot health of diabetic individuals.Wearable technology designed to monitor various aspects of foot health and provide feedback or alerts to the wearer.Unlike regular socks, which primarily serve to provide comfort and protect the feet .smart socks incorporate sensors and advanced materials to offer additional functionalities and benefits.



Temperature monitoring can reduce foot ulcers by 72

Data can save life, Research has shown that temperature monitoring can reduce ulcer by 72%,

A continuous foot monitor in the everyday life of users then users wear smart socks integrated with a human touch sensor these socks incorporate Continuous Glucose Monitoring (CGM) technology.

CGM tracks glucose levels in the body every 5 to 15 minutes, providing real-time data. Temperature sensors should be enclosed with water-resistant resin pods.

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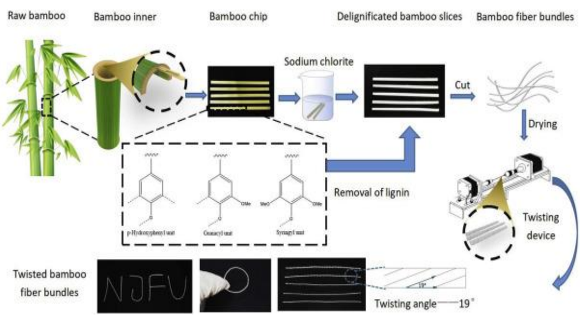
PRODUCTION PROCESS OF BAMBOO SMART SOCKS



The production process for bamboo yarn used in bamboo smart socks typically involves the following steps:

1. Harvesting Bamboo: Bamboo is harvested from bamboo forests or plantations using sustainable practices to minimize environmental impact.
2. Extraction of Bamboo Fibres: The harvested bamboo is processed to extract fibres. This can be done through mechanical or chemical methods. Mechanical methods involve crushing the bamboo and then mechanically combing and separating the fibres.

Chemical methods involve treating the bamboo with chemicals to break it down into a pulp, from which fibres are extracted.

3. Bleaching (Optional): Depending on the desired colour and purity of the yarn, the bamboo fibres may undergo a bleaching process to remove impurities and achieve a uniform colour.

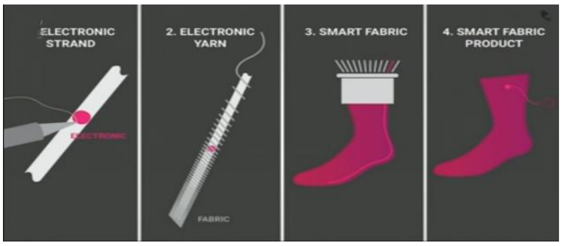
4. Spinning: The extracted bamboo fibres are spun into yarn. This can be done using spinning machines that twist the fibres together to form yarn of varying thickness and strength.

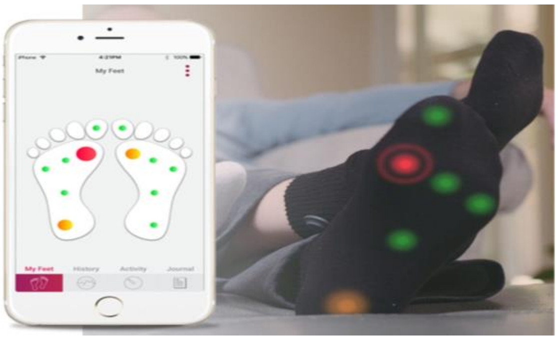
5. Blending (Optional): Sometimes, bamboo yarn is blended with other fibres like cotton, polyester, or spandex to enhance its properties such as elasticity, durability, or moisture-wicking ability.

6. Dyeing (Optional): If coloured yarn is desired, it may undergo a dying process at this stage to achieve the desired colour.

7. Quality Control: Throughout the process, quality control checks are performed to ensure that the bamboo yarn meets specified standards for strength, consistency, and colour.

8. Packaging: Once the bamboo yarn passes quality control, it is packaged and prepared for distribution to manufacturers who will use it to produce bamboo smart socks or other bamboo-based products.

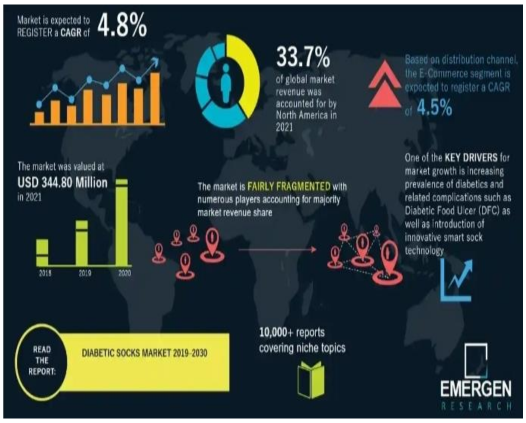




Embedded electronics directly into bamboo fibres yarn, This process involves integrating conductive threads or fibres into the bamboo yarn during the spinning process, such as sensors , while still retaining the flexibility and wash ability of the fabric, ,then connect PCB and battery.

If the Temperature of the foot exceeds the above-mentioned temperature, then the smart socks will alert the patients in red, which is a sign of inflammation, meaning that very urgent care is required. Smart socks are embedded with sensors that can detect hot spots or early to protect sensitive electronic components and other items from moisture, humidity, water.

FINITE ELEMENT MODEL OF THE FOOT: 3D MESH



- Applying a finite element model to
-
- the foot involves breaking down the foot's complex structure into smaller, simpler pieces called elements.
- These elements are connected at specific points called nodes.
- Next, we assign properties to each element, such as material stiffness and density. This allows us to simulate how the foot behaves under different conditions, like walking or running.
- Then, we apply forces or loads to the model, such as the weight of the body or impact from walking or running.
- Finally, we analyze the results to understand things like stress distribution, strain levels, and areas of potential injury. If strain values exceed safe limits, an alert is triggered to prevent injury.

MARKETING OF SMART SOCKS

- With a projected value of 344.8 million in 2021 and 179.7 millionin 2022, the global diabetics' socks market is estimated to grow at a compound annual growth rate (CAGR) of 4.8% and 5.9%.
- The purpose of diabetics' socks is to reduce the chance of harm and protect the feet. More awareness in the foot problem and improvement in technology for socks designed specifically for people with diabetics

- Growth in market revenue is mostly being driven by people's growing awareness of their health.
- Market growth can be increased, if the product is available in the online services, increasing the awareness in the internet users, available in cheaper rate.

CONCLUSION

- Bamboo is a sustainable material which makes an eco-friendly choice for the user
- Embedded with temperature sensor, which indicates an increased temperature in a particular place on any part of the socks.
- CGM for real-time monitoring of glucose levels.
- They enable the early detection of temperature changes associated with potential ulcer formation while incorporating wireless connectivity into smartphones for self-monitoring
- In the context that precaution is better than cure.
- Developments aim to improve foot health management and the quality of life of diabetic patients.

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16.OPTIMIZING MOISTURE CONTROL IN KNITTED FABRIC USING ERI SILK

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ABSTRACT

Silk knitted fabric is a new avenue in the international market, produced from both Mulberry and Non-Mulberry silk varieties. Eri silk knitted fabrics are natural, ahimsa, eco-friendly and glamorous. These knitted fabrics have better physical, dimensional, thermal and moisture management properties which evidence that the fabric is suitable for suitable for both summer and winter wear. Moisture management and wicking properties of Eri silk knitted fabrics have been studied. Three different knit structures, namely single jersey, single pique and honeycomb, have been developed with the combination of two different yarn count and tightness level. The fabrics developed are analysed in terms of wetting time, spreading speed, absorption rate, and maximum wetting radius, accumulative one way transport index(AOTI)and over all moisture management capacity(OMMC). The OMMC indexes of Eri silk knitted fabric are found to range from 'very good' to "excellent' category, which indicates the suitability of eri silk yarn to skin fit as well as active wear applications.

Keyword:Erisilk,knittedfabric,moisturemanagement,pique,singlejersey,wicking, honeycomb

1. INTRODUCTION

Eri silk has unique thermal, physical and moisture management characteristics when compared *with other* commercial silk varieties [1,2,3]. eri silk coarser yarn (ΔR~32.85) while comparing the finer (ΔR~30.15) yarns. This is due to increases in the thickness of fabric contributing a higher amount of air in the fabric interstices, which confirms the previous report by Stankovic B et al [4] eri knitted fabrics, if the yarn becomes finer or the loop length increases, the thermal resistance and thermal conductivity of fabrics also decrease proportionally. This contradiction is explained by Nida Oglakcioglu et al [5]

Eri silk is multivoltine silk spun from open-ended cocoons, with the ability to deliver an outstanding dimension of fashion textiles (1) Eri silk cocoons are open-mouthed, which cannot be reeled like mulberry silk, which is spun into yarn in the worsted spinning system [6] Eri silk has better softness than other silk materials as well as better thermal insulating properties than wool and higher comfort than cotton [7,8] The acidic amino acids of aspartic and glutamic acid and the basic amino acids of arginine, histidine and lysine have higher proportions in eri silk fibroin [9,10].

Eri silkworm is hardy and more tolerant to temperature and humidity fluctuations [11] climate change can impact Eri silkworm production, leading to unstable productivity under extreme conditions [12]. Eri silkworm strains (39 to 45 days), which can increase fiber productivity. Studies show that silkworm strains can influence the properties and quality of the fibers [13]. The degradation temperatures obtained in this study are close to those of Eri silk fibers reported in other regions, such as 359 °C for Eri silk from Kenya [14] and 369 °C for Eri silk from Bangalore [15]

A lower thermal resistance value is observed for mulberry silk fabric as compared to that of eri silk knitted fabric. It is revealed from previous literature [16,17] Eri silk having lower thermal conductivity of 0.118 W/mK in transverse direction [18] along with its fluffy nature owing to specific volume of 0.765 g/c.c [19] Eri silk fiber had higher thermal stability than B. mori silk fiber [16]. Eri silk fiber's fineness ranging from 14 to 16 microns is very close to wool fibers which can easily be blended with wool [20] Eri silk exhibits heat resistance and water absorption capabilities, enabling it to provide warmth in cold weather and a cooling effect in hot weather [21] Eri silk is widely used in the textile and clothing industry as a raw material for scarves, jackets, blankets, and other products [22] Eri silk in biomaterial applications such as drug delivery, wound healing, and tissue engineering scaffolds [23]

1 Materials and Methods

1.1 Materials

Eri silk yarn was procured from Unworthy Textiles, Raipur, India. The physical parameters of eri silk fibre used for development of spun yarn are density 1.31g/cm^3; fineness 3.33 - 4.44 d tex; tenacity 27.43cN/tex;elongation-at-break22%andmoistureregain 10%(ref.18).The count of yarn samples was measured according to ASTM D 1907-01 standard, and single yarn strength was evaluated by using Instron strength tester as per ASTM D2256 standard.TheevennessparametersweremeasuredasperASTMD1425M:14methodbyusingUSTERevenness tester UT 5. Table 1 shows the various yarn characteristics

Parameter	Coarse yarn	Finer yarn
Yarn linear density, Nm	2/80^s	2/140^s
Actual yarn count, tex	24.92	14.32
Count CV%	3.50	4.20
Twist value, TPM	531.50	492.12
Breaking force, gf	397	297
Elongation, %	11.90	12.20
Tenacity, cN/tex	16.19	17.20
Unevenness U%	10.8	11.2
Thin /1000m (-50%)	12	21

Table1—Eri silk yarn properties

1.1 Fabric Development

The fabric samples were produced as per the sample plan furnished inTable2.Single jersey ,single pique and honeycomb fabric samples were knitted in two different tightness levels (slack and tight),with the same machine settings. The single cylinder circular knitting machine with the following specifications was used for the development of samples : gauge 24GG; diameter 24inch; speed 10 rpm; feeders 74; number of needles1720 and yarn input tension of 3.5cN/tex .Knitting room humidity of 60% and a temperature of 32±2°C were maintained

Sample code	Fabric structure	Yarn count, Nm	Machine set loop length, cm
CSJ-T		$2/80^{s}$	0.27
CSJ-S	Single Jersey	$2/80^{s}$	0.33
FSJ-T	F 1	$2/140^{s}$	0.25
FSJ-S	F 2	$2/140^{s}$	0.31
CSP-T	Single Pique	$2/80^{s}$	0.27
CSP-S		$2/80^{s}$	0.33
FSP-T	F 1	$2/140^{s}$	0.25
FSP-S	F 2	$2/140^{s}$	0.31
CSH-T	Honeycomb	$2/80^{s}$	0.27
CSH-S	F 1	$2/80^{s}$	0.33
FSH-T		$2/140^{s}$	0.25
FSH-S	F2	$2/140^{s}$	0.31

Table 2— Fabric sample plan

C–coarseyarn,F–fineyarn,T–tightfabricstructure,S–slackfabricstructure,SJ–singlejersey, SP–singlepique

1.2Testing

The dimensional properties of the fabric were evaluated according to international testing standards, such as weight per unit area (ASTM D 3776), wales and courses per unit length (WP cm & CP cm) and loop length (ASTMD3887), and thickness(ASTMD1777) by using Shirley thickness gauge .All measurements were performed under the standard atmospheric conditions of 20° ± 2°C and 65% RH .Five readings were taken for each of the knitted fabrics and then the averages were calculated. Vertical wicking tests were performed according to DIN 53924 standard. The specimens were cut along the wale-wise and course-wise directions (250mm ×30 mm), which is suspended vertically with its bottom edge of 5 mm immersed in a reservoir of distilled water. The wicking heights were measured and recorded at regular intervals for 10 min to evaluate the wicking ability.

1.3MoistureManagementProperties

According to AATCC test method 195-2009, the multi-directional moisture transport capabilities of fabrics were measured by using moisture management test(MMT) device. The fabric specimen is placed between two horizontal electrical sensors each with concentric pins. A predetermined amount of test solution is dropped onto the top center of the fabric specimen surface .The test solution is allowed to freely move in multi-directions, spreads on the fabric top surface, moves through the specimen from top to bottom surface, and radially spreads on the bottom surface of the specimen. The electrical resistance values have been used to calculate fabric liquid moisture movement that quantifies dynamic liquid moisture transport behavior of fabric.

In this experiment, the specimens of size 8.0 × 8.0cm^2 were washed and conditioned for a day in the standard atmospheric conditions before testing. The indices were graded according to theAATCC195-2009 method on five grade scale. Table 3 gives the details of grading of moisture management indices.

3. RESULTS AND DISCUSSION

3.1 Physical Properties of Knitted Fabrics

The properties of fabric samples are given in Table 4. The fabric weight per unit area and thickness of the fabrics vary with the change in yarn count, stitch length and knit structures. Geometrical properties of eri silk knitted fabrics are found in accordance with established understanding of knitted fabric behaviour.

3.2 Vertica Wicking Test

Table 5givesthe data on wicking height(cm)at10 min for both course and wale directions. Eri silk knitted fabric has rapid and better wicking, which may be due to the presence of higher ratio of hydrophilic to hydrophobic of amino acids residues initschemicalstructure[19,20].

It is observed that the single jersey fabric shows better wicking property than single pique and honey comb structures. There suit confirms the earlier findings of Wong *et al.*[21]. They reported that according to the capillary principle, small pores are packed first and the liquid then moves to the larger pores. The higher pore size of honeycomb and single pique structures are attributed to poor wicking. Further more, coarser eri silk yarn possesses better wicking property than finer eri silk yarn. Presence of more number of fibres in the yarn cross-section and the resultant higher thickness might support the higher capillarity of fabrics with the coarser yarns. It is observed that the tight forms of the structures possess better wicking ability than that for slack forms in both directions. The fabric also shows shorter wicking heights in course-wise direction than that in wale-wise direction for all knit structures. It may be due to varied loop shapes and densities of the structures for wale-wise and course-wise directions.

The rate of vertical wickability is found fast , ranging from 0.65mm/s to 0.38mm/s for the first three minutes and subsequently its low down in the range of 0.18- 0.08mm/s beyond that time. As reported by Zhuang*et al.*[22], the initial rapid wicking rate could be due to gravitational forces that is interfered with the capillary rise of the liquid through the fabric and also due to the fibre surface energy. Eri knit single jersey has instant water absorbing capacity of 0.65-0.55mm/s ,followed by single pique 0.52-0.47mm/s and honey comb structure 0.48-0.35mm/s

Table3—Grading of moisture management indices

Measuring parameters Wetting time, s	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Top (WT_t)	≥120	20-119	5-19	3-5	<3
Bottom (WT_b)	≥120	20-119	5-19	3-5	<3
Absorption rate, %/s					
Top (AR_t)	0-10	10-30	30-50	50-100	>100
Bottom (AR_b)	0-10	10-30	30-50	50-100	>100
Max wetted radius, mm Top (MWR_t)	0-7	7-12	12-17	17-22	>22
Bottom (MWR_b)	0-7	7-12	12-17	17-22	>22
Spreading speed, mm/s					
Top(SS_t)	0-1	1-2	2-3	3-4	>4
Bottom(SS_b)	0-1	1-2	2-3	3-4	>4
Accumulative one-way transport capacityindex (AOTI), %	< -50	-50 to 100	100-200	200-400	>400
Overall moisture management capability (OMMC)	0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	>0.8

3. CONCLUSIONS

- Knitted structures, yarn count and tightness have significant effect on vertical wicking ability ;single jersey has better wicking property than single pique and honeycomb structure.
- Eri knit single jersey has instant water absorbing capacity of 0.65-0.55 mm/s, followed by single pique 0.52-0.47mm/s and honey comb structure0.48-0.35 mm/s.
- Eri knit fabric has shorter wicking heights in course-wise direction than in wale-wise direction for all knit structures. Coarser eri yarn and tighter knit structures posses better wicking properties in both directions.
- Fabrics made out of finer yarn show faster wetting rate, absorption rate, spreading speed and max wetted radius as compared to those for coarser yarns.
- Tightness has a significant influence on the moisture management properties of knitted fabrics. Slack

structures how increased absorption rate & spreading speed, max wetted radius and reduced time to wetting as compared to tight structures.

- Knitted fabrics with pique and honey comb structures how better absorption rate, faster wetting, and maximum wetted radius. The inner layer of the fabrics shows lower absorption rate than that of outer layer, which indicates that eri knit fabric is suitable for skin fit as well as active wearer applications.
- Accumulative one way transport capacity and OMCC of single pique and honeycomb structures are in the 'very good-4' to "excellent-5' category. It is also observed that the single jersey fabrics made out of finer yarn and slack structure also have sealed up to Grade4. This also supplements the suitability of eri silk yarn to skin fit as well as active wear applications.

The studies reveal that the all eri knitted fabric in general have good moisture management properties and confirm their suitability for performance-based garments

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