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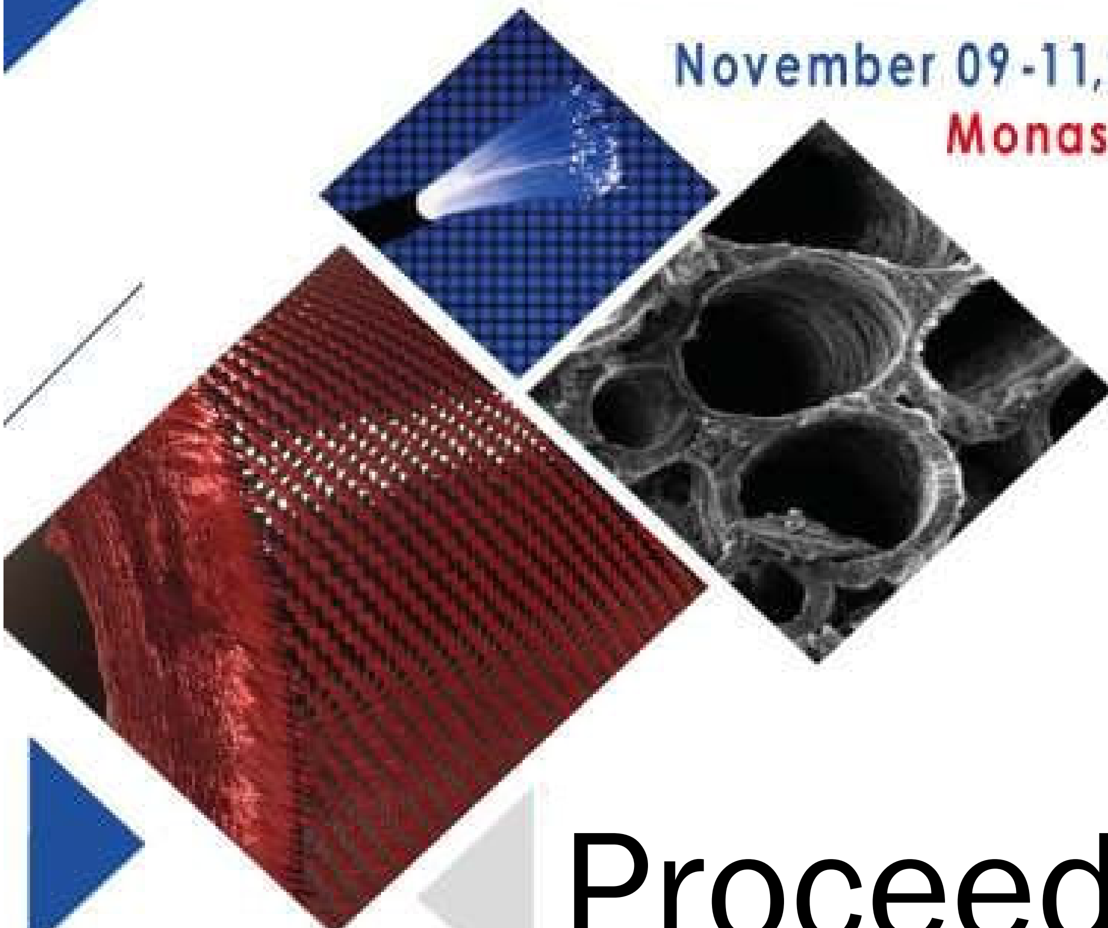

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SUMMARY

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Sustainable materials and processes

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PLENARY CONFERENCES

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INNOVATİVE PRACTİCES FOR ACHİEVİNG A NEW ARTİFİCİAL LEATHER CİRCULAR SECTOR

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ABSTRACT

The paper aims to highlight a mechanical recycling process specifically tailored for PVC coated fabric waste. The primary challenge is to transform PVC-coated fabric waste into PVC powder completely separated from PET fibers, while simultaneously ensuring the optimal recovery of small PVC particles. The effectiveness and efficiency of this process were evaluated through a comprehensive analysis that incorporated qualitative and quantitative studies. First results demonstrated a successful recovery rate of 83.92% for the PVC, compared to the initial amount. The remaining 16.07% of PVC was found to be either entangled with PET fibers or lost during the grinding process.

Then, a comprehensive investigation focused on understanding the behavior and characteristics of recycled PVC powders. The study began by describing the particle morphology qualitatively using an optical microscope to distinguish the different shapes of non-spherical particles. Subsequently, a quantitative analysis of PVC particle size distribution is performed by mechanical sieving. These findings confirm that the majority of particles, 96.39%, are smaller than 600 µm and the greatest fraction (83.44%) is in the size range between 200 µm and 600 µm.

Ultimately, this research delves into the impact of varying PVC recycled content and particle sizes on the mechanical characteristics (breaking load, tearing strength, and elongation at break) of the expanded PVC layer utilized in floorcovering applications. The results showed that incorporating up to 25 g of recycled PVC demonstrated favorable mechanical performance. However, with a particle size distribution of recycled PVC containing particles smaller than 200 µm, expanded layers of satisfactory quality can be produced using up to 86,67% recycled PVC (65g) in relation to the total PVC resin quantity.

Keywords: Recycled PVC powder, particle morphology, size distribution, expanded layer, floorcoverings.

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A SUSTAİNABLE APPROACH FOR TEXTİLE WASTE RECYCLİNG İN TUNİSİA

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Abstract

Given the environmental requirements and economic constraints due to the increase in raw material costs, energy as well as profound climate changes increasingly requiring water savings, the choice of a sustainable development policy in textiles is a necessity.

According to the National Agency of Waste Management ANGED, 2.6 million tons of waste are generated yearly in Tunisia with an average increase of 2.5%. Textile waste represents 8.7% which represents 226000T per year; A huge amount.

The purpose of our work was to propose a sustainable approach to reuse all amounts of yarn waste blue and white from the winding and warping machines of a Textile company in Tunisia. The research aimed to provide a solution to the great demand for denim with the use of reclaimed fabric, which accompanies the increased need for denim with a fancy effect and the obligation of denim producers to follow environmental standards.

The first step aimed to optimize process separation. Mathematical, statistical, and simulation models were then established to predict the best blend between reclaimed and virgin fibers. The results show that it is possible to obtain a good quality of blend yarn using virgin cotton and cotton waste even when the waste content exceeds 50%. These results are significant for textile mills. Reprocessing fibres from denim color-processing waste has a lot of advantages, including reductions in wastewater treatment and the consumption of energy, chemicals and water.

In addition, fibers wastes generated by separation processes (Fibers non-open and cannot be reintroduced for spinning) were transformed on nonwoven using a Drylaid process. Non woven produced were utilized to manufacture composite, mulching for agriculture applications and to synthesize activated carbon to use it to remove sulfur compounds from refinery wastewater.

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TREATMENT AND REUSE OF TEXTİLE WASTE WATER USİNG HYBRİD PROCESSES İNTEGRATİNG MEMBRANE SEPARATİON

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Abstract:
Industrialization plays an important role in the development of any country but its main drawbacks are water consumption and wastewater production. Global industrial water consumptions would increase 1.8 times from 800 billion m^3 in 2009 to 1500 billion m^3 in 2030 under an average economic growth scenario.
In addition, population growth, industrialisation and deterioration of the available fresh water sources are major contributors to the current worldwide water crisis.
The textile manufacturing sector is the major industrial water user in Tunisia with a great variety of process steps requiring the use of large amounts of water and chemicals. Textile wastewaters have been rated as the most polluting amongst all other industrial effluents due to their complex composition.
Over the past two decades, environmental regulatory requirements have become more stringent because of increased awareness of the human health and ecological risks associated with environmental contaminants. Therefore, various treatment technologies have been developed over the last 10 to 15 years in order to cost-effectively meet these requirements.
Due to highly polluted nature of textile wastewaters, water reuse may only be possible after proper treatment, which depends on the concentrations of pollutants and the reuse criteria. At present, various physical, chemical and biological methods have been employed for textile wastewater treatment. These methods are not able to remove colour and high level of salts present in wastewater. In addition, they cannot be effectively used individually hindering the water reuse in the production process.
Membrane systems are found to be advantageous over traditional separation methods due to their lower energy consumption and environmental impact. Membrane processes that can meet the legislative requirements are Ultrafiltration (UF), Nanofiltration (NF) and Reverse Osmosis (RO) since they are able to retain not only relatively small organic molecules but also ions from textile wastewater.
In consequence, the combination of conventional methods with membrane processes seems to be an effective strategy to address complex wastewater streams and to reduce substantially the amount of chemicals used.
On the other hand, membrane technology has received a great interest in a wide range of fields and particularly, the development of ceramic membranes, which is due to their several advantages, such as high chemical, mechanical, thermal stabilities in addition to their separation efficiency and long life. Low-cost ceramic membranes made from different types of raw materials such as clay, apatite, graphite, zeolite, sand, were developed as alternatives to well-known metal oxides like alumina, silica, zirconia and titania. These new membranes can combine various properties in addition to separation, such as adsorption and catalytic properties and thus can represent an alternative solution for textile wastewater treatment and reuse.

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FİBER-BASED SENSOR AND ACTUATOR MATERİALS FOR LOW-LATENCY TACTİLE İNTERNET BASED ON 6G AND WİTH HUMAN-İN-THE-LOOP

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Abstract

The emerging fields of switchable soft robotics and smart textiles have the potential to revolutionize the tactile internet by enabling the development of novel materials and systems that are capable of self-adaptation, sensing, and actuation. Interactive fiber rubber composites (I-FRC), are fiber-reinforced elastomer materials that are equipped with structurally integrated actuator and sensor networks. This innovative approach allows for the direct integration of actuators and sensors during the manufacturing process, resulting in a more robust and adaptable material. The development of I-FRC will enable the reversible and contactless adjustment of mechanical components, leading to a range of potential applications across various fields including soft robotics for human-machine interaction and prosthetics. Smart textiles, on the other hand, offer a promising solution to facilitate the interaction between humans and machines in the tactile internet. These textiles can transduce motion and sense from and to the body, enabling the development of wearable devices that can adapt to the user's needs and environment. With their ability to detect and respond to environmental changes, smart textiles have the potential to improve the safety, comfort, and efficiency of various applications such as healthcare, sports, and entertainment. These scenarios include smart gloves or e-skins for remote teaching and rehabilitation. Particularly important for such applications is a low latency of sensing, data computation, data transfer and actuation. Innovative communication technologies like 6G in combination with high-speed actuators are a promising approach to solve these challenges.
The integration of I-FRC and smart textiles holds immense potential for the development of novel systems that are more robust, adaptable, and responsive to changing environments. The synergy between these two fields can facilitate the development of innovative materials and devices with low latency (6G) that can enhance the user experience and improve the functionality of various applications. Therefore, the exploration and development of these fields are discussed and how they further advance the tactile internet and its applications.

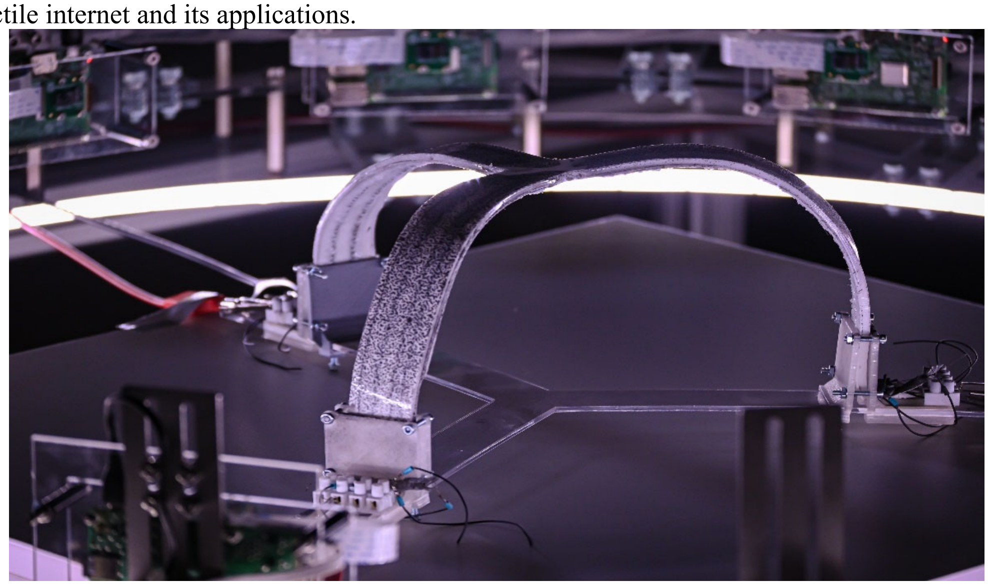

Figure 1: Soft fiber-elastomer composite driven by shape memory alloys with three degrees of freedom, © ITM TU Dresden

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Figure 2: Illustration of low latency interaction between human and machine over large distances, © CeTI TU Dresden

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SUPRAMOLECULAR COATİNGS AND HYDROGELS WİTH ANTİMİCROBİAL PROPERTİES: FROM SCİENCE TO BUSİNESS

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All implantable biomedical systems face several risks once in contact with the host tissue and the main one is the development of bacterial biofilms. To prevent such infections, a multifunctional surface coating that can address this issue would significantly improve clinical outcomes[1].
Polyarginine (PAR), polylysine (PLL), or polyornithine (POR) are synthetic highly cationic homopolypeptides that can act as antimicrobial agents due to their positive charges. We developed a family of new supramolecular coatings based on these homopolypeptides assembled with hyaluronic acid (HA)[2,3]. We demonstrate that exclusively coatings constructed with homopolypeptide chains of 30 residues in length (PAR30, PLL30 or POR30) provide a strong antimicrobial activity[4]. These coatings have an inhibitory effect on all pathogenic bacteria associated with infections of medical devices, including antibiotic resistant bacteria. However, PAR30/HA coating appear as the most effective and the most biocompatible coating. No secondary structure of the homopolypeptides is needed to provide the activity and the mechanism is related to a physical damage on the membrane once the homopolypeptide sticks to the bacteria, with no need to interfere with the bacteria metabolism. A better view of the mechanism was also obtained with molecular dynamics simulation of PAR interaction with bacterial membrane. Moreover, this assembly can also be fabricated in the form of hydrogel[5,6] useful to provide antibacterial properties to porous implants like surgical meshes.
The history of the development of this discovery with the creation of the company SPARTHA Medical will be described and how to get a product and a market.

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DEVELOPİNG SPİNNİNG TECHNOLOGY FOR TEXTİLE RECYCLİNG NEEDS İNDUSTRY 4.0

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Keywords: Textile Recycling, Spinning, Modular, Pilot Plant, Up-Scale, Research 4.0

Abstract

In March 2022, the European Commission launched its "EU Strategy for Sustainable and Circular Textiles". The strategy seeks to decrease the environmental impact of the textile sector and addresses the urgent necessity of reducing textile waste. The global textile industry demands a re-evaluation of the production and disposal of textiles.

Every year, approximately 115 million tonnes of textile waste need to be disposed of globally. Large volumes of this waste end up in landfills, with some being incinerated. In addition, a portion of the waste comprises of microplastics that cannot be composted and are widely dispersed throughout the environment. Accordingly, it is necessary to explore opportunities to implement cradle-to-cradle textile circulation and promote the use of biodegradable fibres to improve the sustainability of recycling initiatives.

How can individuals contribute to this trend? What are the essential tools required to facilitate innovation in this field? How can digitalisation aid in comprehending the required technologies for manufacturing recycled fibre?

A proactive approach, comprising an inter-industry framework of competences, is needed to devise solutions by analysing the real consumption of textiles and projected trends. An overview of European political concepts can provide valuable insights into tackling this problem, leading to new findings in scientific research.

In order to achieve cradle-to-cradle concepts, it is necessary to consider which fibre type is most appropriate: biodegradable cellulose fibres or the high volume of polyester fibres. A discussion on the ecological footprint can also aid in decision-making.

It is also important to consider what actions an engineering company, which focuses on prototype spinning lines, can take to support the cradle-to-cradle circle in textiles. The concept of Industry 4.0, developed in 2012, has been transformed into a Research 4.0 concept called MultiMode®. This concept provides a modular approach to product development, from conception to practical implementation. The necessary requirements for research facilities include INTEGRATION, SCALABILITY, FLEXIBILITY, HIGH PERFORMANCE and ANALYTICS. These elements are integrated into the MultiMode® concept to investigate the spinnability of new polymers, including the possibility of using recycled polymers.

The current level of achievement in product and production aspects of the Industry 4.0 concept will be explored with the aim of determining how the concept of a Digital Twin and AI can assist in our research for our part in the cradle-to-cradle cycle.

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REFİNİNG NATURAL FİBERS: NEW ADVANCES

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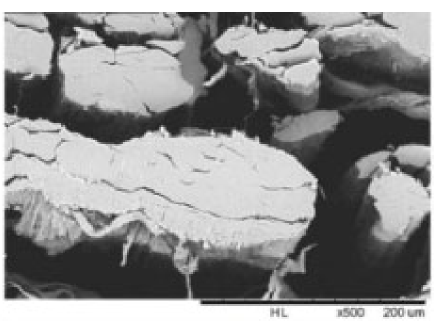
Bast fibers such as hemp and flax have received increasing attention due to their renewable and sustainable nature, local availability, low density, biodegradability and carbon sequestration. Technical bast fibers are extracted from the stem of the plant by a mechanical decortication also producing shives. Bast fibers are composed of individual cells cemented together by a gum composed primarily of lignin and polysaccharides. Removal of these non-cellulosic components (the degumming) is required to produce homogeneous and fine fibers. Degumming is generally a limiting step because developing an efficient and environmentally friendly process is difficult. In addition, this step has a considerable impact on the morphological and mechanical properties of the fibers produced. Among the processes proposed in the literature, steam explosion is promising for several reasons: it is indeed a clean physico-chemical process without solvent and chemical, easy to scale up and credible on an industrial scale. In this paper we described the refining of different bast fibers such as hemp and ramie using the steam explosion process. The influence of the experimental conditions (temperature 170°C-210°C, treatment time 2 min-10 min, neutral pH or alkali for the pre-impregnation) was examined. The impact of the reaction conditions on the composition of the fibers (sugars, lignin contents), their morphology and their mechanical strength was studied in detail. The use of the produced fibers for spinning tests and composites production will be presented. We will also describe the treatment of fibrous plants from phytotechnology, having been harvested on polluted soils, rich in heavy metals. Finally, the valorization of the shives isolated during the decortication stage by the production of wood panels without synthetic glue will also be discussed.



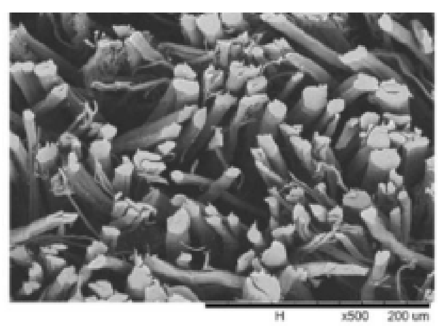


Figure - SEM photos of cross sections of untreated and treated hemp samples by steam explosion

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METAMATERİAL TEXTİLES DESİGN: BARRİER EFFECTS, OPTİCAL İLLUSİONS AND THE PROSPECTS OF İNVİSİBİLİTY

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Key Words: Metamaterial, barriers effects, Frequency Selective Surface, optical illusion, invisibility

1. ABSTRACT

We are surrounded by weaves, some of them transport sound to our ears, stimulate the retinas of our eyes, bring radio, television and endless streaming content to our devices,
All these different waves are governed by the same fundamental physical principles. And recently there has been a revolution in our ability to control these waves using materials, known as metamaterials.

First, in this work, a review of the potential applications of metamaterial is presented such as sound silencers, sonar deflectors, earthquake dampeners, heat shields, invisibility cloaks.

Second, the design of a Frequency Selective Surface (FSS) based on textile for selecting frequence is analyzed. This FSS or "spatial filter" can be integrated into the materials to obtain a metamaterial [1].

Finally perspectives of using metamaterials in the optical field such as optical illusion and illisibility are introduced.

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CELLULOSE AS A SERİOUS CANDİDATE İN CİRCULAR ECONOMY

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Keywords: Cellulose; Nanocellulose; Functionalisation; chemical grafting; Medical applications.

The present lecture is focused on the recent advances the role which cellulose could play in circular economy. Thus, cellulose, from macromolecular size to fibers morphologies, as such and after chemical modification (surface or bulk modification) is a relevant candidate to be the starting raw material for the future and in several application areas (material, energy, building, medical...). After a general introduction aiming at describing the society expectation, this presentation will be divided into three parts:

1. The first part will be devoted to basic considerations about cellulose, its origin and its current and future uses, with particular emphasis on its functionalization potential [1, 2]. In this part, the credibility of cellulose as a serious candidate to play the role of feedstock in the context of the circular economy will be discussed.
2. The second part points out the most relevant surface modification strategies to which the cellulose surface could be subjected, in order to graft new functions. These include, (i) physical treatments (ii) chemical grafting by direct condensation, “grafting from” and “grafting onto” approaches. In this context, recent works investigating green solvent-based or solvent-less systems will be reported [3, 4].
3. All these treatments aim at providing these substrates specific functions, such as hydrophobic character, anti-microbial properties, etc. [3, 4]. Typical examples of achievements in this field will be given and discussed, with a special focus on those aiming at helping medicine in specific challenges. Thus, active surfaces (antimicrobial for example) working in contact or release modes will be given. Other energy providing cellulose-based medical devices will also described and discussed.

Finally, some relevant concluding remarks and perspectives will be given.

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ORAL PRESENTATIONS

Technical materials & smart textiles

PRODUCTİON OF A FULLY FİREPROOF PVC SYNTHETİC LEATHER ARTİCLE

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Key Words: PVC, Synthetic leather, coated textiles, flame retardant

1. INTRODUCTION

The PVC synthetic leather is originally designed to reconstitute the appearance of animal leather, in its various aesthetic aspects, flexibility, mechanical and chemical resistance, and touch. It is mainly used in clothing, furniture, footwear, leather goods, car upholstery, decoration, etc[1, 2].
Although PVC-synthetic leather can have similar or even superior properties to animal leather, such as lightness, waterproofing, resistance to abrasion, etc.[3], some shortcomings can limit their use, especially their poor fire behavior. Even though there are existing commercial products and treatments to improve the fire resistance of PVC synthetic leather, these products are often not adapted to the specific PVC-coated textiles manufacturing processes and real industrial conditions since they are defined mainly based on suppliers' recommendations and not on the existing practices.
In previous work, we tried to apply a flame retardant treatment to polymeric layers of PVC synthetic leather by combining several flame retardants so used for the flame retardant treatment of PVC. Satisfactory results were found.
In the present work, we aim to produce a fully flame-retardant PVC synthetic leather article by creating a flame-retardant textile substrate and bonding it to the already-produced flame-retardant polymeric layers.
The morphology of the flame-retardant synthetic leather showed that the flame-retardant treatment protected the textile substrate structure well and did not alter the interfacial adhesion between the polymeric layers and the textile substrate.
The vertical flame test was used to qualitatively study the fire behavior of the different samples, while also setting up another method to quantitatively characterize them.
Thermogravimetry (TGA and DTG) and differential scanning calorimetry (DSC) measurements were utilized to prove that the flame retardant did not affect the thermal stability of our textile substrate and PVC synthetic leather samples.

2. MATERIALS AND METHODS

2.1. Raw materials

PVC resin, plasticizer (DINP), stabilizer, $CaCO_3$ fillers, blowing agent (Azodicarbonamide), kicker, calcium carbonate, transfer paper, and textile fabric were generously donated by PLASTISS (Monastir, Tunisia). A commercial fire retardant supplied by BEZEMA was used, which is a compound of nitrogen and organic phosphorus known under the trade name APYROL NCE NEW.

2.2. Methods :

2.2.1. Preparation of fireproof textile substrate

The application of the flame retardant to the textile substrate used in our studies, dictated by the product data sheet, was by fulling, the fabric is continuously passed through a tray filled with aqueous flame retardant solution, then passed between two rollers to be wrung out, and finally passed through a continuous drying tunnel at temperatures ranging from 120 to 150°C for 3min.

2.2.2. Preparation of fully fireproof PVC synthetic leather :

As detailed in a previous work, flame retardants used for PVC plastic layers are applied directly in the recipes for the superficial and foamed layer pastes. The superficial layer paste is applied to the

siliconized transfer paper, always setting the desired thickness for this layer, and then passed through the oven at a temperature of 200°C for 20 seconds. The paste of the expanded layer is applied to the first layer after it has been taken out of the oven, always setting the desired thickness.
The poly-cotton knitted fabric, after having been treated with a flame retardant, is applied to the surface of the second layer obtained, and lightly pressed.
The product obtained in this way is passed through the oven for 80 seconds at a temperature of 200°C so that the cross-linking of the second layer is perfectly done and the transfer of the paper to the fabric is correctly achieved. The result is a fully fireproof synthetic leather.

2.2.3. Thermal characterization :

The TGA and DTG curves of the foamed layers have been analyzed using Perkin Elmer STA 6000 in the temperature range of 0–600 °C at a heating rate of 10 °C min–1 under a nitrogen stream and an oxidizing atmosphere. DSC measurements were carried out at a heating rate of 0.1 °C/min in ambient air conditions, using a Mettler Toledo.

2.2.4. Fire behavior study (vertical flame test) :

The vertical flame test was performed at CETTEX according to ISO 6941, by applying a methane flame to the bottom of a fabric sample (50 cm × 20 cm). The test was repeated twice for each sample to assess the burning behavior.

3. RESULTS AND DISCUSSION

It was found that for the untreated substrate, after removing the ignition source, the flame spread rapidly and ignited the entire fabric. However, for the treated substrate, after removing the ignition source, the flame spread was slowed down and the length of charring was much less.
By examining the fiber structure before and after the fire treatment, we found that the majority of untreated poly-cotton fibers shrink and clump after burning, which also proves that untreated fibers can hardly resist to the flame. While treated fibers retain their structures well after burning.
By investigating the DSC and ATG curves, it was concluded that the flame retardant treatment slightly improved the thermal stability of the poly-cotton fabric.
SEM images of the bilateral surface of the PVC synthetic leather showed that the flame retardant treatment did not alter the interfacial adhesion between the textile substrate and the polymeric layers.
The photographic images of the PVC synthetic leather samples before and after the fire treatment applied to the PVC plastic layers and the Poly-cotton textile substrate obtained after the vertical flame test showed that the reduction in char length is quite different and is very significant for the treated sample. A decrease in the structural damage of the treated leatherette is also well observed.
The observed differences are attributed to a better effect of the applied flame retardants in the recipes for the polymeric layers and for the textile substrate.
The thermal analysis has also shown that the fire treatment did not affect the thermal stability of the PVC synthetic leather samples.

4. CONCLUSION

This research work was devoted to improving the fire-retardant properties of PVC synthetic leather. A commercial phosphorus-based flame retardant was applied to the polycotton textile substrate. The fire behavior was studied and the flame retardant effect was significant. Finally, a fully flame-retardant PVC synthetic leather was produced by combining the two flame-retardant polymeric layers and the flame-retardant textile substrate. The vertical flame test performed at CETTEX confirmed the flame retardant effect. A thermal study was also carried out and showed that the fire retardant treatment of the polymeric layers and the textile substrate improved the thermal stability of the whole PVC synthetic leather sample.

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STUDY OF TREATED LEATHER ANTİMİCROBİAL PROPERTİES

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Key Words: Leather, antimicrobial, zinc pyrithione, fungi, bacteria.

Since ancient times the Human has used leather in many fields of his needs life, it was mainly used in wearing articles such as gloves, belts, jackets, and shoes. This noble material is produced from skin of animals. As it is used in intimal contact with human skin, it is very important to insure a high protection for consumer especially in applications needing high resistance to fungi and bacteria proliferation. In this study, sheep leather samples were treated with zinc pyrithione, their antimicrobial activities against *S. aureus*, *E. coli* and *Aspergillus niger*, and their zinc content were investigated.

1. INTRODUCTION

Leather is a skin based material having unique physical qualities, including flexibility, high tensile strength, resistance to tearing, puncturing and abrasion, low bulk density, good heat insulation and water vapor transmission [1].

These properties could justify the considerable use of leather in shoes insoles industry. Activating insoles against the proliferation of bacteria can prevent as well as reduce many diseases and minimize bad odors in shoes during long wearing period. In fact, the intimate contact between shoes and foot affords an excellent environment for bacteria and fungi growth, due to the presence of high moisture and warmth conditions, nutrients from feet sweat, and oils greases from insoles [2]. Some researchers studied the activation of leather with silver [3], zinc oxide, or natural products such as Chitosan [2] detecting a possible antibacterial activity. In this study we tested the efficiency of zinc pyrithione on leather treatment, since its antimicrobial properties were proven in some textile researches [4, 5].

2. MATERIALS AND METHODS

The IsysZnP (ZnP) chemical compound of zinc pyrithione (30%) product was used for Leather treatment. For antibacterial activity, we used Staphylococcus aureus ATCC 6538 (S. aureus) and Echerichia coli ATCC 8739 (E. coli) and the Nutrient Agar. Aspergillus niger (A. niger) from hospital insulation was used in antifungal test. To evaluate the zinc content, the inductively Coupled Plasma Spectrometer (ICP-MS) was used to analyze the digested samples solutions by the microwave digestion system (produced by Milestone).

2.1 Leather treatment with ZnP

Each sample of chrome tanned sheep leather was prepared and then treated by exhaustion in the ZnP solutions with various concentrations (Table 1), before being dried for 30 minutes at 50°C and finally washed to eliminate the non-fixed molecules.

2.2. Antibacterial test : Parallel streak method:

The antibacterial activity of treated samples was probed according to the AATCC 147 method, against the two standard bacteria S. aureus and E. coli. The inhibition width was determined to compare the samples.

2.3.Antifungal test:

The treated leathers behaviour against fungi was determined by evaluating the growth of Aspergillus niger spores harvested for 7days, following AATCC 30 standard.

2.4. Measurement of Zinc content

Leather samples were digested by the microwave digestion system and the resulting solutions were cooled and diluted, before being treated by the Inductively Coupled Plasma Spectrometer (ICP-MS).

3. RESULTS AND DISCUSSIONS

As shown in figure 1, the zinc amount fixed on the leather treated samples by exhaustion process increase in a linear way when the applied ZnP concentration was varied from 0.25% to 1%. The highest amount of the zinc was 559 mg/kg when 1% of ZnP was applied to the sample (figure 1). The inhibition halos according to diffusion tests given in table 1 are measured to assess the effect of zinc concentrations on the antibacterial and antifungal activities of the treated samples.

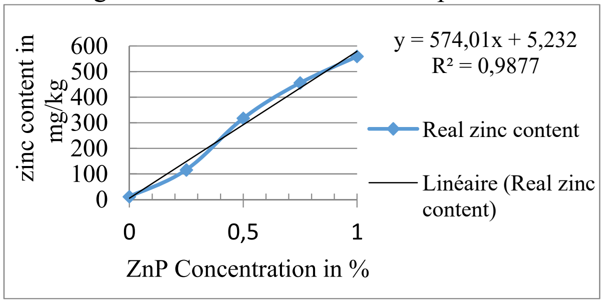

Figure 4 : Zinc amount variation

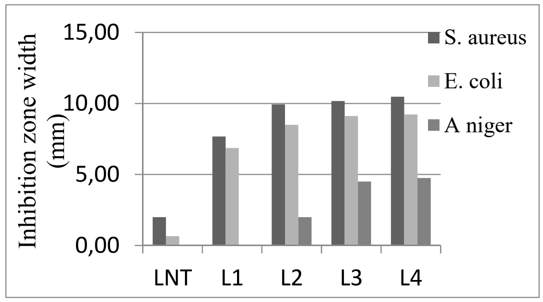

Figure 3: Treated samples Inhibition zone Variation

By comparing with the untreated sample, the results show an efficiency of the treatment against the bacteria S. Aureus and E. Coli, corroborated by significant inhibition halos. Indeed an important antifungal effect was observed. Compared to the untreated samples on which fungi has pushed on, There is no growth of A. niger on treated samples with 0.25% of IsysZnP. Moreover, Starting from a concentration of 0.5% (sample L2) of the IsysZnP product, treated sample can have a very good diffusion of the antibacterial activity on the nutrient agar (figure 2 and 3); a significant bacteriostatic activity can be deduced. These results prove that zinc pyrithione can be used to avoid fungi and bacteria proliferation on leather.

Table 1. Antimicrobial activity of leather treated samples against S. Aureus and E. coli

		Inhibition Halo (mm) ±0.1			Samples area covered with A. Niger
Sple	ZnP C%	S. aureus	E. coli	A. niger	
LNT	0	2,00	0,66	0	Macroscopic growth
L1	0,25	7,67	6,87	0	No growth
L2	0,5	9,93	8,55	2	No growth
L3	0,75	10,16	9,05	4,5	No growth
L4	1	10,48	9,77	4,75	No growth

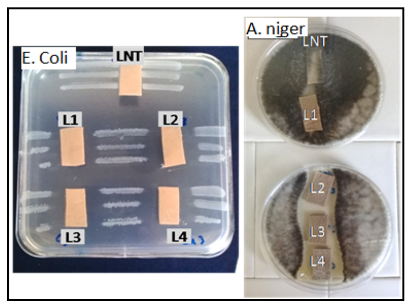

Figure 6 : Antimicrobial activity of leather treated against E Coli and A. niger

4. CONCLUSION

Leather treating by zinc pyrithione as a finishing step can offer efficient antimicrobial properties which are being increasingly demanded considering the development of microorganisms threating the human health. By this result we can say that zinc pyrithione can be used to obtain a final insole, which can be effective against microorganisms, in-vitro and in-situ modes, to improve human comfort.

Acknowlegments

Authors express their sincere thanks to the Ministry of Industry of Tunisia for the project funding.

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DESİGN PROCESS FOR TEXTİLE FACADES AND THE VARİOUS STAKEHOLDERS İNVOLVED İN THE PRODUCTİON

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Key Words: TEXTILE ENVELOPING, BUILDINGS ARCHITECT, DESIGNER, ENGENEER.

1. INTRODUCTION

Textile architecture is much more than the manufacture of high-quality weather protection systems and umbrellas. It is about linking technical knowledge with aesthetic understanding. Cladding a facade with a textile building envelope is often chosen in the context of renovation, conversion, or new construction. The curtain wall marries the building with an envelope and gives it an aesthetic side. In addition, the textile facades protect against the sun's rays and driving rain.

For several years now, the building envelope has been the subject of many studies centered on the challenges of energy saving and efficiency, above all for its function as a separating filter between the interior and the exterior, with specific performance requirements in terms of environmental comfort.

Also, textile fibers in architecture enable significant architectural innovations due to weight savings [1]. Today, major industrialists are studying new emerging uses of textiles in the building industry. Current trends include composite materials, filtration and indoor air quality, anti-ageing treatments for surfaces, and nanotechnology in coating.

This study aims to understand how the processes of designing textile materials intended for building envelopes develop and study the relationship between architects and designers and engineers to achieve contemporary architecture through the textile wrapping of buildings.

2. MATERIALS AND METHOD

The process of designing a textile facade involves several stakeholders, including architects, structural engineers, textile manufacturers and subcontractors for the installation of elements. First, the architects define the general design of the facade and its integration into the building, as well as the functionality expected from the facade. They work closely with the structural engineers to ensure that the facade meets the technical requirements for strength and stability. Next, textile manufacturers are involved in the detailed design of fabric and fasteners. They work closely with the architects to ensure the fabric meets design and performance specifications. Textile manufacturers must also consider manufacturing constraints and costs. Element installation subcontractors are involved from the start of the design process to ensure that element installation is carried out efficiently and safely. They work with architects and engineers to understand the technical details of the façade and the installation requirements. Finally, throughout the process, stakeholders work closely together to ensure that the design is feasible, efficient and meets performance requirements. Design iterations and adjustments are frequent to ensure that the façade meets the expectations of all stakeholders.

The role of the designer in the process of designing a textile facade can be very important. The designer can collaborate with the various stakeholders, such as architects, structural engineers, fabric manufacturers and installers, to create an aesthetic, functional and durable façade [2]. The designer can provide expertise in the choice of materials, coloring, patterns, and textures to meet the aesthetic needs of the project while respecting technical and budgetary constraints. Additionally, the designer can help solve design problems by providing creative solutions to meet performance requirements, such as resistance to heat, light, weather, and wear. They can also collaborate with stakeholders to ensure a seamless integration of the textile facade with the other architectural elements of the structure. In sum, the designer can play a crucial role in creating an effective and attractive textile facade, which meets the aesthetic and functional needs of the project, while ensuring the safety and durability of the structure.

3. RESULTS AND DISCUSSION

The design process for textile facades can vary depending on several factors, such as the type of building, the environmental context, manufacturing constraints, local regulations, safety standards and aesthetic requirements [3]. However, here are the general steps in the design process for textile facades:

- Project Analysis: This step involves understanding the client's needs, functional requirements, and design constraints. The designer must study the architectural plans and the existing design elements to ensure that the textile facade fits well into the overall design of the building.
- Site assessment: The designer must assess the site and the environmental context to identify potential challenges such as weather conditions, sun and wind exposure, noise and vibration that could affect the performance of the textile facade.
- Research and Development: This stage consists of researching appropriate materials, fastening systems and manufacturing techniques to meet the requirements of the project. Prototypes can be developed to test different solutions.
- Detailed Design: In this stage, the designer creates detailed drawings of the textile facade, integrating structural and functional details to ensure the design meets safety standards and aesthetic requirements.
- Prototyping: The prototypes make it possible to test the resistance of the materials and the durability of the structure of the textile facade.
- Manufacturing: Once the design is finalized, the textile facade panels can be manufactured and assembled in the factory, before being transported to site for installation.
- Installation: On-site installation of the textile facade can be carried out by specialized teams, who must ensure that the facade is correctly installed and secured.
- Maintenance: Maintenance of the textile facade is essential to ensure its durability and long-term performance. Maintenance teams must carry out regular inspections and repairs to ensure that the textile facade remains functional and aesthetic.

In each step, stakeholders such as architects, engineers, fabricators, installers, owners, and end users can have an important role in the design process. [4]

The synergy between the different stakeholders is essential to ensure the success of the design process of textile facades. Clear and regular communication between the architect, engineer, designer, fabricator, and client is crucial to ensure that all needs and expectations are considered. Sharing ideas and knowledge can lead to significant innovations and improvements in the design process. For example, the designer can propose aesthetic and functional solutions, the engineer can suggest resistant and durable materials, the architect can bring ideas for the integration of the facade in the building, and the manufacturer can propose practical solutions for fabrication and installation. In addition, the synergy between the different stakeholders can contribute to the efficiency of the process by avoiding errors and unnecessary delays, reducing costs, and ensuring the final quality of the product.

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VALORİZATİON OF POSİDONİA OCEANİCA, ALFA AND HEMP FİBERS AS THERMAL İNSULATİON AND ACOUSTİC ABSORBER PANELS

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Key Words: NONWOVEN, THERMAL INSULATION, ACOUSTIC ABSORPTION, NATURAL FIBERS.

1. INTRODUCTION

In a global context of reducing the damage caused using synthetic materials, sustainable resources emerge as one of the major challenges facing industrial players. The European Commission in 2017 reported that synthetic fibers represent about 75% of the total fiber market in Europe coupled principally with various decisive factors related to the well-prospering chemical sector, increased production in textile materials. For ecological reasons, effective strategies are constantly emerging with the aim of replacing synthetic products with biosourced fibers and derivatives due to their attractive characteristics, including availability, biodegradability, low cost[1]. *Posidonia Oceancia* is a flowering marine plant which is endemic to the Mediterranean Sea, covering a quasi-continuous area of the Mediterranean coasts locally interrupted at estuaries and ports. The dead leaves, most often lost in autumn, are transported by storms and can thus be found along the sandy coasts[2]. *Stipa tenacissima* is another plant that is a perennial grass of arid and semi-arid lands of North Africa and southern Spain. In Tunisia, the alfa plant is mainly present in the region of Kasserine and covers about 12,000,000 ha. Hemp is a bast fiber extracted from plants growing up to 1.2–4.5 m, mainly cultivated in Europe and Asia. In this work, the thermal performance of *Posidonia Oceanica* and *Stipa tenacissima* were established in comparison with hemp fibers by investigating their thermal conductivity for different density ranges. The influence of opertaing temperature and humidity conditions on the thermal conductivity of the panels are studied. The acoustic characteristics of the developped panels are also investigated.

2. Materials and Methods

Three types of non-woven panels were developed in this work using Airlaid technology, consisting of posidonia Oceanica, hemp and alfa fibers mixed with 10 wt% of (PE)/(PET core) bi-component fibers. The steady-state thermal conductivity for the three types of panels was determined on 300×300 mm² according to NF EN 12667. Thermal conductivity is firstly measured at respective cold and hot plate temperatures of 0°C and 20°C to ensure an average temperature of 10°C, then at 10°C and 30°C to obtain an average temperature of 20°C. Sound absorption coefficient measurements were performed using the impedance tube. The porcedure described in ASTM E 1050 standard was used jointly with the three-microphone one/two-cavity method.

3. Results and Discussion

The results showed that the thermal conductivity was lower at 10°C (Figure 1). The variations were estimated to be 3 % for posidonia, for esparto 0.8 % and 2.6 % for hemp.

The results also showed that the thermal conductivity of wet panels (23°C and 50% RH) increased by 2.8% for posidonia, 5.3% for hemp and 7.2% for alfa panels, compared to those obtained on dried panels at 70°C.

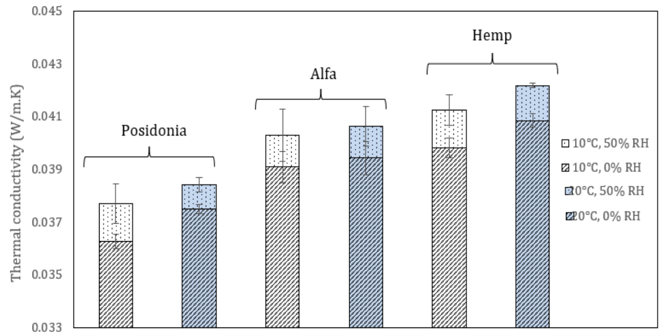

Figure 7. Thermal conductivity as function of bulk density

Figure 2 compares the sound absorption coefficients of the three non-woven samples of 40 mm thickness. It can be noticed that the three materials act as effective sound absorbers. The sound absorption coefficient of hemp and posidonia panels were similar across the frequency range and tend to be high above 1050 Hz, where the sound absorption coeficient typically exceed 0.8. These results were higher than those obtained for alfa panel notably at frequencies above 2000 Hz.

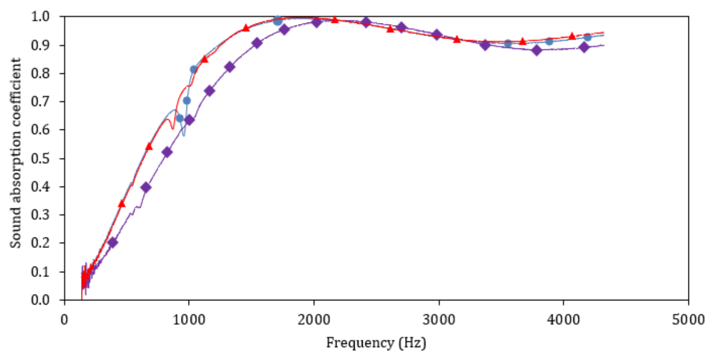

Figure 8. Sound absorption coefficient of the panels. Posidonia hemp alfa

4. Conclusion

The current paper presented the results of an experimental study on the use of abundant posidonia, alfa and hemp fibers to develop airlaid thermal insulation panels. The panels presented thermal conductivity values in the same range as those of commercial mineral wool insulation products and lower than those of most of natural insulation products like cork, kenaf and wood fiber boards. Impedance tube measurements confirmed their effectiveness as sound absorbers. Thus, the valorization of biosourced posidonia, alfa and hemp fibers into airlaid non-woven panels would represent a viable alternative for the subsitituion of synthetic sound absorption materials.

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DESİGN OF DURABLE AND COMFORTABLE META-TEXTİLE FOR FUNCTİONAL APPLİCATİONS

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Key Words: woven fabrics, meta-materials, wearable textile, Confort, Durability, User experience.

1. INTRODUCTION

By utilizing multilayer textiles, it is possible to create meta-textile [1]. The commonly employed conventional structure has three layers, which is similar to the structure found in typical electronic printed circuit board substrates [2]. To create the corresponding textile version, a fabric support with conductive patches is required along with an intermediate textile substrate [3]. Finally, conductive yarns are woven into the conductive layer, as a ground layer is typically necessary. The second layer is the textile substrate whose dielectric properties are crucial to the meta-textile performance. Moving to the first layer containing conductive patches, the unit cells have the capability to turn the textile into an electromagnetic metamaterial [4]l. This special material is necessary for absorbing various microwaves and shielding the human body [5]. Careful analysis and research are necessary to optimize meta-textile performance.

Meta-textile integration has seen the greatest advancements in embroidery and printing, with woven techniques falling behind in exploration [6] [7]. To achieve a comfortable and effective means of protecting the human body from microwaves, a meta-textile has been woven utilizing the woven technique and cross patches. By analyzing various properties of comfort, this meta-textile has achieved an optimal user experience. Specifically, the use of cross patches makes for an ideal shape to absorb waves, thus providing a superior means of protection. In order to test the durability of the textile substrate and confirm its comfort properties, the meta-textile was subjected to various tests.

2. MATERIALS AND METHODS

In order to solve the problem of electromagnetic waves, a technological textile design intervention has been implemented. This innovation consists of the creation of a new type of intelligent textile, known as barrier effect meta-textile which woven with cotton and polyester. Designed to safely protect the human body from electromagnetic waves, this futuristic material accompanies our body.

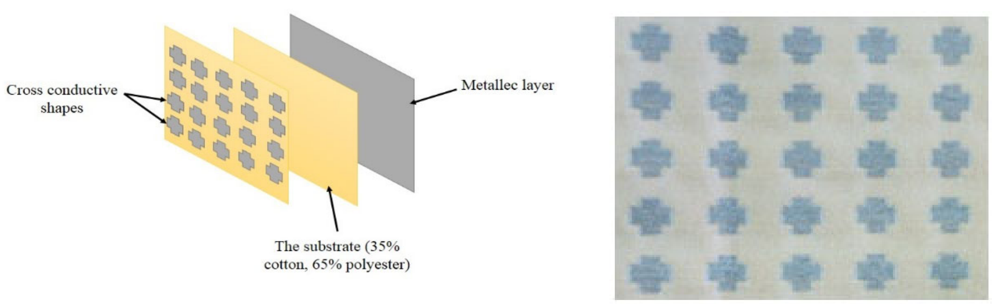

Figure 1. The different layers of the proposed meta-textile with cross patches

However, before anything else, it is imperative to take into account the adaptable textile properties to make a wise choice. Indeed, the comfort and satisfaction of the user depend on the response of the fabric to the expectations concerning electromagnetic waves. Particular criteria lead to a pleasant comfortable experience when it comes to protective fabrics and all that is associated with this term.

The resistant and flexible fabrics bring undeniable comfort. You can bend over, and move around for a while without the garments resisting and you can also enjoy a sweater that follows your arm movements perfectly. To achieve this level of resistance, the substrates are tested and the amount of fabric required for these tests is consequently greater. Approximately two additional meters of fabric are required for the tensile and tear tests while four meters are required for the slip tests. The total length of fabric required is therefore approximately seven meters.

Table 1. Different test of durability of the meta-textile

Test	Standard	Size of Specimens	Number of specimens For 1 fabric
Tensile	UNE-EN ISO 13934-1 : 2013	300 mm x 60 mm	5 specimens warps and 5 specimens wefts
Tear	UNE-EN ISO 13937-2 : 2000	200 mm x 50 mm	5 specimens warps and 5 specimens wefts
Seam slippage	UNE-EN ISO 13936-2 : 2004	100 mm x 400 mm	12 specimens warps and 12 spécimens wefts
Abrasion and pilling	UNE-EN ISO 12945-2 : 2021	-	-

3. RESULTS AND DISCUSSION

On the warp direction, the fabrics had a maximum breaking force of 1348 N, while on the weft direction, it was 1891 N. The fabrics that were created had an average weight of 353 g/m2. Their bending stress was measured to be 2351 mg/cm. Additionally, the recovery crease angle was 94° on the warp direction and 74° on the weft direction.
Using a Shirley stiffness meter, we performed tests on the fabrics' basic textile properties including bending, recovery from creasing, and tensile. Determination of the bending rigidity (S) was done on both the warp and weft directions. The equation (1) defines the bending rigidity of either the warp or weft directions.

$$S_{warp,weft} = mc^3_{warp,weft} \qquad (1)$$

The fabric weight is represented by m, while the bending length is measured in the warp or weft direction with c as its symbol.
Calculated from Eq. (2) is the fabric's bending rigidity.

$$S=\sqrt{S_{warp}\times S_{weft}} \qquad (2)$$

The measuring of the recovery angle (α) was done according to UNE-EN 22313 in order to determine the recovery from creasing of a specimen horizontally folded and loaded with 1 kg for 5 min.

4. Conclusion

From bedding to clothing, a range of products can be made from versatile cotton and polyester blends. This blend is easier to wash and dry than cotton because polyester does not shrink or warp.
Because of its cotton composition, a polyester and cotton blend of clothing presents a more breathable option compared to pure polyester clothing.
Absorbency, high abrasion resistance, excellent colorfastness and ease of care come from the polyester/cotton blend.

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DEVELOPMENT OF A MULTİFONCTİONNEL WET LAİD NONWOVEN FROM WASHİNTOGNİA PALM FİBER AND CMC BİNDER

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ABSTRACT: Washintognia palm fiber was used to produce a wet-laid nonwoven web for multifunction applications. To study the effect of some parameters related to the web characteristics (sheet weight, binder ratio) on the mechanical and physical properties of the web, we used a factorial design plan with two levels. The diagram of the superposed contours graphic method was used to find the optimum parameters of the process for the application of the palm nonwoven. The wetlaid nonwoven obtained according to the optimal manufacturing process showed good tensile strength as well as good air permeability linked to the high porosity which was manifested in its SEM images.

KEYWORDS: Washingtonia palm fiber, nonwoven fabric, wetlaid, factory design.

1. INTRODUCTION

Fibers and vegetal materials are increasingly considered, given that they are light, flexible, inexpensive, abundant, and biodegradable.
There is a myriad of literature related to the possibility of using natural fiber in many technical applications. Cotton, hemp, flax, kenaf, agave, halfa, and other natural fibers show a good potential to be used as insulation materials and as reinforcement materials for composites [1].
In the present work, a wet laid nonwoven was synthesized from washintognia palm fiber. An industrial process was developed to obtain palm fiber using a mechanical and chemical device. Nonwoven were manufactured using a laboratory “sheet maker” (figure1). The nonwovens were prepared by mixing technical palm fibers and a Carboxy-Methyl-Cellulose (CMC) binder in appropriate ratios.
To study the effect of some parameters related to the web characteristics (sheet weight and binder ratio) on the mechanical and physical properties of the web, we used a factorial experimental design plan with three levels. The diagram of the superposed contours graphic method was used to find the optimum parameters of the process for the application of the washintognia palm nonwoven fiber on field of agrotextile [3].

2. Materials and methods

2.1. Development of the wetlaid nonwoven fabric from Washintogbia palm fiber

The principle of obtaining wet nonwovens in this case is very similar to the principle of fabricating paper. The materials used are Washingtonia palm technical fibers and a CMC binder.
The characteristics of the washintognia technical palm fibers are an average diameter of 128 µm and an average length of 5 mm. The carboxymethylcellulose (CMC) binder used in our case has a chemical formula of $C_6H_7O_2(OH)_2CH_2COONa$, a molecular weight of 263.1976 g/mol, and a degree of substitution of 1. CMC is an environmentally friendly polymer material. The nonwoven produced can be considered as a bioproduct.
The manufacturing process for nonwovens comprises the following four steps:

- First step: preparation of aqueous suspension
- Second step: forming the sheet
- Third step: dewatering
- Fourth step: drying

The manufacture of the nonwoven fabrics was carried out using an automatic "Sheet Maker" machine.

The fibrous suspensions were prepared in a 50 L capacity reservoir (mixing cylinder), which makes it possible to have a homogeneous suspension by agitation of the mixture (water-fibres).
In our case we used M (g) of fibre mixture of dry Palm techniques and its paste which were suspended in 20 L of water. The basis weight of the formed sheet is given by the following formula:

$$M = 0,02657 \times G \times V \qquad (1)$$

With:
M = the mass of the material in g;
G = the desired basis weight of the sheet formed in $g.m^{-1}$
V = the volume of water to be added to the tank in L.
The formation of the sheet consists of transferring a volume of 1 L of fibrous suspension from mixing cylinder to the metering device (or doser). Then the above suspension is delivered to the subsequent stage "formation column of the sail" in a controlled and dosed manner; the suspension distribution is carried out on a metallic sieve.
To separate the fibers from the water which bathes them, it is necessary to aspirate it under the fabric by suction systems. This machine is equipped with suction nozzles located underneath the sieve which ensure the suction of the residual water. Thereafter the nonwovens are sent to dry. Indeed, we have fixed the nonwovens obtained between two plates and we put them in the oven for one hour at a temperature of 105 °C.

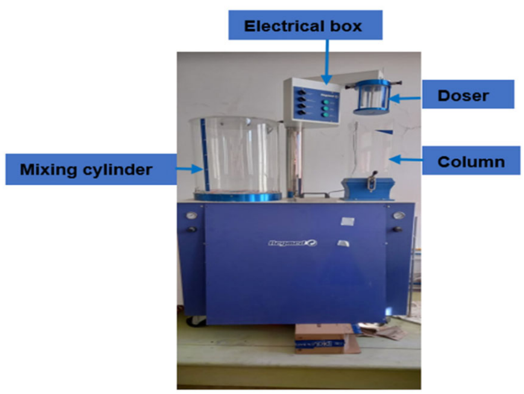

Figure 1: Wet nonwoven machine: Sheet Maker

After drying, the nonwovens are immersed in a CMC binder solution with a well-defined concentration. Thereafter, these nonwovens were dried at room temperature and thereafter subjected to a certain pressure by means of a forming press at a temperature of 150 ° C for 90 seconds. The obtained samples of nonwovens are shown in figure 2.

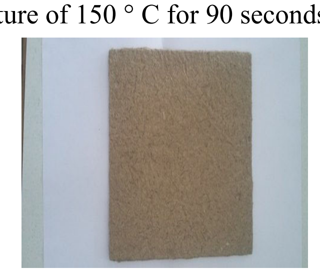

Figure 2: Wet laid nonwoven Washingtonia palm fiber

Thickness, air permeability and tensile strength were measured for the fabricated samples. The determination of the thickness is carried out on the basis of the French standard NFG07-153. Its principle is to apply a constant

and normal pressure to the surface of the fabric between a circular presser foot with a cross-section of 25 cm^2 and a horizontal reference plate.
The principle of the method used for the determination of air permeability consists in measuring an air flow passing perpendicularly through the test surface of a test piece with a defined differential pressure for a given time. Air permeability is an important parameter that directly influences the end use of the nonwoven fabric. This property, expressed in (L / m 2 / s), was measured using a TEXTEST FX 3300 air permeability tester and according to ISO 9237.
In order to determine tensile strength of nonwovens, tensile tests were conducted on rectangular shaped samples (150mm × 50mm) using a Lloyd Instrument Mers LR 5K dynamometer. These tests were performed according to standard NFG 07-119. The length between clamps was taken at 100 mm and the speed was set at 100 mm / min.

2.2. Design of Experiments

The nonwoven wet-laid properties were affected by many factors [2]. To study the effect of the web characteristics on the strength and on the physical and mechanical properties of the nonwoven, we used a factorial experimental plan with 2 factors and a total of 9 experiments**.** [4] We opted to vary two factors which are:
1. Sheet weight (g/m2);
2. Percentage of binder (%);
Tables 1 shows the levels of different factors and values obtained for the independent variables in the 9 tests required to construct the model.

Table 1: levels of the factory design

Factors	1	2	3
Sheet weight (g/m2)	30	60	90
Percentage of binder (%)	1	2	3

3. Results and discussions

The following table 2 illustrates the results of measurements of different characteristics of the nonwovens manufactured.

Table 2: Values of the different variables

nonwoven	thickness(mm)	Air Permeability (L. m-2. s-1)	Strength at Break(N)	Elongation (%)
1	1,5	309	13,45	2,3
2	1,57	428	7,41	2,48
3	1,55	441	12,86	3,63
4	1,42	430	11,33	2,1
5	2,05	345	19,2	3,05
6	1,57	313	24,27	2,76
7	1,95	275	15,87	2,17
8	1,63	313	21,65	2,5
9	2,26	214	23,6	3,04

3.1. Influence of Control Factors on the Properties of the Nonwovens Studied

Figure 2 shows that the thickness of the nonwoven produced increases with the increase in weight of the sheet formed. We notice that the thickness is slightly influences by the percentage of the binder. This can be explained by the fact that the binder served as a binding agent in the nonwoven structure of its main constituents which is the palm fiber by causing swelling or notable thickness.

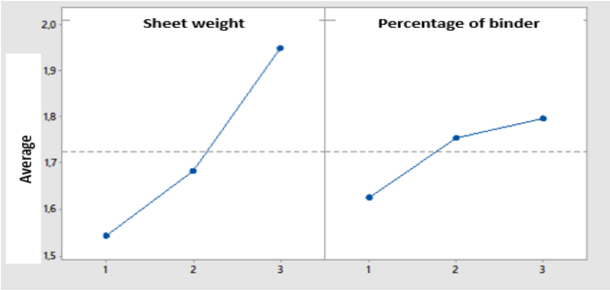

Figure 2: Main effects plot for thickness

As shown in Figure 3, nonwovens become more and more impermeable to air while increasing the sheet weight. This impermeability increases with the addition of the binder. In fact, the air permeability of nonwovens decreases by 370 L.m^{1}s^{-1} up to 300 L. m^{-1}. s^{-1} by going from 2 to 3% of the binder. In fact, the binder improves the connection between the fibers in the structure and therefore it becomes more compact and therefore the impermeability increases.

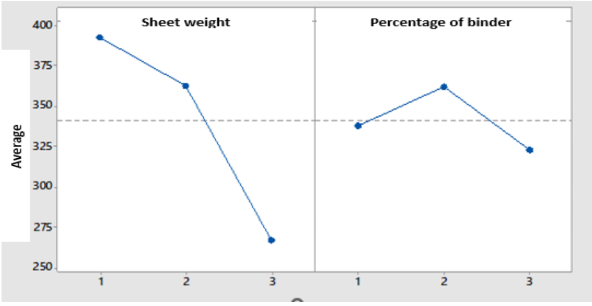

Figure 3: Main effects plot for air permeability

According to Figure 4 and 5, we see that the evolution of the mechanical properties of the nonwovens manufactured differs from one factor to another. Indeed, the breaking strength is strongly influenced by the weight of the sheet as well as the percentage of binder.

Thus, as the sheet weight increases, the tensile strength of the nonwovens increases. This increase is very pronounced going from 30 to 60 g/m². This is attributed to the denser structure. Indeed, as the weight of the sheets forming the non-woven increases, there is a significant number of fibers which contribute to the breaking stress.

In addition, we notice that by increasing the percentage of binder, the structure of the nonwovens is maintained more and more, hence the increase in the tensile strength of these materials. This property has a threshold value of approximately 24 N for a binder percentage of 3%.

For elongation, we note that the elongation of these materials is very low and does not exceed 3%. By increasing the weight of the sheets constituting the nonwovens, the breaking elongation of these materials decreases. This can be attributed to the increase in friction between the fibers constituting the nonwoven following the increase in their quantity in the material. The elongation increases as a function of the percentage of binder as the structure becomes more compact and the binder slows down rupture and improves deformation.

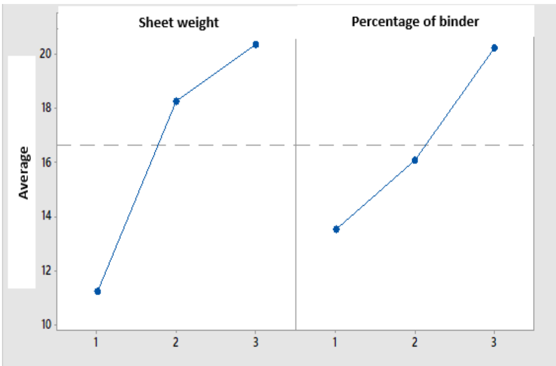

Figure 4: Main effects plot for strength break

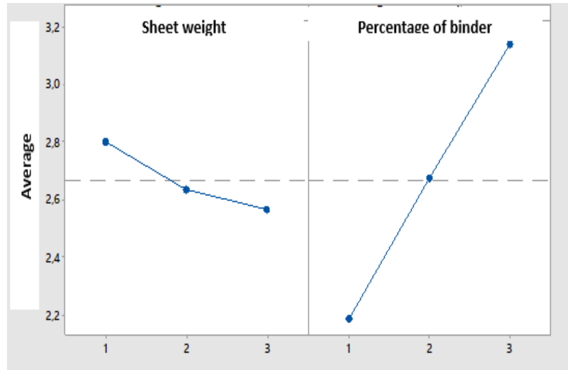

Figure 5: Main effects plot for elongation

3.2. Optimization of the Nonwoven Manufacturing Process Using the Graphic Method for a specific application

Since the nonwoven produced can be used in many fields with different types of performance required, we must select an application and then optimize the parameters of the manufacturing processes. From our bibliographic research, nonwovens based on natural fibers manufactured by wet process can be used field of agrotextiles. [5]

Thus, we adopted the superimposed contour diagram method to determine the optimal case. The principle of this graphical method consists of giving for each answer an objective and an acceptance zone.

Table 3: objective and limits of controlled properties

	Objective	Minimum	Maximum
thickness(mm)	Minimize	1,4	2
Air Permeability (L. m-2. s-1)	Maximize	313	441
Strength at Break (N)	Maximize	15,87	24,27
Elongation (%)	Maximize	2,76	3,63

This diagram of the superimposed contours was produced using the MINITAB software [6]. This made it possible to draw the different contours of each studied parameter and to parameter and to implement a compromise zone where each point validates the optimal. Therefore, the choice of the optimal condition was made in this white area, as shown in the diagram. From the diagram in Figure, we chose:

- Sheet weight: 60 g/m^2
- Percentage of binder: 2.25 %

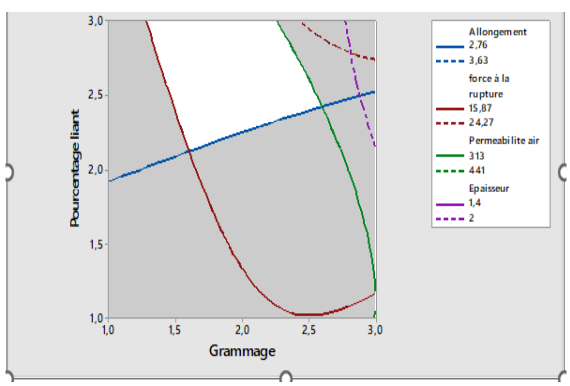

Figure 5: Diagram of the superposed contours

3.3. Characterization of nonwoven obtained under optimal manufactured conditions

By proceeding under optimal manufacturing conditions, nonwovens were produced. Subsequently, the different characteristics of these new materials were determined according to the standards, and they are illustrated in Table 4.

Table 4: Properties of optimal nonwoven

Properties	Optimal
thickness(mm)	1,5
Air Permeability(L. m-2. s-1)	420
Strength at Break(N)	23,96
Elongation (%)	2,45

We examined the wet-laid nonwoven obtained by the optimal process using a JEOL JSM-5400 electron scanning microscope. From SEM micrographics figure 6, we note that the fibers inside the web are distributed with good uniformity. It is a good isotropic arrangement, regular and not very porous.

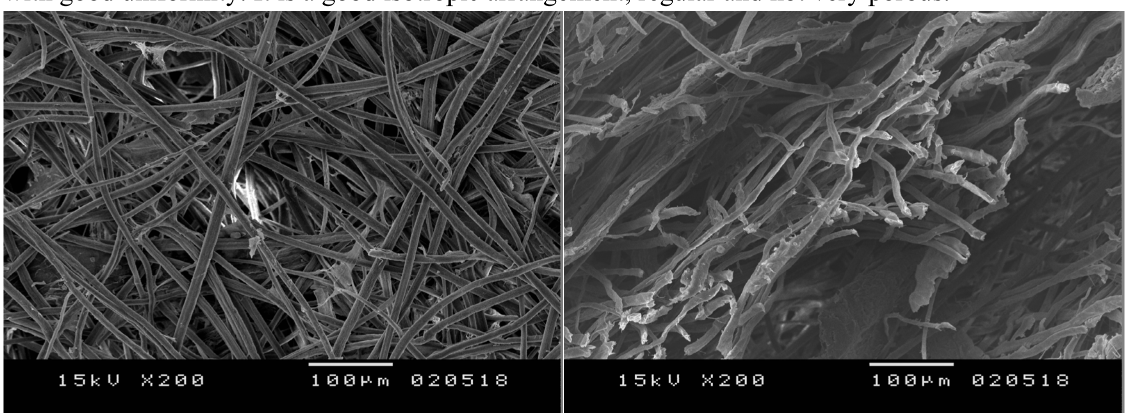

Figure 6: SEM micrographics of wet-laid optimal nonwoven

4. Conclusion

The wetlaid nonwoven obtained according to the optimal manufacturing process showed good tensile strength (23,96N) as well as good air permeability (420 L. m^{-2}. s^{-1}) linked to the high porosity which was manifested in its SEM images which allows us to say that we can apply this nonwoven in the field of agrotextiles.

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UNİAXİAL TENSİLE PROPERTİES OF DORLASTAN® CORE SPUN YARNS: EFFECTS OF YARN COUNT, DORLASTAN® DRAFT, AND DORLASTAN® LİNEAR DENSİTY ON THE SHAPE OF STRESS-STRAİN CURVES.

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Key Words: Elastic core-spun yarn; tensile curves, Dorlastan® draft, yarn count, chord method.

1. INTRODUCTION

The behaviour of the tensile curve of elastic core spun yarns is not only a function of the nature and structural arrangement of the constituent fibers in yarn. Nevertheless, the variations of the yarn count, the elastane count, and the elastane draft also play a key role in defining the characteristics of the tensile curves of the elastic core spun yarns. Therefore, this study aims to distinguish different zones of the tensile curves of elastic core-spun yarns using the chord method and to predict the effect of the yarns' count, Dorlastan® count, and Dorlastan® draft on the different zones of stress-strain curves of the elastic core-spun yarn. Yarn samples were prepared on industrial-scale spinning machines having different counts (100, 50, 33.33, and 25 tex), three different counts of elastane filaments (156, 78, and 44 dtex), and various elastane drafts are considered in this study.

2. MATERIALS AND METHODS

In this investigation, Dorlastan® filament is used as the core, and cotton fibers are used as the covering material. Dorlastan® counts 156, 78, and 44 dtex were used as core respectively with 100, 50, 33.33, and 25tex sheath cotton yarn counts to produce Dorlastan®core spun yarns designated by 100/156, 50/78, 33,33/78, 33,33/44 and 25/44. The Dorlastan® draft values used in this study are given in Table 1.

Table 1. Different ratios, and draft values used.

100			50			33.33			25		
Dorlastan® count(dtex)	%	Draft	Dorlastan® count(dtex)	%	Draft	Dorlastan® count(dtex)	%	Draft	Dorlastan® count(dtex)	%	Draft
	4.0	3.90		4.0	3.90		4.0	3.30		4	4.40
	4.5	3.47		4.5	3.47	44	4.5	2.93		4.5	3.91
	5.0	3.12		5.0	3.12		5.0	2.64		5	3.52
	5.5	2.84		5.5	2.84		5.5	2.40		5.5	3.20
156	6.0	2.60	78	6.0	2.60		6.0	3.90	44	6	2.93
	6.5	2.40		6.5	2.40	78	6.5	3.60		6.5	2.71
	7.0	2.23		7.0	2.23		7.0	3.34		7	2.51
	7.5	2.08		7.5	2.08		7.5	3.12		7.5	2.35

The manufactured core spun yarns are subjected to a tensile test. The tensile properties of the Dorlastan® core spun yarn was tested using a Lloyd-type dynamometer. To obtain reproducible results, specific pretension values for the elastic core spun yarns are used [1].

The chord method is used to distinguish different zones of the shape of stress-strain curves of Dorlastan® core-spun yarns. Furthermore, to assess the effect of the Dorlastan® draft, the Dorlastan® linear density, and the yarn count on different zones of the stress-strain curves, the variation of the difference between the extreme points of each zone in terms of elongation and strength is calculated. ΔF and ΔE which represent respectively the variation of the difference between the strength and elongation limiting each zone of the stress-strain curves are also calculated [2].

3. RESULTS AND DISCUSSION

The chord method [2] is used to determine different zones of the tensile curves of yarns 100/156, 50/78, 33.33/44, 33.33/78, and 25/44 within various Dorlastan® drafts. The curve derived from the tenacity compared to deformation, according to deformation of the yarn 100/156 with Dorlastan® draft equal to 3.47, is presented in Figure 1.

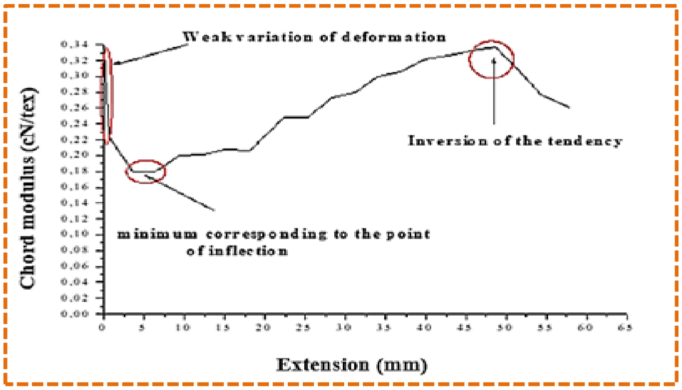

Figure 1. The Chord modulus method applied for the yarn 100/156 (Dorlastan® draft = 3.47)

The obtained findings revealed the decreasing trend of the difference between the extreme points of the elastic zone in terms of elongation and strength for all yarn counts. Furthermore, the results showed a growing trend of the viscoelastic and viscoelastoplastic part on the shape of the stress-strain curves of the yarns 100/156, 50/78, and 25/44 while the Dorlastan® draft increases and at the same time the yarn count increases. For yarns 33.33/78 and 33.33/25, the results highlight the effect of the Dorlastan count.
The statistical analysis revealed that the yarn count and the Dorlastan® draft had almost significance on the full course of the stress-strain curves of the elastic core spun yarn. This study will be an endeavor for industry personnel to achieve more durable and dimensionally stable denim fabrics.

4 CONCLUSION

Regarding the earlier studies related to this topic in the literature, in the present work, we particularly used the chord method to distinguish different zones of the stress-strain curve. This method allows us to analyze the full course of the tensile curve of the elastic core spun yarn contrary to other methods that use for example the method of Meridith [3] or Coplan's construction to determine only the yield point and the breaking elongation or tenacity of yarn. Nevertheless, in this study, the approach is different, since a variation of the difference between the strength and elongation limiting respectively elastic zone, viscoelastic zone, and viscoelastoplastic zone of the stress-strain curves are also calculated.

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STUDY OF ABSOLUTE HUMIDITY ON A TEXTILE TRIBOELECTRIC GENERATOR

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Key Words: TRIBOELECTRICITY, TRIBOELECTRIC GENERATOR, HUMIDITY, TEXTILES

1. INTRODUCTION

Triboelectricity is a phenomenon when two uncharged surfaces are brought into contact or they are rubbed and then separated, they become charged [1]. Based on the triboelectricity effect, a lot of research has been carried out over the last decades to harvest electrical energy by developing novel devices named as Tribo Electric Generators (TEGs) and lately as Tribo Elecrtic Nano Generators (TENGs). A TEG is a device that mainly harvests energy that converts the external mechanical energy into electricity, combining the triboelectric effect and the electrostatic induction, by making use of various set-up modes [1, 2].

Energy harvesting of a TEG using triboelectricity has gained great attention over the last years, because of the power that is needed for the wearable electronics, e-textiles and sensors in order to operate [3]. In addition, textile based TEGs are advantageous due to their large contact areas and the fact that the wearer can be in continuous movement and in contact to the textile garment. Also, the wide variety of textiles offer many properties such as elasticity, flexibility, conductivity, breathability and washability that make them easily compatible with TEGs. At the present work we investigate the effect of the absolute humidity (AH) at the performance of a textile based TEG device which combines vertical and sliding modes, similar to a part of a wearable garment.

2. MATERIALS AND METHODS

The experimental setup is shown in Figure 1. It is a prototype TEG that is developed to measure the triboelectric effect on a variety of textile samples. It consists of a tapping unit which brings the samples into contact, two flat electrodes where the samples are attached on them, and a force sensor that measures the applied load among the samples during the contact. Due to a special designed 3D arm, the movement of upper sample towards the lower one follows an elliptical motion, which corresponds to the contact between the samples, their sliding and finally their separation. Therefore, it is similar to the motion of a textile based TEG which could be embedded in the moving parts of a real-life wearable garment. 20 grf load was applied when the two samples are sliding at each other [4, 5]. External conditions such as temperature and the relative humidity were controlled via an air-conditioning system. Relative humidity and temperature were measured by two calibrated high precision sensor hydrometers. A set of textile samples (5cm x 5cm) were prepared for triboelectric measurements. Para-aramid was attached at the lower electrode and used as a reference sample. At the upper electrode, 5 different samples were attached which had the same structural characteristics (linear density and jersey pattern) and different raw material such as acrylic, polyester (PES), cotton, wool and modal. In Figure 2 (a) and (b) are illustrated the front and back side of a polyester (PES) yarn knitted sample. A typical electrical measurement which includes the contact of the samples, their sliding and finally their separation, is shown in Figure 3, as appeared on the screen of the oscilloscope.

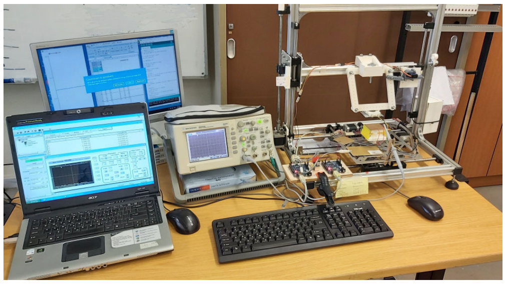

Figure 1. Experimental setup

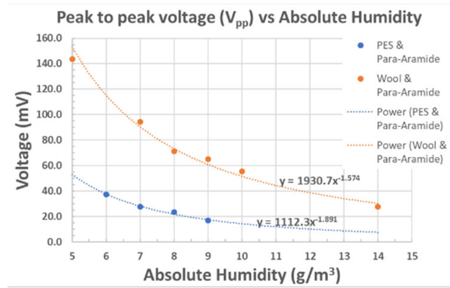

Figure 4. Average peak to peak outcome voltage versus absolute humidity for two sets of samples

Figure 3. Typical voltage peaks during a measurement loop

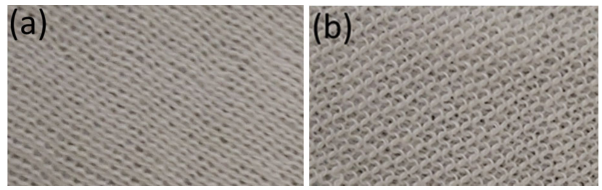

Figure 2. (a) Front side and (b) back side of polyester (PES) yarn knitted sample

3. RESULTS AND DISCUSSION

In Figure 4 is presented the measured Voltage (peak to peak) versus the change at the absolute humidity for two set of samples, polyester (PES) and para-Aramid and wool and para-Aramid. Absolute humidity was calculated using Equation (1) via the measured relative humidity RH [6], where T is in ^{0}C.

$$\boldsymbol{AH} = \frac{\mathbf{13.253 \text{ x } \boldsymbol{RH} \text{ x } 10}^{\left(\frac{7.591\,T}{T+240.726}\right)}}{\boldsymbol{T}+\mathbf{273.15}} \qquad (1)$$

It is observed that the outcome V_{pp} is decreasing as the absolute humidity is increasing for both set of samples. The decrease is more abrupt at lower AH values and smoother for higher AH values. In addition, a power-law dependence was observed revealing a similar trend between PES and para-Aramid and wool and para-Aramid samples. The higher voltage values between wool and para-Aramid are due to the structural characteristics of wool.

4. CONCLUSION

The effect of absolute humidity with respect to the triboelectric phenomenon via a textile TEG was studied. It is concluded that by increasing the AH the outcome voltage is decreasing for all set of samples, as expected.

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IN VITRO PERFORMANCE OF A BIOMEDICAL TEXTILE TREATED WITH NITOGEN N_2 JET TECHNOLOGY

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Key Words: PET; medical application; surface modification; N2 supercritical jet; surface topography, in vitro tests

1. INTRODUCTION

Over the last decades, polyethylene terephthalate (PET) has been largely used for the manufacturing of synthetic textile biomaterials such as sutures, vascular grafts, stents or hernia meshes thanks to its good mechanical properties and its biocompatibility [1]. Whatever the application which is considered, the natural porosity of textile materials tends to cause exaggerated tissue development after implantation. This mechanism, identified as the Foreigh Body Reaction (FBR), can prevent the implant from remaining flexible, which is a critical limitation especially in the heart valve application. FBR is accompanied by the development of fibrous cellular tissue (fibrosis) and the formation of calcifications that eventually stiffen the porous material, which impedes the movement of the implant. Hence, it is interesting from a clinical perspective to minotor this process [2]. The FBR mechanism seems to be considerably affected by the surface features of the implanted material (hydrophilicity, roughness, porosity, etc..). In particular, it has been proven that the development of the fibroblast tissue relies on the properties of the textile pores of a surface and on the topography of the yarns used to manufacture the textile [3]. One approach to restrict fibroblast proliferation and textile stiffening is to raise the roughness of the textile surface.
For this topic, a mechanical surface treatment was used to modify the surface roughness by including plastic deformation with particle jetting which is the supercritical N2 jetting technique by studying the supercritical N2 jetting parameters such as static jetting pressure, standoff distance (SoD), particle size and density on the roughness that can be obtained on medical woven textile surfaces [4]. The results show that the particles generate a layer of frayed fibers on the textile surface, which increases in correlation with jet pressure and SoD.

2. MATRIALS AND METHODS

The process consists in spraying a cold and dry flow of small size particles at textile yarn scale (down to 50 nm) embedded in a high-speed and high pressure (up to 3500 bars), as detailed in our previous work [5]. Corundum abrasive particles were considered to treat the surface of the textile material. Actually, these particles present the advantage of being characterized by a sharp edge angular geometry. This specific shape is expected to locally cut the individual filaments involved in the fibrous construction in order to create hairiness.
The material used in this work was plain weave fabric obtained from multifilament material. The size of the treated samples was 34mm × 40 mm. In order to assess the impact of the fabric tightness of the textile on the results 2 weft densities were considered 34 yarns/cm and 28 yarns/cm.

3. RESULTS AND DISCUSSION

Influence of the jet pressure on surface topography

Results show that the hairiness of the fabric increases with the pressure whatever the fabric which is considered. When the flow rate is 0.6 g/s and the SOD is 400 mm and when the pressure varies from 900 to 1300 bars, the hairiness level can be defined by 3 levels, as showed in table 1.

In fact, when the value of the pressure raises, the velocity of the jet also raises and delivers more kinetic energy to the particle. This is converted into cutting energy as the sharp edges of a particle strike some of the individual filaments involved in the construction of the tissue substrate. The cut filaments are frayed and contribute to the obtained hairiness of the surface.

Table1. Surface Roughness measures

	Control Samples	P 900	P 1100	P1300
P_{34}	3.05	3.35	3.75	4.18
P_{28}	2.58	2.87	3.75	5.61

Biological tests

Cryopreserved human mesenchymal stem cells (MSCs) were derived from a sternal bone marrow aspiration of a healthy donors. MSCs represent a relevant in-vitro cell model because they resemble fibroblasts, have a strong adhesion capacity and are proliferating cells. To prevent tear of the textile, which can play a role in adhesion and proliferation of cells, discs of 14 mm diameter matching the diameter of 24 multi-wells culture plate were cut with an ultra sound gun allowing the formation of soft edges.

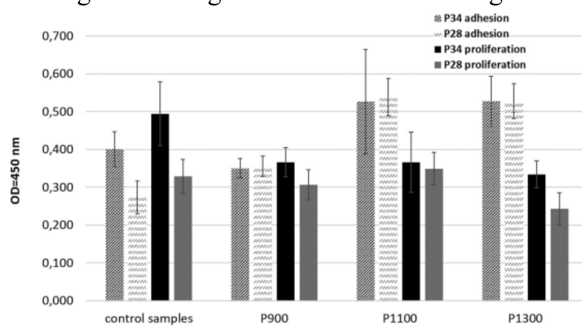

Figure 1: MSC's adhesion and proliferation

Results presented in Figure 1 compare the absorbance rate for P34 and P28 fabric samples under several treatment pressure conditions, and bring out how influent the treatment is on both the cell adhesion and proliferation. Several observations can be made. First, results show that the cell adhesion increases in a significant way (by up to 30%) after treatment at 1100 bars (the absorbance value goes from 0.4 to 0.53 for P34 and from 0.28 to 0.54 for P28). Actually, the increase in hairiness generated by the particles impact at 1100 bars offers more surface area for cells to fix on the sample material. This confirms the initial assumption regarding the effect of hairiness on the proliferation of cells. Actually, when hairiness is created, some distance is created between 2 neighbor hairs, generating some voids on the surface of the textile.

4. CONCLUSION

The objective of this research was to investigate the potential of a mechanical surface treatment technique to increase the hairiness of multifilament textile materials dedicated to medical applications. The hairiness is expected to limit fibrotic tissue proliferation on the uneven surface topography.

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EVALUATİON OF THE PERFORMANCE OF THE ELASTİC BAND USED ON STRETCH FABRİCS

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Key Words: Elastic band, denim fabric, shrinkage, relaxation test, sewing methods

1. INTRODUCTION

Elastic bands are widely used in manufacturing textile products, and such textiles have been well received by the market as they present excellent elongation and recovery properties. The elastic band is a flexible, stretchable, narrow fabric. It serves to increase the ability of the garment to stretch, either to accommodate movement or to make the garment suitable for wearers of many different physical sizes. Thus, the most important property of elastic bands is their ability to undergo large elastic deformations, that is, to stretch and return to their original shape in a reversible way [1]. The elastic band can be threaded through casings or stitched directly to the fabric. It can undergo some finishing treatments such as washing, and dyeing. Thus the sewing conditions of the elastic band on the fabric and the washing treatment can affect enormously the performance of the elastic bands and consequently the end product. Therefore, this study aims to select the best suitable combination of denim washing treatment and methods of attaching the elastic band to the fabric according to the shrinkage of the elastic band.

2. MATERIALS AND METHODS

In this investigation, two types of knitted elastic bands designated by YT28143 and YT28016 were used, and attaching elastic to two types of denim fabrics (F1 and F2) where done by three methods: (the first method: stitching elastic band and folding, the second method: stitching elastic band, folding and topstitching and the third method: sewing with waistband attaching machine). After that, fabrics were subject to five washing treatments (simple wash, medium wash, deep wash, bleach wash, and cationic dye) Thus, four input parameters were analyzed to evaluate their impact on the shrinkage of the elastic band. Each parameter has levels that define the experimental limits. İn order to objectively investigate these input parameters, a complete factorial experimental design of type 3x5x2x2 was used. The length variation of the samples was saved before and after the attachment of the elastic band to the denim fabric and before and after denim washing treatments. Consequently, the shrinkage ratio was calculated.
The elastic band characteristics are given in Table 1.

Table 1. Characteristics of elastic bands used.

	White knitted elastic band	Black knitted elastic band
		
Designation	YT28016	YT28143
Composition	65% polyester, 35% gum (Elastomer)	65% polyester, 35% gum (Elastomer)
Width (mm)	25 ±1	30 ±1
Weight/100m	1.15kg	1.35kg
Extensibility (%)	i.	ii

3. RESULTS AND DISCUSSION

Figures 1 and 2 present the effect of washing treatments of the denim fabric and the attachment methods of the elastic bands YT28143 and YT28016 to the stretchable woven on the shrinkage parameters of the end products.

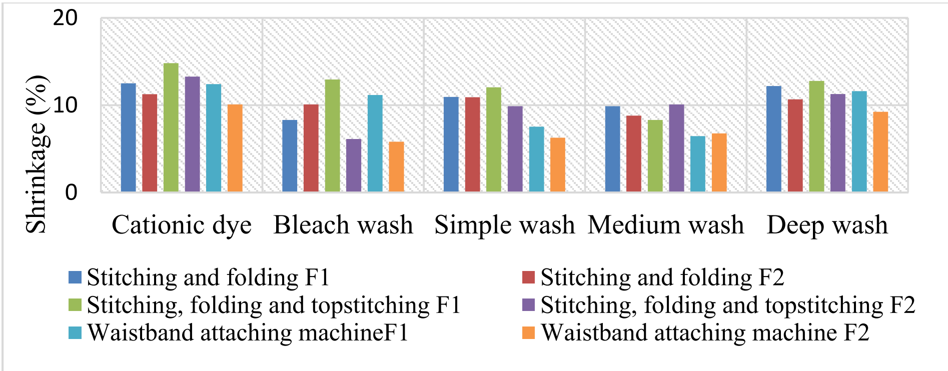

Figure 1. Effect of the washing treatments and sewing methods on the shrinkage ratios of the elastic band YT28016

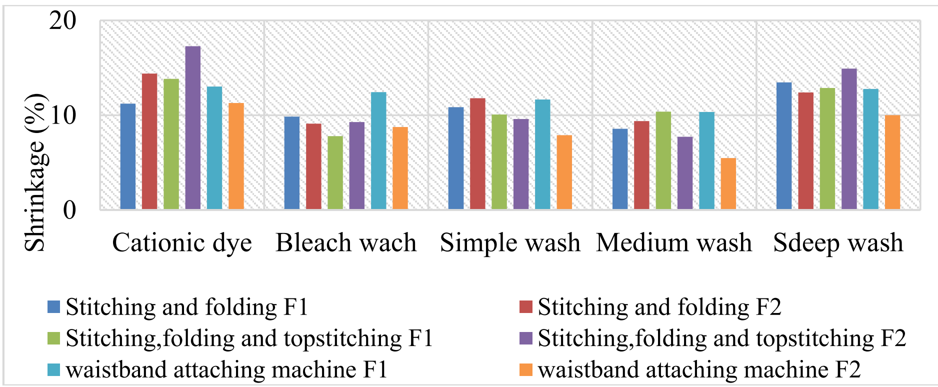

Figure 2. Effect of the washing treatments and sewing methods on the shrinkage ratios of the elastic band YT28143

The obtained findings revealed that elastic bands YT28143 and YT28016 attached to the denim fabric by the second method (stitching elastic band, folding, and topstitching) and underwent the cationic dying present a greater shrinkage percentage than other sewing methods and washing treatments used. Also, the cationic dye has a remarkable effect on the shrinkage parameter of the two types of elastic bands whatever the methods of attaching the elastic band to the fabric. Therefore, the interactions between input parameters were investigated. The results show a good interaction between the methods of attaching the elastic band to the fabric and the washing treatments and the methods of attaching the elastic band to the fabric and the elastic bandwidth.

4. CONCLUSION

The main purpose of this paper is to study accurately the performance of the elastic band used on denim fabric. Thus, the effect of washing treatments, sewing methods, and elastic bandwidth on the shrinkage ratios was established. Furthermore, the best suitable combination of denim washing treatment and methods of attaching the elastic band to the fabric according to the shrinkage of the elastic band is the cationic dying and the sewing methods which include the stitching of the elastic band, folding, and topstitching.

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STENT GRAFTS FROM POLYMERİC MATERİAL: A NOVEL DESİGN TO İMPROVE THE İMPLANT DURABİLİTY

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Key Words: Vascular grafts, stents, stents grafts, compiliance

1. INTRODUCTION

Stent grafts have become a solution of choice to treat aneurysm diseases over the last 2 decades. As these devices are implanted in a mini-invasive way, the patients comfort related to the procedure is largely improved compared to open heart surgery. The long experience acquired in the clinic shows that a large range of thoracic as well as abdominal pathologies can be treated with a large range of devices varying in diameter and design. However, stent grafts being composed of a polymeric textile membrane and metallic stent segments, their durability depends largely on the interactions that occur between these 2 materials. Metallic segments are very abrasive and tend to degrade the textile cover through apex indentation or relative friction, when the stent graft undergoes cyclic loading. This work investigates a strategy to replace the metallic stent segments with less abrasive polymeric segments obtained from monofilament material.

An additional goal is to integrate the polymeric stent segments directly into the textile membrane using the embroidery technique for secure assembling purpose. Limited relative movement between the composing elements is expected to improve the lifetime of the device. However, the mechanical properties of the embroidered assembly must match the deformability and elasticity required by the aneurysm treatment application. This was tested in the frame of this study.

2. MATERIALS AND METHODS

In a preliminary approach, the assembling of a PET woven textile substrate (plain weave, 60 yarns/cm, 180 tex yarn density) with a 100 mm monofilament was performed with a computer controlled embroidery equipment. The 301 embroidery assembling point was considered to obtain a regular "stent segment" pattern on the substrate as can be seen in figure 1.

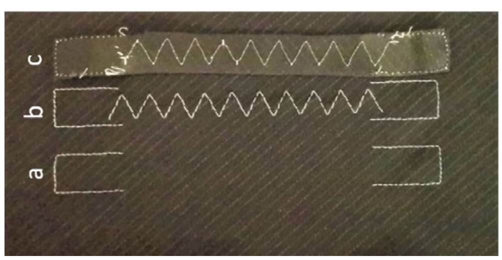

Figure 1. Embroidery pattern

Several geometrical parameters were considered by varying the filament diameter as well as the reinforcement segment height and width. Extension tests were then performed on the obtained prototypes in order to compare the elasticity of the embroidered structure with the elasticity of a control non reinforced substrate.

3. RESULTS

Figure 2 represents the mechanical response of an embroidered fabric loaded in a cyclic way (1Hz, 10% deformation) over 15 cycles. The results show that the embroidered monofilament provides a limited loss of elasticity to the fabric which is characterized by a spring back effect between the 2nd and the last cycle of around 96%. Regarding the non-reinforced control textile, this value goes down to 88 %.

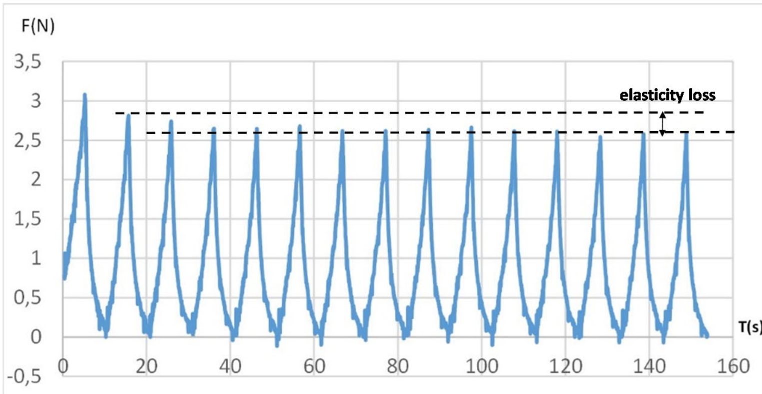

Figure 2. Typical mechanical response of the assembled material

4. CONCLUSION & PERSPECTIVES

Results show that it is possible to provide elasticity to a fabric when combining it with an embroidered monofilament. Further tests are required in order to find the optimized reinforcement geometrical pattern, in order to replicate the deformability of current metallic stent-grafts.

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EFFICIENT ADSORPTION OF ACID BLUE 74 FROM AQUEOUS SOLUTIONS USING AMINO-FUNCTIONALIZED CELLULOSE LOADED WITH FE_3O_4 NPS

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Keywords: cellulosic material, magnetite, amination, adsorption, kinetic.

1. INTRODUCTION

Various studies have been carried out to assess the levels of aquatic toxicity, phototoxicity, and metal bioavailability associated with specific classes of dyes from various water sources. The findings of these investigations have led to the emergence of stringent environmental regulations [1]. This issue has placed the textile dyeing and dyestuff manufacturing industries in a challenging position, prompting them to take substantial measures to treat wastewater containing dyes. Besides, dyes are deemed problematic pollutants due to their toxicity, which can lead to various health issues in humans, including allergies, dermatitis, skin irritation, cancer, and mutations [2,3]. Furthermore, dyes can interfere with light transmission and disrupt biological metabolic processes, causing harm to aquatic ecosystems [4]. Different techniques such as ozonation, adsorption, and advanced oxidation processes have been adopted for wastewater treatment. Among these methods, adsorption has proven to be particularly efficient and offers a practical approach for treating industrial wastewater contaminated with dyes (Kataria et al., 2016; Saini et al., 2017). However, the selection of a suitable adsorbent is complicated by factors such as cost, potential for reuse, environmental sustainability, and field applications (Saini et al., 2017). Therefore, there is a crucial need to develop new and effective adsorbents for removing dyes from wastewater. Recently, nanoadsorbents have emerged as a promising alternative. Indeed, these materials can be effectively employed in wastewater treatment due to their unique properties, including higher surface area, lower production costs, enhanced efficiency and magnetic characteristics. In this study, we investigate the utilization of cellulose derived from coffee pulp as a support material for the removal of an anionic dye namely AB 74. Besides, our research explores methods to enhance the interaction between the selected dye and this support using aminated cellulose loaded or not with magnetite nanoparticles.

2. EXPERIMENTAL STUDY

2.1. Materials and Methods

All reagents [DiMethylFormamide (DMF), Thionyl chloride ($SOCl_2$), DiEthylenTriamine (DET), ferric chloride $FeCl_3$, ferric sulfate ($FeSO_4$) ammonium hydroxide] and the dye Acid Blue 74 (AB 74) were provided from sigma-Aldrich company and used without any further purification.

2.2. Extraction of cellulose Fibers from coffee pulp

The cellulose fibers used in the present study were isolated from coffee pulp by a chemical treatment method. The extraction of cellulose fibers required the removal of the non-cellulosic materials such as lignin, hemicellulose and pectin. This was achieved using an alkaline treatment followed by a hydrogen peroxide bleaching.

2.3. Preparation of DET-CCP

DET-CCP support was prepared in two stages: (1) preparation of CDC-CCP according to previous study [5], and (2) subsequent amination of the CDC-CCP with DET [5]. The incorporation of amine groups onto CDC-CCP was performed as follows. A sample of 1 g CDC-CCP, 20 mL of distilled water and 3 mL of DET were introduced into a round bottomed flask. The mixture was stirred for 3 h at reflux. At the end of the reaction, the product (namely DET-CCP) was separated from the mixture through filtration, rinsed at first with methanol/acetone (50/50 v/v), then with water and finally dried.

2.4. Coating supports with Fe_3O_4 NPs

To incorporate Fe_3O_4 nanoparticles, we have employed the co-precipitation method, which was chosen to create nanoparticles with consistent composition and a narrow size distribution [6]. The loading of the two samples (CCP and DET-CCP) was carried out using the following procedure: a specific amount of each substrate was placed in distilled water and stirred for specific time. After that, a certain amount of $FeCl_3 6H_2O$ and $FeSO_4 7H_2O$ were added to the mixture, which was then heated to a constant temperature for a fixed period under vigorously stirring. This reaction was conducted under nitrogen atmosphere to prevent the oxidation of Fe^{2+}. Following this, a 2 M NH_4OH solution was added drop by drop until the pH reached approximately 10. Vigorous stirring was maintained for a specified period. The Fe_3O_4 loaded supports (CCP@Fe_3O_4 and DET-CCP@Fe_3O_4) were subsequently retrieved, thoroughly washed with distilled water until a neutral pH was achieved, and then dried until a constant mass was obtained.

2.5. Characterization of the Prepared Supports

The FTIR spectra of the prepared supports were performed using a Fourier Transform Infrared Spectrometer (Nicolet FT-IR 460) in KBr disks. IR spectra were recorded in a transmittance mode and scanned in the range of 500-4000 cm^{-1}.

Scanning electron microscopy (SEM) technique (XL30 ESEM) has been used to investigate the changes in the surface morphology of the different studied adsorbents.

The magnetic measurements were performed at 300 K (VSM) at 25 °C and in a magnetic field varying from -4 T to +4 T.

2.6. Batch Adsorption Studies

Batch experiments were carried out by agitating a known amount of each adsorbent with 100 mL of dye aqueous solution using an Ahiba Nuance® laboratory machine. Experiments were conducted by studing different parameters such as pH of the medium, contact time, initial dye concentration and temperature. After each adsorption experiment, the solution was separated from the adsorbent by filtration using a 0.45 µm membrane filter. The residual dye concentration was then determined with a DR® 3900 spectrophotometer by measuring the absorbance at λ_{max} of 610 nm.

The amount of dye adsorbed at equilibrium, C_{ads} ($mg \cdot g^{-1}$), was calculated as follows:

$$C_{ads} = \frac{(C_0 - C_e) \times V}{W} \qquad (1)$$

where C_0 and C_e are the initial and the equilibrium dye solution concentrations ($mg \cdot L^{-1}$), respectively. V is the volume of the solution (L) and W is the weight of the adsorbent (g).

2.6.1. Kinetic of AB74 Adsorption

In this study, three models namely pseudo-first order, pseudo-second order and intraparticle diffusion kinetic equations were used.

The linearized form of the pseudo first-order model is represented by the following equation:

$$log(q_e - q_t) = \log q_e - \frac{K_1}{2.303}\, t \qquad (2)$$

Where q_e and q_t (mg. g^{-1}) are the amounts of AB74 adsorbed at equilibrium and at time t, respectively. k_1 (min^{-1}) is the Lagergren rate constant of adsorption. The values of k_1 and q_e for the adsorption of AB74 onto CCP, CCP@Fe_3O_4, DET-CCP and DET-CCP@Fe_3O_4 were determined from the plot of log (q_e-q_t) versus t. The pseudo-second-order kinetic equation is given as follows:

$$\frac{t}{q_t} = \frac{1}{K_2 q_e^2} + \frac{t}{q_e} \quad (3)$$

Where k_2 (g. mg^{-1} .min^{-1}) is the pseudo-second-order rate constant. The constants of pseudo-second-order model, k_2 and q_e can be obtained from the slope and intercept of the plot of t/q_t versus t.

2.6.2. Modeling of the adsorption isotherms

The adsorption isotherm models are widely used to describe the relation between adsorption capacity and equilibrium concentration at a constant temperature. The data for the adsorption of AB74 by the tested adsorbents were analyzed by the Langmuir and Freundlich isotherms.
The linearized form of Langmuir equation is given as follows:

$$Q_e = \frac{Q_{max} K_L C_e}{1+K_L C_e} \quad (4)$$

where Q_{max} is the theoretical monolayer saturation capacity (mg·g^{-1}), b is the Langmuir adsorption constant (L·mg^{-1}) related to the energy of adsorption and K_L=Q·b (L·g^{-1}) is the Langmuir equilibrium constant. The Langmuir constants were determined from the slope and the intercept of the linear plot of C_e/Y_e versus Ce.
The Freundlich equation is represented as below:

$$Q_e = K_F C_e^{1/n} \quad (5)$$

Where K_F and 1/n are the Freundlich constants depending on the temperature and the given adsorbent–adsorbate couple. The parameter n is related to the adsorption energy distribution and K_F indicates the adsorption capacity.

3. RESULTS AND DISCUSSION

3.1. Adsorbents characterization

3.1.1. FTIR analysis

The changes of the chemical structure of the studied samples were analyzed through FTIR spectra as shown in Figure 2.

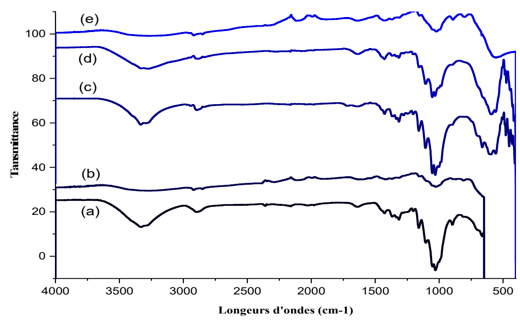

Figure 9. Spectra of: (a) CCP, (b) CCP@Fe_3O_4, (c) CDC-CCP, (d) DET-CCP, and (e) DET-CCP@ Fe_3O_4

FTIR spectroscopic analysis was performed to confirm the grafting of amine functions onto cellulose extracted from coffee pulp, as well as the incorporation of magnetite nanoparticles into the various prepared substrates. We can observe that the IR spectra of the various prepared substrates reveal the presence of characteristic bands of cellulose material. Indeed, we observe the presence of bands located at around 3354 and 2919 cm^{-1}, which characterize the stretching vibrations of O-H and C-H groups, respectively [6]. The bands at approximately 1130 and 1040 cm^{-1} can be attributed to the stretching of the C-O-C group in β (1,4) glycosidic linkages and the stretching vibration of the C-O group, respectively [6]. We also observe the presence of a band at around 1425 cm^{-1}, corresponding to in-plane stretching deformation of H-C-H and O-C-H bonds, and a band around 1371 cm^{-1}, which may be attributed to the deformation vibration of the C-H group [7]. The IR spectrum of CDC-CCP (Figure 1(c)) shows the appearance of a new band at approximately 1738 cm^{-1}, which corresponds to the deformation vibrations of the C-Cl bond [8]. This suggests the substitution of hydroxyl groups by chloride groups during the first step of the chemical modification. The grafting efficiency of amine groups was confirmed in the FTIR spectra of Figure 1(d). Indeed, it showed the appearance of a new, low-intensity band at around 1552 cm^{-1} that can be attributed to the deformation vibrations of the N-H group present in secondary amines (> NH). The band at around 1640 cm^{-1} can be assigned to the deformation vibration of the N-H group in primary amines NH_2 [8]. It is worth noting that the band at 3354 cm^{-1} becomes more pronounced in the case of the DET-CCP spectrum [Figure 1 (d)] compared to that of CCP [Figure 1 (a)]. This can be explained by the fact that this band is also characteristic of the elongation of the N-H group present in aminated cellulose [9]. The IR spectra related to the Fe_3O_4@CCP [Figure 1 (b)] and Fe_3O_4@DET-CCP [Figure 1 (e)] samples exhibited the appearance of a new band at around 558 cm^{-1}. This band can be attributed to the vibration of the Fe-O group [10]. Furthermore, the elongation vibration band at 3354 cm^{-1} becomes broader in the case of the complex materials CCP@$Fe_3O_4$and DET-CCP@Fe3O4 compared to the same band in the CCP and DET-CCP samples. This suggests a strong interaction between hydroxyl and/or amine groups and magnetite NPs [11]. The obtained results confirm the insertion of magnetite nanoparticles into the chemical structures of cellulose and aminated cellulose.

3.1.2. SEM analysis

The characterization of CCP support by SEM is presented in Figure 2 (a). As can be seen, the extracted and bleached cellulose material exhibited a porous structure with macropores distributed regularly along the cellulose fibrils. The SEM image of the cellulose loaded with magnetite nanoparticles (Figure 2(b)) reveals a different morphology compared to that of untreated support. Indeed, we observe the presence of irregular crystallites of Fe_3O_4 nanoparticles that are dispersed in the macropores of the cellulose surface.

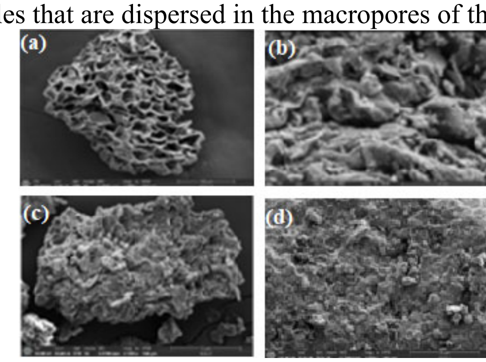

Figure 10. SEM images of: (a) CCP, (b) CCP@Fe_3O_4, (c) DET-CCP and (d) DET-CCP@Fe_3O_4

Figure 2(c) depicts SEM image of the DET-CCP support. As can be observed, there is a significant change in the substrate morphology resulting from the chemical modification process. Indeed, the morphology of cellulose functionalized with amine groups showed fibrils with lower porous structure compared to that of unmodified cellulose. This suggests the presence of an additional layer formed by molecules carrying the amine groups on the fiber surface. Additionally, streaks on the modified cellulose fibers are also observed, suggesting the increased surface roughness due to the grafting of amine groups. Figure 2(d) shows SEM images of DET-CCP@Fe_3O_4. The aminated cellulose loaded with magnetite nanoparticles exhibited a low porosity morphology. The dispersion of magnetite nanoparticles is more uniform within the structure of aminated cellulose. The absence of significant pores in the loaded aminated cellulose indicates that the magnetite nanoparticles have successfully integrated into the modified material.

3.1.3. Magnetization

Figure 3 shows the magnetization curve recorded at room temperature for CCP@Fe_3O_4 sample.

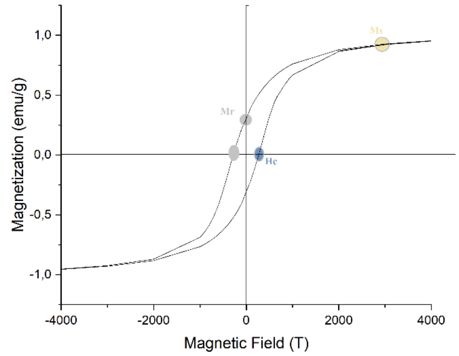

Figure 11. Magnetization curve of CCP@Fe_3O_4

We note the appearance of a magnetic hysteresis loop that exhibited typical ferromagnetic property with a saturation magnetization (Ms) of 0.934 emu/g, a remnant magnetization (Mr) of 0.33 emu/g and a coercive force (Hc) of 282.72 T.

3.2. Adsorption of AB 74

3.2.1. Effect of the pH

The initial pH was varied between 2 and 9 (Figure 8). Higher adsorption capacities were obtained at acidic pH compared to neutral or alkaline conditions. Specifically, the adsorption capacity reached its maximum at pH 2 for DET-CCP and DET-CCP@Fe_3O_4 supports, and at pH 3 for CCP and CCP@ Fe_3O_4 supports. Beyond pH 2 and 3, the effectiveness of dye retention diminishes.

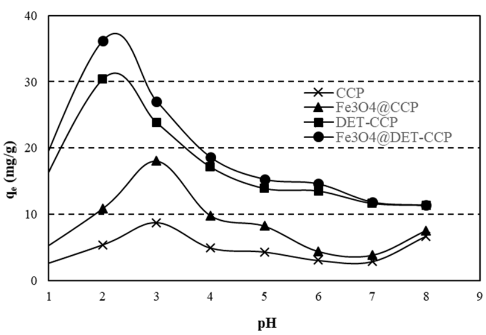

Figure 4. Effect of pH on the removal of AB 74

3.2.2. Effect of contact Time

Figure 5 illustrates the impact of contact time on the adsorption capacities of AB 74.

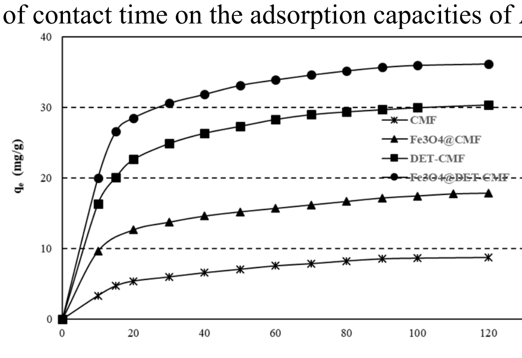

Figure 12. Effect of contact time on the removal of AB 74

An initial rapid adsorption of the tested dye onto the diverse substrates was obtained within the first 20 minutes, followed by a gradual deceleration that eventually led to equilibrium. The first stage of initial adsorption can be attributed to the sufficient availability of unoccupied adsorption sites on the surface of the adsorbents. Subsequently, the adsorbed quantities increased at a slower rate due to the reduced availability of adsorption sites and their occupation by solute molecules. Finally, a saturation plateau was obtained.

3.2.3. Effect of initial dye concentration

The results are presented in Figure 11 which indicates that the adsorption capacities increased with the initial concentration of AB74. This can be explained by the fact that as the dye concentration in the solution increases, more dye molecules are available to diffuse to the surface of the solid particles of the studied supports. For dye concentrations higher than 400 $mg.L^{-1}$, a plateau is observed, which represents the maximum adsorption capacity. This plateau may be due to the saturation of active sites on the adsorbent in the presence of a high dye content.

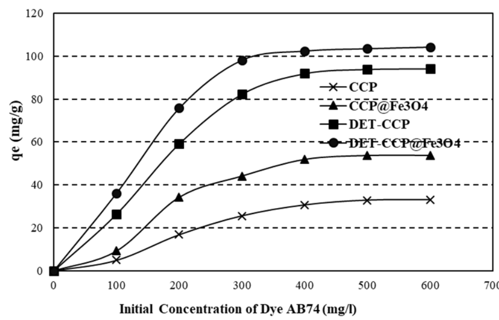

Figure 13. Effect of initial dye concentration on the removal of AB74

Figure 6 also showed that the adsorption capacities of the studied adsorbents are presented in the following order: DET-CCP @Fe_3O_4 > DET-CCP > CCP@Fe_3O_4) > CCP. This can be attributed to the nature of the adsorbent, the number of active sites, the size, proportion and specific surface area of the magnetite nanoparticles incorporated into the CCP and DET-CCP supports.

3.2.4. Kinetic study

Kinetic experimental data were analyzed by the pseudo-first-order, pseudo-second-order and intraparticle diffusion models. The kinetic parameters of pseudo-first-order and pseudo-second-order models are listed in Table 1. It was observed that the correlation coefficient (R^2) determined from the Pseudo-second order model is higher than that of the Pseudo-first-order model. Moreover, values of $q_{e.cal}$ calculated from pseudo-second-order equation were closer to the experimental values, $q_{e,exp}$, than those calculated from pseudo-first-order one. Hence, these results indicated that adsorption phenomenon belongs to the pseudo-second-order model.

Table 1. Parameters of pseudo-first-order and pseudo-second-order models

Support	**Pseudo-first-order**				**Pseudo second order**		
	$q_{e(exp)}$ ($mg.g^{-1}$)	q_e ($mg.g^{-1}$)	k_1 (min^{-1})	R^2	q_e ($mg.g^{-1}$)	$k_2 x 10^{-3}$ (min^{-1})	R^2
DET-CCP @Fe₃O₄	36,18	29,458	0,04053	0,968	39,370	2,366	0,999
DET-CCP	33,63	24,110	0,0362	0,992	33,557	2,284	0,999
CCP @Fe₃O₄	18,04	15,346	0,0375	0,926	19,531	4,061	0,998
CCP	08,73	10,283	0,0362	0,935	10,684	3,363	0,994

The experimental results were also fitted to the intra-particle diffusion model (Figure 7). As can be seen, the graphical representations of this model for the various prepared supports yield lines that do not pass through the origin. This indicates that solute transfer is not solely governed by intra-particle diffusion and other phenomena and mechanisms may contribute to the adsorption process.

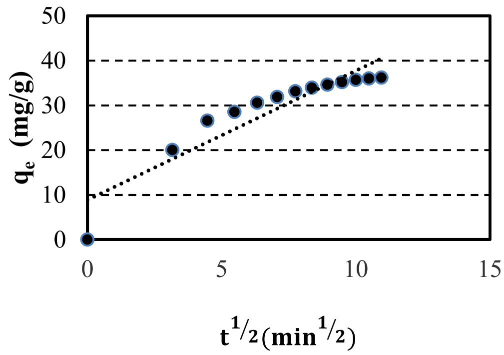

Figure 14. Intra-particle diffusion model for the retention of AB74 by DET-CCP@Fe_3O_4

3.2.5. Modeling of the adsorption isotherms

Equilibrium adsorption data were analyzed by Langmuir and Freundlich models. The related parameters were summarized in Table 2. According to the obtained results, the Langmuir model with correlation coefficients ranging between 0.919 and 0.993 represent a better fit to experimental data than the Freundlich one (0.820 < R^2 < 0.943). Additionally, the theoretical adsorption capacities (Q) are smaller than those obtained experimentally. This suggested that the reactive sites are not totally occupied by the dye molecules.

Table 2. Langmuir and Freundlich parameters for the removal of AB74.

		Langmuir isotherm			Freundlich isotherm		
Support	T (°K)	Q (mg/g)	b	R^2	1/n	K_F	R^2
	293	149,254	0,008	0,964	1,734	12,218	0,907
	313	91,743	0,012	0,988	2,255	56,633	0,895
DET-CCP @Fe3O4	333	62,893	0,008	0,984	2,018	7,423	0,910
	353	57,143	0,006	0,962	1,790	2,307	0,904
	293	133,333	0,006	0,943	1,606	4,871	0,902
	313	99,010	0,006	0,970	2,255	56,633	0,895
	333	84,034	0,006	0,970	1,761	3,772	0,943
DET-CCP	353	84,746	0,004	0,931	1,518	1,214	0,929
	293	68,966	0,004	0,919	1,515	1,085	0,907
	313	53,763	0,005	0,950	1,650	1,053	0,924
	333	47,393	0,004	0,928	1,558	1,697	0,911
CCP @Fe3O4	353	27,027	0,007	0,945	1,612	2,544	0,889
	293	46,729	0,004	0,950	1,552	2,010	0,942
	313	46,083	0,005	0,968	1,704	1,050	0,937
CCP	333	44,643	0,010	0,984	2,237	8,713	0,905
	353	47,619	0,020	0,993	2,975	223,542	0,820

4. CONCLUSION

The aim of this study is the preparation of a novel magnetic material synthetized from aminated cellulosic product. Firstly, cellulose was extracted from coffee pulp to obtain CCP which was then modified by DiEthyleneTriamine (DET) resulting in amino-functionalized cellulose (DET@CCP). Secondly, Fe_3O_4 NPs were loaded on CCP and DET@CCP products by co-precipitation method allowing the preparation of a magnetic composites namely CCP@Fe_3O_4 and DET-CCP@Fe_3O_4. The prepared materials were then analyzed by Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM) and magnetic properties measurements. Afterwards, the CCP, CCP@Fe_3O_4, DET@CCP and DET-CCP@Fe_3O_4 were used as adsorbents for the removal of AB 74 dye from aqueous solutions. Different parameters, such as pH of the dye solution, contact time, initial concentration of AB 74 and temperature were varied and studied. The kinetic adsorption data of AB 74 were studied using pseudo-first order, pseudo-second order and intraparticle diffusion models. The adsorption equilibrium isotherms were further analyzed based on Langmuir and Freundlich equations. Results revealed that the adsorption kinetic process was best described by the pseudo-second-order model. In addition to that, the Langmuir isotherm model provided a better fit for the adsorption data compared to the Freundlich one.

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DEVELOPMENT OF A BİOBASED CONDUCTİVE INK FORMULATİON AND ITS APPLİCATİON THROUGH SCREEN PRİNTİNG FOR ELECTRONİC TEXTİLE DEVELOPMENT

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Key Words: Graphite, Graphene, Biodegradable Conductive Inks, Screen Printing, Electronic Textiles

1. INTRODUCTION:

Electronic textiles represent a prominent sector within the printed electronics industry, utilizing various printing techniques and conductive inks. Among these techniques, screen printing stands out as a preferred choice due to its speed, high pattern resolution, simplicity, and cost-effectiveness compared to other methods[1]. However, a significant challenge in the development of electronic textiles lies in the conductive inks often containing harmful chemicals such as N-methyl-2-pyrrolidone, dimethylformamide[2] and poly(vinylidene fluoride)[3]. This limitation restricts their use, particularly in wearable garments. Therefore, the central objective of our research was to develop environmentally-friendly screen-printing inks by reducing or eliminating the use of these harmful chemicals. To achieve this goal, we employed a cellulose-derived polymer, known for its biodegradability and water solubility, as a matrix. Furthermore, we opted for the use of eco-friendly solvents such as water and low-boiling-point ethanol to dissolve the polymer, without requiring the addition of other additives, unlike many formulations relying on bio-sourced products but still containing environmentally-unfriendly chemical additives[4]. To maintain the electrical conductivity of the inks, we incorporated graphite and graphene as conductive fillers. This approach allowed us to create inks capable of efficiently conducting electricity while avoiding the use of toxic chemical compounds.

2. MATERIALS AND METHODS:

A textile substrate made entirely of polyester (100%) was utilized, featuring a unit weight/area of 89.2 grams per square centimeter and a thickness measuring 0.04 millimeters. Biodegradable cellulose-based polymer. The solvents employed in the process were water and ethanol (99.8% purity, with a molecular weight of 46.07 g/mol). The filler materials utilized included graphite particles with an approximate size of 60 nanometers and graphene synthesized through the HUMMER method [5].

Conductive inks were manually applied to polyester substrates using the screen-printing technique. For this purpose, the fabric was positioned between the screen-printing mesh and the printing table, then the ink was spread over the mesh using a polyurethane squeegee (at an angle of 45° to the mesh). The printed patterns were then dried in an oven at a temperature of 130°C for 3 minutes.

3. RESULTS AND DISCUSSION:

The measurement of conductivity as a function of graphite and graphene amount was investigated to determine the relationship between the electrical proprieties of the printed pattern and the fillers wt% **(Figure 1-a)**. As can be seen in the figure, when the fillers amount increases from 10 to 50 wt%, a significant in electrical conductivity, ranging from 7×10^{-3} to 35×10^{-2} S cm^{-1} and from 27×10^{-2} to 5×10^{-1} S cm^{-1} for graphite and graphene, respectively. This is mainly attributed to the higher number of fillers, which leads to the formation of an electrically efficient conductive way **(figure 1-b.c)**. To evaluate the applicability of the printed textile, a circuit connected to an LED was developed on the graphene printed PET fabric. With this later, we succeed to switch on an LED bulb using a 4.5 V battery, demonstrating the potential of our textile for application in electronic circuits **(Figure 1-d)**. Our printed textiles underwent thorough testing, including measurements of the contact angle, demonstrating the ability of the printed textile surfaces to repel water which is advantageous for the durability of these textiles. Moreover, tensile strength tests were conducted, demonstrating the good mechanical properties of these textiles.

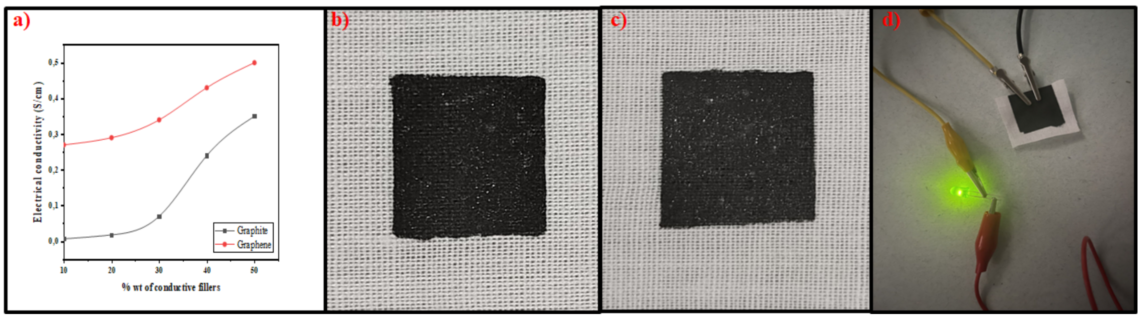

Figure 15: Electrical conductivity curves for samples printed with graphite-based paste and graphene-based paste a); Images of the fabricated graphite coated textile; b) and graphene coated textile c); Image of a conductive fabric using the battery and LED for an electronic circuits d)

4. CONCLUSION:

In summary, our research focused on developing eco-friendly screen-printing inks to reduce reliance on harmful chemicals, promoting recyclability. We utilized a biodegradable polymer and incorporated graphite and graphene as conductive additives to achieved electrical conductivity without resorting to toxic substances. This approach enables the development of flexible, and wearable electronic textiles. Extensive testing, covering assessments of impermeability, mechanical strength, and electrical conductivity, yielded promising outcomes, including an increase in electrical conductivity as the filler percentages increased.

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TOWARDS MANUFACTURİNG SELF-REGULATİNG PPE FOR EXTREME HEAT

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ABSTRACT: Desert dwellers wear double-layered clothing. The air between the two layers heats up on contact with the dark-colored outer garment. Having become less dense, the air rises and creates an airflow. To verify this phenomenon and know the important parameters, we created a model positioning two layers of fabric parallel. An anemometer measures the airflow between the two layers. This article presents the results of a first study. We observe that an airflow does exist between the two layers of fabric and that it reaches a maximum speed for an optimal distance between the two fabrics. This study did not demonstrate the influence of fabric texture or color.

Key words: Thermal comfort, Air gap, Airflow, PPE, Extreme Heat

1. INTRODUCTION

Summers are getting hotter and hotter. Heatwave episodes are becoming more and more severe, and global warming forecasts predict a further increase in temperatures. However, employees must continue to work outside in very hot weather. They need clothing to improve their thermal comfort in these conditions. To design these new types of clothing, this study was inspired by the clothes worn by desert inhabitants. Indeed, they wear two layers of clothing creating an air gap. The air between the two layers heats up on contact with the dark-colored outer garment. Having become less dense, the air rises and creates an airflow. While dark color contributes to thermal comfort [3], the air gap is also an important parameter [1], [2], [4]. To verify this concept, a model was built and different combinations of fabrics and air thicknesses were tested.

2. MATERIALS AND METHODS

The model consists of two frames (inspired by embroidery frames), as shown in Figure 1. A frame has a height of 245 mm and a width of 235 mm. Each frame holds one of two fabrics simulating the two layers of clothing. The frames are vertical, parallel to each other, and each slide in a ½ box (i.e. open on one side), not shown in Figure 1. In one of the ½ boxes, a five-lamp heating system simulates the sun. One PID adjusts its temperature at 60 °C. The other ½ box is not heated and remains at room temperature. The distance between the two frames can be adjusted using a slide and screw nut system. The model is fixed to a table. An opening has been cut in the table. It is located under both frames. It allows air to circulate.

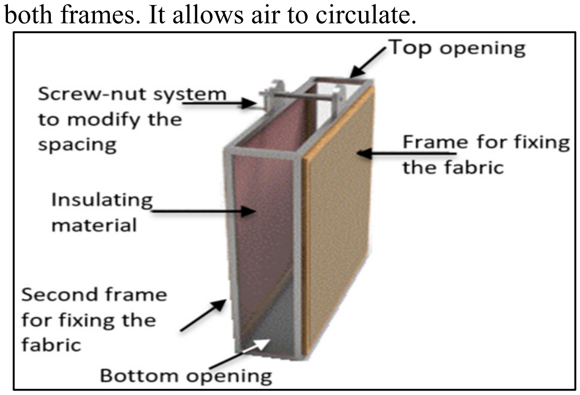

Figure 1: The schematic of the model, without the ½ boxes or the heating system

The model is covered with an insulating material cover to maintain the different zones at constant temperature. Another opening, made in this cover, with the same dimensions, is located above the two frames, aligned with that of the table. It also allows air to circulate. Temperature, humidity and air velocity measurements are performed with two anemometers. A measurement is recorded every second. A test lasts at least 10 minutes. The results are collected in an Excel file. Then the mean and standard deviation of the air speed are calculated. We find them on the curves of the different tests. The two anemometers can be fixed between the two frames. Often one is enough. If the both are present, they are at different heights. The presence of an anemometer between the two frames imposes a minimum air gap of 12 mm.

3. RESULTS

3.1. Inside and outside airflow comparison

The first step of our work is to measure the airflow inside and outside the model. The first anemometer is fixed between the two frames. The second is attached to the outside of the model. This make it possible to verify that if an airflow is observed inside the model it does not come from outside. Figure 2 shows the airflow measurements using the two anemometers during a 10-minute experiment. One is placed between the two frames (Inside) and the other outside (Outside). These measurements show the emergence of an airflow between the two frames due to the temperature difference.

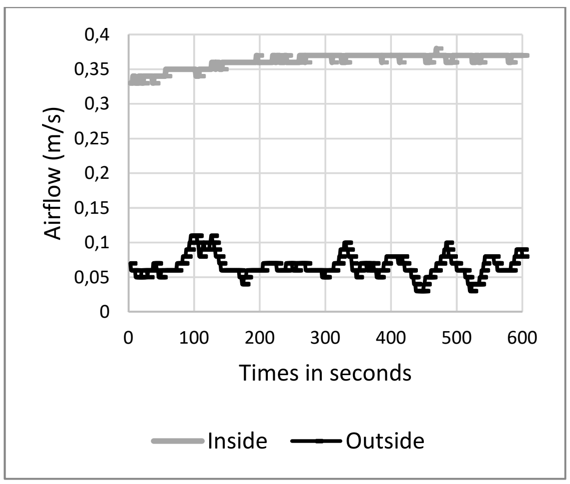

Figure 2: Comparison of airflow measurements inside and outside the model

3.2. The two fabrics distance influence

The second step of our work is to verify the influence of the distance between the two fabrics. We decide to start with the minimum distance and then increase it. The presence of the anemometer between the two frames requires a minimum distance of 12 mm. The anemometer is placed in the middle of the frame (in height and width). Figure 3 shows the evolution of average airflow values as a function of the distance between frames. The distances then increase by 2 mm. The observed airflow reaches its maximum between 18 and 20 mm and then it decreases when the frames move away. This experiment is carried out with the fabrics presented in Tables 1 and 2. Only beige corduroy is used (for side exposed to 60°C). These fabrics are chosen based on our stock availability.

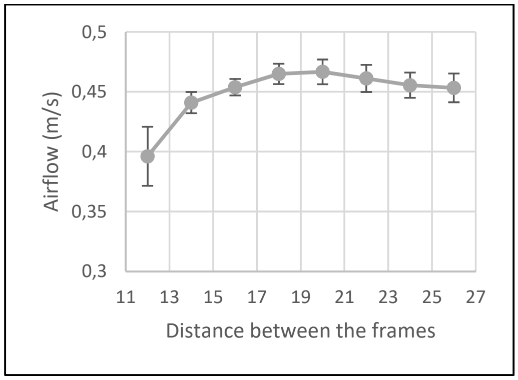

Figure 3: Influence of the distance between the two frames

Then we reproduce the experiment starting from the maximum distance of 26 mm and decrease it. Figure 4 shows the evolution of average airflow values as a function of the distance between frames. The distances decrease by 2 mm. the curve in Figure 3 is also shown to be able to compare the 2 curves. The observed airflow reaches its maximum between 18 and 20 mm. This time again, the experiment is carried out with the fabrics presented in Tables 1 and 2. Only beige corduroy is used (for side exposed to 60°C).

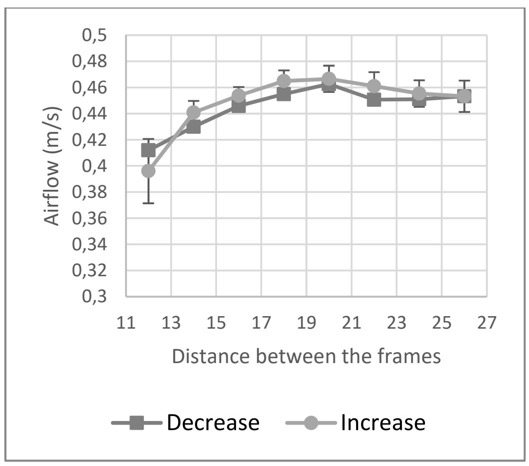

Figure 4: Influence of the distance between the two frames taking into account the direction of movement of the frame

Table 1: Compositions of the fabrics used

Fabrics	Material	Weave and color
Unheated face fabric	Cotton	Plain weave White and red
Fabric exposed to 60°C	Wool	Corduroy Black
	Wool	Corduroy Beige

Table 2: Features of the fabrics used

Fabrics	Surface mass (g/m2)	Thickness (mm)	Air permeability (cm3/cm2/s)
Unheated face fabric	118	0.22	295
Fabric exposed to 60°C	378	1.32	112.4

3.3. The anemometer position influence

The third step of our work is to verify the influence of the position of the anemometer in height and width. Two series of measurements were made. For the first series, the anemometer is placed in the upper position, for the second it is lower. 120 mm separate the two positions. The same anemometer is used to avoid differences due to calibration.

We start with the minimum distance of 12 mm and then increase it by 2 mm. This experiment is carried out with the fabrics presented in Tables 1 and 2. Only black corduroy is used (for side exposed to 60°C). Figure 5 shows a slight difference between the two flows. The flow measured in the upper position is slightly higher than the lower position.

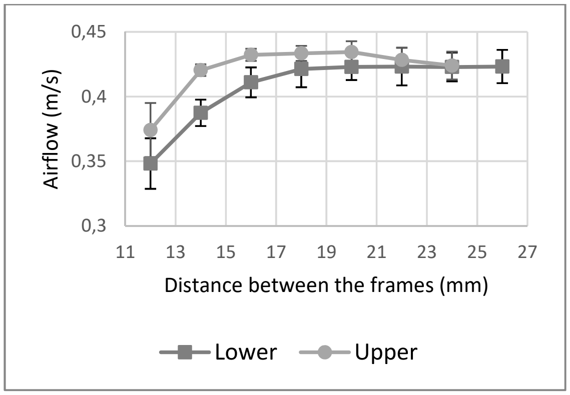

Figure 5: Influence of the position of the anemometer

3.4. The texture fabric influence

The next step of is to verify the influence of the texture of the fabric. As indicated in the table 1, the fabric exposed to 60°C is a corduroy. We carry out two series of tests with two orientations for the corduroy: one series with the corduroy oriented vertically and the other series with the corduroy oriented horizontally. The experiment is carried out first with black corduroy (figure 6), then with beige corduroy (figure 7). Figure 6 shows that the vertical orientation of the black corduroy promotes airflow. This is on average 23% higher than for horizontal orientation.

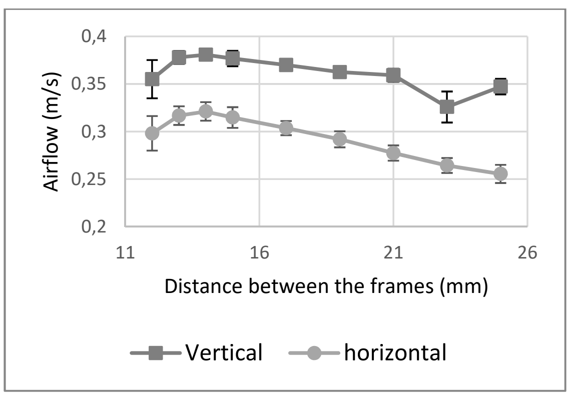

Figure 6: Influence of the orientation of the line of the black corduroy

Figure 7 shows that the vertical orientation of the beige corduroy has no influence on air circulation.

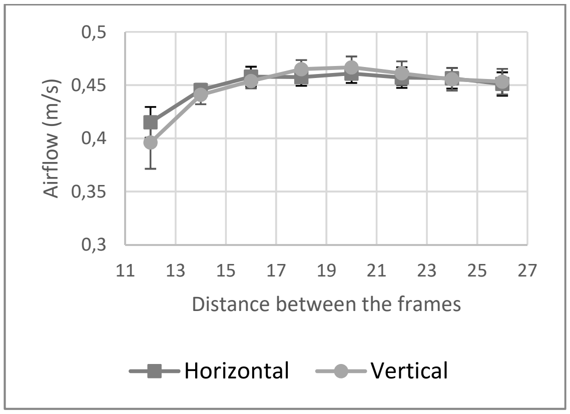

Figure 7: Influence of the orientation of the line of the beige corduroy

3.5. The color fabric influence

To test the influence of color, two corduroys are used. These two corduroys, presented in Tables 1 and 2, have the same characteristics (except the color). The first experiment is done with black corduroy, the second with beige corduroy. Figure 8 shows the results. We expected to see more airflow with the black corduroy, but the results show slightly more airflow with the beige corduroy.

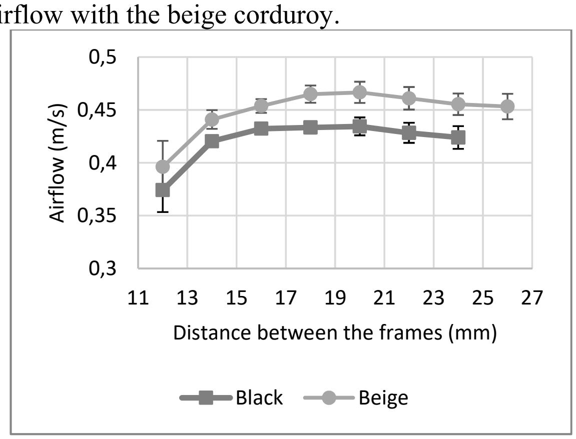

Figure 8: Influence of the color of the corduroy

4. DISCUSSION

The various tests show that an airflow is created between two layers of fabric when one of the two layers is exposed to a temperature of 60°C. The speed of this airflow depends on the air gap. Experiments show that there is an optimal distance. Whether the air gap is increased or decreased, the airflow curve as a function of the distance between the frames remains the same.

The position of the anemometer influences the flow. The anemometer in the high position has a slightly greater flow than the anemometer in the low position. This must be confirmed by a more detailed study.

The measurements also made it possible to observe the influence of texture. For our study, we used two corduroys, one black and one beige. The results are very different. For black corduroys, the presence of vertical lines promotes air circulation compared to horizontal lines. However, for beige corduroys we do not observe any difference. The study of texture needs to be in-depth and correlated to surface condition parameters.

The measurements did not reveal the influence of color. However, for the moment, we have only been able to test a black corduroys and a fairly dark beige corduroys. The study of color needs to be in-depth and correlated with objective color measurements.

5. CONCLUSION

The long-term goal is to design a garment with a double layer of fabric. This first study shows that an airflow is formed between two layers of fabric when one of the two fabrics is exposed to high heat (60°C). We observed the influence on the airflow of the air gap, the color and the texture of the fabric. To these parameters are added parameters that we were not able to test such as the material of the fabrics and their texture, and humidity, an important parameter (Md Rashedul Islam, 2022). However, the airflows measured on the model are still too weak to ventilate clothing. It is still necessary to optimize the fabrics, textures, materials and air gap to obtain sufficient flow to ventilate the garment.

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SMART TEXTİLE SENSORS EMPOWERED BY PİEZOELECTRİC ENERGY HARVESTİNG

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Key Words: Wearable technology; Smart textiles; Nanocomposite materials; Piezoelectric energy harvesting; Autonomous sensor systems.

1. INTRODUCTION

In recent years, the evolution of wearable technology has sparked a transformative shift in the landscape of sensor technologies, paving the way for innovative applications in healthcare, sports, environmental monitoring, and beyond. Central to this paradigm shift is the quest for self-sustaining, energy-autonomous sensors that can seamlessly integrate into the fabric of everyday life. In response to this burgeoning demand, the convergence of smart textiles and advanced materials science has given rise to a new frontier of sensor development [1].

This manuscript presents a pioneering exploration into the realm of self-powered smart textile sensors, underpinned by the potent synergy between piezoelectric energy harvesting and nanocomposite materials. Specifically, we focus on the use of Poly(vinylidene fluoride hexafluoropropylene) (PVDF-HFP) as a polymer matrix, fortified with lead zirconate titanate (PZT) nanoparticles [2]. The resulting nanocomposite films offer a promising avenue for the realization of wearable sensors that can generate electrical energy from mechanical stimuli, thus obviating the need for external power sources [3].

Our research delves into the synthesis, characterization, and practical implications of these novel nanocomposite films. By harnessing the exceptional piezoelectric properties of PVDF-HFP and PZT nanoparticles, we unlock the potential for a new generation of smart textiles capable of sensing, transmitting data, and harvesting energy from the wearer's movements. This work represents not only a significant technological advancement but also a bridge between the realms of materials science and wearable technology, propelling us closer to the realization of truly autonomous and intelligent textile-based sensor systems.

2. MATERIALS AND METHODS

This process involves using specific materials, including Lead Titanate-Zirconate (PZT) nanoparticles, Poly (vinylidene-fluoride hexafluoropropylene) (PVdF-HFP), and Tetrahydrofuran (THF) as a solvent.

To create the nanocomposite, Polyvinylidene fluoride-hexafluoropropylene (PVdF-HFP) and Polylactic acid (PLA) are initially dissolved separately in Tetrahydrofuran (THF). Once both solutions have fully dissolved, they are combined to form a PVdF-HFP solution. In parallel, different quantities of lead titanate zirconate (PZT) nanoparticles are prepared by dispersing PZT nanoparticles using ultrasonication. These two solutions are then mixed together [2].

Subsequently, the resulting mixture is poured onto a glass plate and evenly spread to enhance the uniformity of the film thickness. This prepared film is then placed in an oven to facilitate the drying process of the nanocomposite.

In summary, this procedure combines various materials and precise steps to create a nanocomposite film, making it ready for potential applications in fields such as smart textiles and sensor technology.

3. RESULTS AND DISCUSSION

The crystalline structure of PVdF-HFP/PZT nanocomposites was further examined using FTIR spectra, as illustrated in Figure 2. The FTIR analysis revealed distinct vibrational peaks at 1071, 1176, and 397 cm^{-1}, attributed to the bending vibrations of the C-C bonds, the swinging vibrations of CH_2 groups, and the motion vibrations of CF_2 groups, respectively, within the pristine PVdF-HFP material [4]. Additionally, vibrational peaks at 796 and 1071 cm^{-1} were identified, indicating the presence of the non-polar crystalline α-phase of PVdF-HFP.

Remarkably, the absence of any bands corresponding to OH bending affirmed the hydrophobic nature of both neat PVdF-HFP and the composite PVdF-HFP-PZT films. This hydrophobic characteristic remained consistent even with the incorporation of PZT nanofillers, ranging from 0.1 wt.% to 1.5 wt.%, thus underscoring the film's continued resistance to moisture absorption.

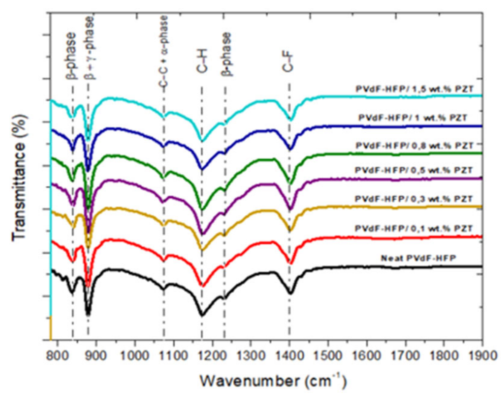

Figure2. FTIR Analysis of PVDF-HFP and PVDF-HFP/PZT Nanocomposites with Varied PZT Nanofiller Content (0.1% to 1.5% wt.)

4. CONCLUSION

PVDF-HFP/PZT blends underwent uniaxial stretching to tailor their structural and piezoelectric attributes with the aim of augmenting the electroactive β-phase. The findings stemming from the morphological characterization, assessed through Fourier transform infrared spectroscopy (FTIR) and X-ray diffraction, underscore the pronounced interaction between the nanofillers and the PVDF-HFP/PZT matrix. As a consequence of this effective nanofiller dispersion, the nanocomposite demonstrates a notable piezoelectric effect, as evidenced by the emergence of the β-phase and the concomitant reduction of the α-phase.

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Sustainable materials and processes

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PREDİCTİON OF THE MOST ECONOMİCALLY ADVANTAGEOUS COLOR FORMULATİON

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Abstract: This paper presents a technique based on genetic algorithm used for prediction of the most economically color recipe to reproduce the desired color. The objective is to optimize the color formulation step in reproducing the desired shades by simultaneously minimizing the CMC color differences, the metamerism index between the standard and reproduced colors and the cost of the proposed recipe. Two range of dyes were used in this study for dyeing bleached woven cotton fabrics: Four direct dyes (CI Direct Red 227, CI Direct Orange 34, CI Direct Blue 85 and CI Direct Black 22) and three reactive dyes (CI Reactive Red 238, CI Reactive Yellow 145, and CI Reactive Blue 235).

Keywords: color recipe prediction, genetic algorithm, multi-objective function, CMC color differences, metamerism index, and economical color recipe.

1. INTRODUCTION

In general, the most important problem in color recipe prediction is to determine the dyes to be applied and to find their respective correct concentrations to produce a match for a target shade. However, it is important to note that the cost of dyes used in the color formulation step is also a very important factor, along with other factors such as dye performance, color accuracy, and compliance of desired shades. Finding the right balance between cost and quality is crucial for achieving optimal results in color formulations. By carefully selecting dyes based on their cost, manufacturers can ensure that their color formulations meet budgetary constraints and maximize profit margins.

The majority of color formulation methods are based on Kubelka-Munk theory. For a detailed description of the Kubelka-Munk theory, one can refer to literature **[1,2]**. Different methods and techniques, based on colorimetric and spectrophotometric algorithms **[3-5]** or on artificial intelligence techniques **[6-8]**, have been proposed and applied for the color recipe formulation.

Color formulation plays a crucial role in colorimetry, particularly within the dyeing and finishing industries where it presents a significant challenge. In order to tackle this issue, this research proposes the implementation of a multi-objective genetic algorithm that aims to optimize the replication of desired shades at the lowest cost. The algorithm achieves this objective by simultaneously minimizing the CMC color differences, the metamerism index between the standard and reproduced colors and the cost of the proposed recipe. To evaluate the effectiveness of the algorithm, two sets of dyes were utilized to dye cotton fabrics, resulting in impressive outcomes characterized by minimal disparities in color and metamerism index while optimizing the cost of the proposed recipe. All CMC color differences values were either below or within the acceptable threshold of 1, and the majority of samples exhibited minimal metamerism, indicating a successful color match.

For evaluating the color differences between the target color and the color reproduced by the proposed recipe, we adopted the CMC(2:1) color differences formula in D65/10° **[9]**. It is currently the ISO standard for the textile industry (ISO 105-J03). For the metamerism index MI used in this paper, it was calculated compared to the pair of illuminants D65 and A **[10]**.

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2. MATERIALS AND METHODS

The textile samples utilized in this study were 100% bleached cotton fabrics. Two sets of dyes were employed to dye these samples, including three reactive dyes (CI Reactive Red 238, CI Reactive Yellow 145, and CI Reactive Blue 235) and four direct dyes (CI Direct Orange 34, CI Direct Red 227, CI Direct Blue 85, and CI Direct Black 22). All dyeings were performed in a laboratory machine type *DataColor AHIBA Nuance Speed* with a liquor ratio of 10:1. The reflectance spectra of the dyed samples were measured using a spectrophotometer *Spectraflash 600 Plus*.
For the step of color recipe a genetic algorithm was developed **[11,14]**. The proposed algorithms should predict the most suitable and economical dyeing recipe in multicomponent mixture.

3. RESULTS AND DISCUSSION

Results obtained by applying the proposed algorithm to predict the most economical dyeing recipes of 40 target color samples showed a good matching between all the proposed recipes and the target colors based on the CMC color differences. All values of CMC color differences are considerably less than 1 which is very acceptable in the textile industry **[15]**, except some target samples which the maximum $\Delta ECMC(2:1)$ are at the limit of the acceptability threshold. Concerning the metamerism the majority of proposed recipes has minimal values of metamerism and are considered as a good match. The highest values of metamerism index for other samples can be explained by the use of dyes different from those used for the preparation of target colors. It corresponds to a questionable match, thus it needs to be a subject to additional analysis.

4. CONCLUSION :

This work presents a new algorithm for color recipe prediction which uses multi-objective optimization to optimize simultaneously the CMC color differences, the metamerism index between the standard and reproduced colors and the cost of the proposed recipe. The developed algorithm is able to predict the right dye recipe while optimizing costs. This is especially crucial in industries where color plays an important role, such as textiles. The cost control is essential to maintain profitability.
The technique of combining CMC color differences, the metamerism index and the used dyes cost in the same algorithm objective function is helpful in achieving reliable results in color formulation. Application of this algorithm to reproduce standard colors results in satisfactory outcomes, with a majority of predicted recipes having low values of CMC color differences and minimal metamerism. These initial results demonstrate the potential of the proposed algorithm and suggest further investigation is warranted.

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SUSTAİNABLE DYEİNG PROCESS OF COTTON FABRİCS WİTH MİXTURES OF REACTİVE DYES: RECONSTRUCTİON AND REUSE OF EXHAUSTED DYEBATHS.

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Key Words: Dyeing, Dyebath Reuse, Color, fastness, DBO and DCO.

1. INTRODUCTION

The textile industry has long been recognized as a major contributor to global pollution. In this industry, the finishing process standing out for its significant environmental impact, characterized by an excessive water and energy consumption, as well as the generation of toxic effluents. To address these concerns, various methods have been developed such as wastewater treatment, green chemistry, and the optimization of textile processes [1,2]. However, their implementation often presents challenges due to high costs and complexity, impeding widespread adoption among textile companies. In this context, the direct reuse of residual dyebaths emerges as a promising approach to reduce the environmental footprint of textile dyeing. By reconstituting exhausted dyebaths obtained from previous dyeings, water, dyes, and auxiliaries can be conserved [3,4]. Previous studies, realized for dyeing with just one dye (reactive or acid), have demonstrated that this method can produce comparable colors and fastness to the initial dyeing process [5].

Considering these opportunities, this study explores the viability of employing residual dyebath reuse technique for dyeing cotton fibers using different mixtures of reactive dyes (in bichromatic, trichromatic or even more). For this, a range of three reactive dyestuffs was selected for experimentation. These dyes are used in binary and ternary mixtures to achieve a wide range of shades on cotton fabrics. After each dyeing cycle, residual dyebaths were analyzed, reconstituted, and reused multiple times. Several responses were evaluated to assess the effectiveness of the dyebath reuse method. Dyebath exhaustion, (*K*/*S*), CIELab coordinates and fastnesses were measured to evaluate the conformity of dyed samples. Additionally, DBO and DCO values were assessed to evaluate the environmental impact of the different residual dyebaths.

2. Materials and Methods

In this study, pre-bleached woven 100% cotton samples were used for dyeing. The fabric had specific characteristics including 2/2 twill weave pattern, fabric weight of 206.25 g/m^2, fabric thickness of 0.59 mm, and warp and weft densities of 25 and 19 threads/cm, respectively. To dye these textile samples, a range of three reactive dyes, namely C.I. Reactive Yellow 145, C.I. Reactive Red 238, and C.I. Reactive Blue 235, were used. Their compatibility in mixtures was proved in previous study [6]. Other chemical auxiliaries such as a wetting agent, electrolyte, and alkali were added in dyebaths to enhance the dyeing efficiency. Dyeings were carried out using an Ahiba machine, maintaining a liquor-to-fiber ratio of 10:1. After each dyeing cycle, a finishing treatment was conducted to remove unfixed dyes from the samples. The treatment included hot rinsing, neutralization, soaping, and cold rinsing steps.

3. Results and Discussion

After each dyeing, residual dyebaths were analysed using a spectrophotometer, reconstructed and reused for at least five successive cycles. Figure 1 illustrates the steps involved in the dyebath reuse procedure. The absorbance spectra measured for an example of studied mixtures (dyebath composed of 0.25% yellow dye, 0.25% blue dye, and 0.25% red dye) are presented in Figure 2. The absorbance values obtained at the specific λ_{max} of each dye were used to determine the residual dye concentrations of the residual dyebaths.

The results obtained from the conducted experiments were highly satisfactory. The color differences observed between samples dyed with the original dyebaths and those dyed using the residual dyebaths remained below the threshold of 1, indicating acceptable color conformity with minimal deviations. Reproducibility of dyeing, color evenness and fastnesses of dyed samples are also good. These results prove the effectiveness of the dyeing process using reconstructed residual dyebaths for the studied mixtures of reactive dyes. Furthermore, the reuse of residual dyebaths resulted in significant water conservation, with a remarkable reduction of approximately 80% in water consumption compared to conventional dyeing methods. Obtained values of DBO (biological oxygen demand) and DCO (chemical oxygen demand) for the reused dyebaths showed a slight increase compared to the initial dyebaths. However, these changes remained within acceptable limits. The impact on water pollution indicators remained manageable, emphasizing the overall viability and positive environmental performance of the dyebath reuse method.

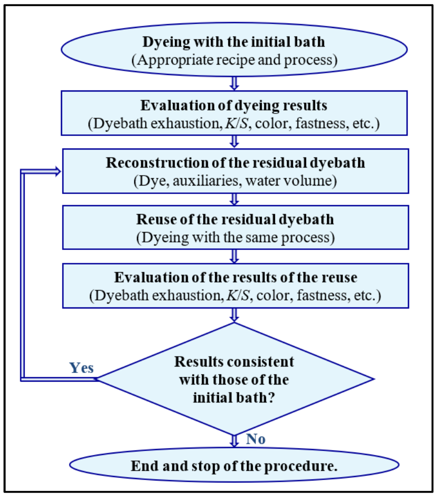

Figure 1. Dyebath reuse procedure.

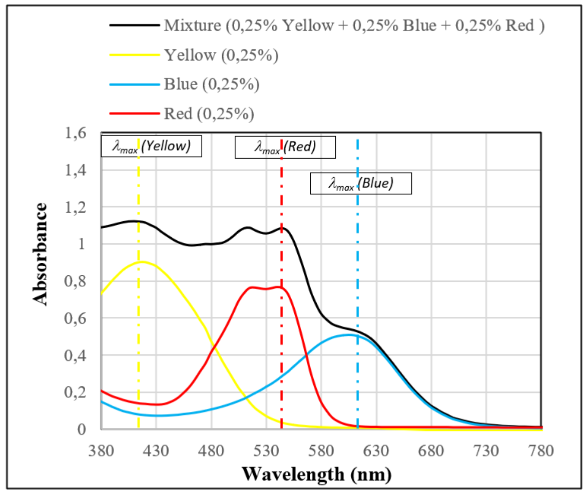

Figure 2. Absorbance spectra of an example of mixture.

4. Conclusion

This study has investigated the feasibility of reusing residual dyebaths for cotton dyeing with different mixtures of reactive dyes, in particular trichromatic mixtures. Through analysis, reconstitution, and multiple reuses of residual dyebaths, the effectiveness of the dyebath reuse method was evaluated. The results have demonstrated that the color of samples dyed with reused dyebaths remained comparable to the initial dyebaths, exhibiting acceptable levels of color conformity, *K/S* values, and fastness properties. This indicates the successful application of the dyebath reuse method in achieving desired color outcomes while reducing the consumption of water, dyes and auxiliary substances.

To further advance the dyebath reuse method, additional studies and developments should be explored. Particularly, expanding the range of dyes and shades presents an opportunity to enhance the versatility and effectiveness of the dyeing process. By applying this technique, resources could be optimized and effluents minimized, leading to a more sustainable approach for cotton dyeing.

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APPLİCATİON OF THE REBA METHOD TO ASSESS ERGONOMİCS AND MUSCULOSKELETAL RİSK İN FEED OF THE ARM SEWİNG MACHİNE WORKSTATİONS: A CASE STUDY İN GARMENT MANUFACTURİNG

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Key Words: Ergonomics, REBA method, Workstation analysis, Musculoskeletal risk, Garment manufacturing.

1. INTRODUCTION

The garment manufacturing industry poses ergonomic challenges and musculoskeletal health risks to workers due to the physically demanding nature of the work [1]. This study focuses on evaluating the ergonomic aspects and musculoskeletal risk factors in feed of the arm sewing machine within the garment production chain. The REBA (Rapid Entire Body Assessment) method is applied to assess posture-related risks and identify areas for improvement [2]. The objectives are to determine overall risk levels using the REBA method and identify specific high-risk postures [3]. The findings aim to provide insights into ergonomic challenges and recommendations for enhancing worker well-being and productivity in the garment manufacturing industry.

2. MATERIALS AND METHODS

The study aimed to assess ergonomic risks in the feed of the arm sewing machine workstation, which involves the task of sewing garments in a sitting position within the garment manufacturing process. Video recordings were made to capture the work processes for analysis. The REBA method scores each part of the body and determines the risk levels by using the tables which were developed by Hignett and McAtamney to measure the risk levels of the working posture. It was applied to evaluate the ergonomic risks, considering joint amplitudes in the upper limbs, neck, and trunk. Risk scores were assigned to different body parts based on observed postures. An overall risk score was calculated for each position, indicating the general level of ergonomic risk. A detailed review of the scores helped identify specific postures that contributed to high-risk levels. When applying REBA [4], six steps are followed. First, the task is observed. Next, specific postures are selected for assessment. These postures are then scored. The scores are processed to establish the REBA score. Finally, the urgency for control measures is determined by confirming the action level.
The findings were documented, including risk scores, constrained postures, and recommendations for improvement. This study provides valuable insights into the ergonomic challenges in garment manufacturing positions and offers suggestions to enhance worker well-being and mitigate musculoskeletal risks.

3. RESULTS AND DISCUSSION

The REBA method was applied to assess the ergonomic risks associated with the feed of the arm sewing machine tasks in the garment manufacturing process. Analysis of the video recordings revealed various postures and gestures performed during this task. The evaluation focused on the postures of the shoulder, elbow, wrist, neck and trunk. The measurements conducted for the feed of the arm sewing machine position resulted in TMS risk scores ranging from 9 to 12. These risk scores indicate a high level of risk, necessitating prompt intervention for improvement. The sewing position exhibits regular, repetitive, and fast movements of the upper limbs, with infrequent gestural pauses. Additionally, the sewing task imposes significant physical exertion, leading to increased strain on the shoulders, elbows, and neck. The results of the evaluation indicated a high level of ergonomic risk. The overall risk score obtained was 11,09, which falls within the category of

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"high risk requiring intervention." This suggests that immediate measures should be taken to improve the ergonomic conditions of this workstation.
To address the identified ergonomic risks and enhance worker well-being in the workstation, several improvements are suggested. These recommendations aim to minimize musculoskeletal stress and optimize working conditions. First, ergonomic principles should be applied in the design and layout of the workstation, ensuring proper alignment and minimizing excessive reaching or bending. Second, providing ergonomic tools and equipment, such as adjustable-height boards can significantly reduce strain on the body. Third, training sessions should be conducted to educate workers about proper body mechanics, postural awareness, and the importance of regular breaks and stretching exercises. Additionally, implementing job rotation and task variation strategies can help reduce prolonged exposure to repetitive movements. Lastly, conducting regular ergonomic assessments and continuously monitoring and modifying interventions based on the findings will ensure a safer and more comfortable working environment. By implementing these improvements, the aim is to mitigate musculoskeletal risks, promote worker well-being, and enhance productivity in the garment manufacturing industry.

4. CONCLUSION

In conclusion, this study focused on evaluating the ergonomic aspects and musculoskeletal risks in the feed of the arm sewing workstation of the garment manufacturing industry. The application of the REBA method provided valuable insights into the postures, movements, and associated risks involved in the sewing task. The findings revealed a high level of ergonomic risk, highlighting the need for prompt intervention to improve working conditions and mitigate musculoskeletal stress. To address these risks, it is recommended to implement ergonomic principles in workstation design, provide appropriate tools and equipment, offer training and education, introduce job rotation and task variation, and conduct regular assessments. By prioritizing worker well-being and addressing ergonomic challenges, the industry can promote a safer and more comfortable work environment.
Further research is needed to explore additional interventions and optimize worker well-being in other positions within the garment production chain. By continuously improving ergonomic conditions, the garment manufacturing industry can enhance worker health, productivity, and overall efficiency.

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ON THE VALORİZATİON OF CERTAİN COMPONENTS EXTRACTED FROM OPUNTİA FİCUS İNDİCA L. İN TEXTİLE FİNİSHİNG

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Key Words: textile finishing, bio-sourced materials, Opuntia ficus indica L

1. INTRODUCTION

The valorization of local natural resources is an approach consistent with sustainable development and with the conservation of the environment and its protection. Within this framework lies the subject of the thesis proposed for the valorization of Opuntia ficus indica L. in textile and para-textile applications: such as: the formulation of adjuvants for dye baths (wetting, dispersing) or/and the formulation of thickeners and adjuvants for textile printing pastes. The potential use of extracted fibers as reinforcement for bio-sourced composites is conceivable, in particular in packaging or for the extraction of cellulose nano-fibers and their use in the development of nano-composites.

The objective of this work is the detailed study of the potential of the major components extracted from Opuntia ficus indica L. (in particular from the plant racket) for the formulation of adjuvants for dye baths (wetting, dispersing).

2. Methodology

The experimental approach adopted: the presentation of the raw material, the extraction process implemented as well as the chemical, physical and rheological characterization of the product extracted from the opuntia ficus indica (OFI) plant.

We adopt the following scheme:

Review of the state of the art relating to Opuntia ficus indica L.: composition, extraction methods and techniques, physico-chemical properties and intended/possible applications.

Experimental study for the extraction and valorization of the main components of Opuntia ficus indica L.

Characterization of the extracts obtained in terms of ability to work as adjuvants in textile finishing.

3. Results and discussions

The different results found during this study can be summarized as follows:

In terms of extraction yield, we reached a value of 17.56%,

In terms of the characteristics of the extract: it turned out to be rich in polysaccharides (54%) and galacturonic acid (38%), with more protein (1.19%).

This being proven by IR-TF and NMR spectra.

At the rheological behavior level, the extract shows viscosities for the 1 and 4% solutions, respectively of the order of 1.6 and 4.6 mPa·s. and interesting emulsifying properties (93%).

4. Conclusion

We can conclude that our extract has very promising emulsifying properties in the textile field; this is approved by the very appreciable extraction rate and by the antioxidant power of this extract.

In fact, this work presents a first part in the valorization of the extract of this plant and as prospects we propose to use it as a thickener-emulsifier in printing pastes or as a coagulant and flocculants in the fields of treatment of textile effluents and apply it on an industrial scale.

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PLASMA JET TECHNOLOGY TO IMPROVE THE HYDROPHOBICITY OF FLAX FABRICS

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ABSTRACT
Functional textiles have become very demanded in modern societies regarding their protective character (flame resistance, anti-bacterial...).
Hydrophobic textiles are required in clothing and housing applications mainly as anti-stain materials.
They are obtained conventionally by using either toxic elements like Fluor or chemical processes with waste (water waste, chemicals…). In this study, we investigated the hydrophobic properties of woven textile material based on flax and treated with Si grafting assisted by atmospheric plasma technology using Hexamethyldisiloxane, HMDSO as Monomer. This treatment presents the advantages of being eco-friendly as a process (only electrical consumption of the plasma jet machine) and as chemicals (Si is non-toxic, no wastes). We varied the concentration of grafted Si on the textile surface by changing machine parameters like HMDSO flow and exposition time of textile to plasma jet. Then we investigated its hydrophobicity and resistance to washing. Observations with Scanning Electronic Microscopy (SEM) show that the coating becomes thicker for higher concentration and more extended time exposition.
Nevertheless, the coating is non-continuous and remains on the surface exposed to the jet without penetrating the fiber core. This coating significantly improves the textile substrate's hydrophobic, evidenced by contact angle goniometry. The surface tension shows a spectacular decrease with a contact angle of 150°. The treated textiles have been washed to test the permanency of the treatment after 1, 2, and 3 washing cycles. Morphological and contact angle analyses showed a decrease in the quantity of Si deposition and the contact angle, evidencing a loss in the quantity of Si molecules grafted on the surface. However, the substrate was still hydrophobic with a contact angle of 130° versus 150° respectively for washed and non-washed material. This result proves that a thin film of Si is firmly grafted to the cellulosic material.

Key Words: FLAX FABRIC, HYDROPHOBY, PLASMA JET, SI GRAFTING

1. INTRODUCTION
The use of artificial fibers such as carbon, aramid or glass fibers has been the subject of major studies in recent decades to give them some functionalities (flame retardant and water-repellent textile). Current development trends are turning to natural fibers because of their many advantages over artificial fibers: renewability, biodegradability, low cost, low density, non-toxicity, good availability, low abrasiveness (compared to glass fibers) and good mechanical properties. However, certain drawbacks limit their industrial applications such as low compatibility with the hydrophobic polymer matrix, thermal sensitivity to the temperature of the mixing process and flammability. It is on these weaknesses that research and development efforts are now focused on functionalisation of textiles made from natural fibers. Thus, for example, hydrophobic and breathable clothing in development. For fire safety reasons, some fabrics must be flame retardant. Specific additives are then necessary depending on the desired application.

2. MAIN OBJECTIVE
The main objective in this work is flax fabric functionalisation, which we investigate its hydrophobic properties and treated it with Si grafting assisted by atmospheric plasma technology using Hexamethyldisiloxane called HMDSO as Monomer.

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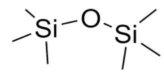
3. MATERIALS AND METHODS

The flax used within this work was provided by Hexcel, with an areal weight of 200 g/m² was used in this study. The composition of flax fibers is 81% by weight of cellulose, 13% by weight of hemicellulose, and 2.7% by weight of lignin in good agreement with literature [2]. The product used is hexamethyldisiloxane (HMDSO) provided by Sigma Aldrich.

Table 1. Chemical HMDSO structure



The flax samples were treated using an atmospheric pressure plasma jet technology (Figure1) system from Plasmatreat Company (Plasma treater AS400, Stein Hagen, Germany) for surface activation at atmospheric pressure [3]. The control of the Silicone film thickness by the variation of the following machine parameters : first, the flow rate of HMDSO and Exposition time of the textile to the plasma jet. Then, the morphological characterization and the chemical composition using SEM (Scanning Electron Microscopy) and EDX (Energy Dispersive X ray). Finally, measuring the contact angle in order to determine the water repellency and checking the resistance of treatment against washing.

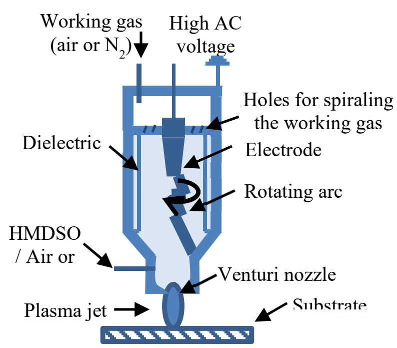


Figure 1. Picture of the Atmospheric Pressure Plasma Jet technology system used for the deposition of SiO_x film

4. RESULTS AND DISCUSSION

The control of the silicon film thickness increases by the variation of machine parameters: the exposition time to the torch and HMDSO flow rate. A morphological characterization of flax fibers grafted with 40 g/h HMDSO in two passages of the torche at 10m/min using plasma jet treatment.

Morphological observations and chemical composition

A morphological observation in the figure2.b of a coated fabric show that silicone film is visible but not continuous, Si element represents 22% in weight in some area of the surface. Then, the observation of fibers cross-section after coating in figure 2.c under EDX shows the presence of Si on the fiber surface exclusively, silicone film does not penetrate the fibers core. As it is shown in figure2.d that Si coating is still deposited on the fibers after 3 washing cycles. The material loses 0.06 wt.%, 0.7 wt.% and 0.67wt.% respectively after the 1st, 2nd and 3rd washing cycles.

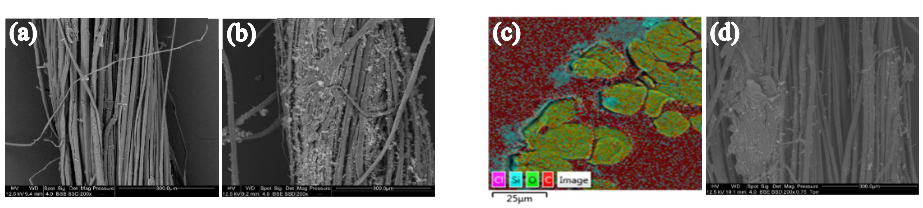


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Figure 2. Picture of a raw fabric (a), coated fabric (c), cross-sectional composition of coated fabric (c) and washed fabric (d)

Water repellency

The following table1 summarize the contact angles and deposition time values measured after Silicone deposition that are the key factors required for the water repellency determination. Thus, when the fabric is coated with plasma jet, it will be considered as hydrophobic if the water droplet stands for 49,5min. Also, we remark that the contact angle decreases to reach 140° for the 1st washing cycle. Then almost stabilized at 128° after the 2nd washing cycles. Furthermore, water droplet absorption time decreased drastically to reach 14.6 min after the 1st wash and 9.5 min for the 2nd and 3rd washing cycles. In consequence, washing alters the coating water repellency performances but a thin coating remains strongly deposited to the flax fabric

Table 1. Contact angle and drop deposition time results before and after washing for a 40g/hr dose

Coated fabric		1 washing cycle		2 washing cycles		3 washing cycles	
Contact Angle (°)	Deposition time (min)	Contact Angle (°)	Deposition time (min)	Contact Angle (°)	Deposition time (min)	Contact Angle (°)	Deposition time (min)
149 ±6	49.5 ±4	140 ±1	14.6 ±3	128 ±3	9.66 ±4	126 ±6	9.5 ±4

5. CONCLUSION

In conclusion, silicone film deposited on flax woven surface show a not continuous coating which is deposited on the outer fibers surface exposed to plasma jet and it make the fabric hydrophobic. Also, washing decreases the fabric hydrophoby drastically after the 1st cycle. In addition, a thin silicone film seems to be strongly deposited on flax surface; it is still there after 3rd washing cycles.

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FLAME RETARDANCY OF COTTON FABRİC BASED ON CHİCKEN EGGSHELLS

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Key Words: Fire-retardant, eggshells, cotton fabric

1. INTRODUCTION

Textile fibers contain a high content of carbon and hydrogen in their structure which provides the fuel for combustion and therefore are hazardous in case of a fire accident. A suitable flame retardant treatment for textiles is a common practice for their fire safe applications. Although plenty of well-known effective FR systems are already known for textile applications, there is a need to develop new effective environmental friendly agents and their treatments to meet existing environmental and technical requirements. The present study aimed to use chicken eggshells particles in a coating formula based on acrylic paste. Several parameters have been studied to determine optimum treatment conditions: eggshell particles content, squeezing rate, bath temperature.

2. MATERIALS AND METHODS

2.1. Materials collection

Unboiled chicken eggshells (COB) were gathered from restaurants and household waste within the central area of Monastir. The studied fabric is a 100% cotton plain weave fabric, 153g/m^2. The fabric was prepared in a treatment bath containing 2g/L anionic detergent and 3g/L sodium carbonate, at a temperature of 60°C for 30 min. It was then rinsed and dried.

2.2. Preparation

The waste chicken eggshells were washed with in tap water and rinsed with distilled water. The internal white membrane eggshell was manually separated from the eggshells. A second rinsing of the samples was carried out at this stage with distilled water at room temperature. Drying was carried out at 50°C in an oven for 2 hours to eliminate any left-over water in the eggshell. In order to obtain a powder, the eggshells were ground using an electric grinder [1]. The obtained particles (70,53µm of diameter) is the result of a grinding for 60s and a sieving through a 595µm sieve mesh.

2.3. Coating process

The eggshell powder was dispersed in a solution containing an acrylic binder under mechanical stirring (550rpm) for 2min. Then the suspension was heated in a thermostatic bath (25°C and 30°C). The treatment bath contains 10mL of water and 20mL of acrylic binder [2]. The coating process is illustrated in figure 1 and many process parameters will be discussed.

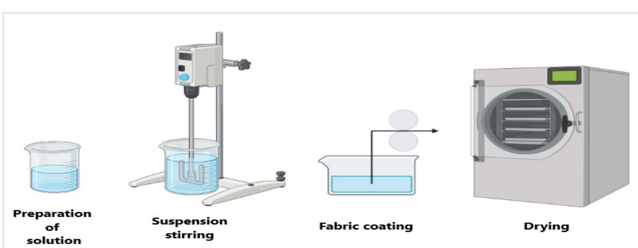

Figure 16. Coating process

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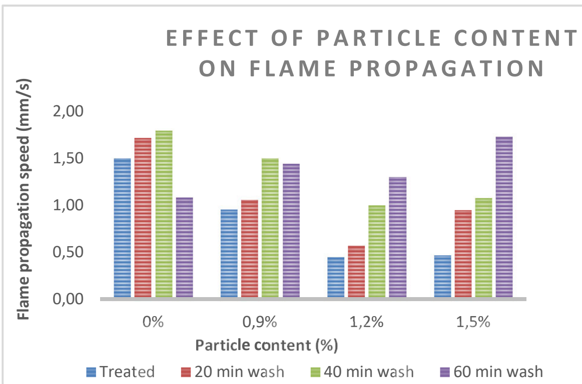
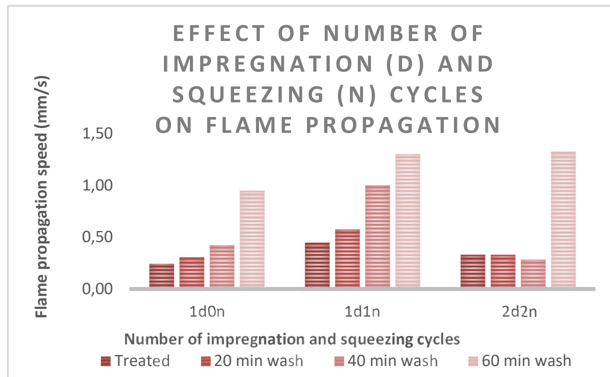
2.4. Flammability test: ASTM D6413 Standard Test Method for Flame Resistance of Textiles (Vertical Test) is used in this work. The time during which the sample stopped burning was recorded in order to determine the flame propagation speed. The measurements were repeated three times for each sample.

2.5. Wash durability: Coated samples were washed, rinsed and then dried at 80°C for 5 minutes. They were then conditioned for 24 hours before starting the flammability test [3].

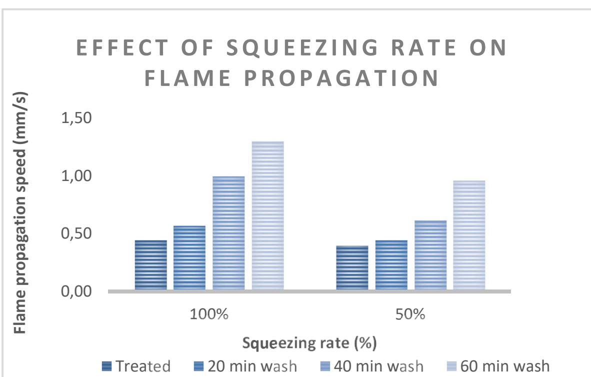
3. RESULTS AND DISCUSSION

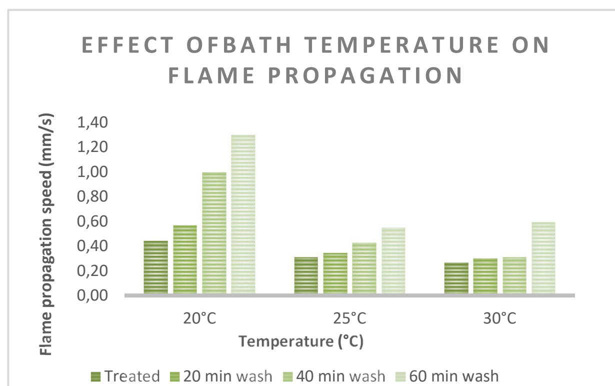
Flame retardancy performance: Figure 3 summarizes the effect of coating parameters on the flame-retardant properties of eggshell-based treated cotton.





(a) (b)





(c) (d)

Figure 17. Effect of various coating parameters on fire propagation speed : (a) Eggshell particles content, (b) number of impregnation and squeezing cycles on flame propagation, (c) process squeezing rate, (d) bath tretment temperature

According to the results found, a better retarding effect was demonstrated for a particle content equal to 1.2%, with a more stable wash fastness. (Figure 3.a)
Better fastness was observed for double impregnation and squeezing (Figure 3.b).
Treatment bath temperature ensures good durability even with a 40min wash cycle (Figure 3.c).

4. CONCLUSION

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In this study, the effectiveness of eggshell-based flame retardant treatment was achieved with an eggshell particles content equal to 1.2%, in a double impregnation bath at 30°C and 100% squeezing rate. Physic and chemical characterization of eggshell particles will be added to the full paper to explain the fire retardancy properties of the eggshell particles used in the coating formulation.

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LIVING DESIGN: VALUING NATURE INSTEAD OF EXPLOITATION

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ABSTRACT: Climate change, pollution, biodiversity decline, and overexploitation are alarming signs of the current ecosystem's state. Regenerative design offers a framework to adapt biodesign urgently, aligning scientific advancements with natural systems for a sustainable future. Living design enhances natural systems' vitality to meet present and future needs. Collaboration between scientists and designers is crucial, emphasizing biologist designers and living materials for sustainability. Neri Oxman's "Silk Pavilion" project exemplifies cohabiting with living organisms to create large-scale architectural structures, preserving biodiversity, and regenerating the natural system

KEYWORDS: Living Design, Regenerative Design, Sustainability, Cohabitation.

1. INTRODUCTION

Amidst our ecological crisis, designers are reevaluating our relationship with the environment and natural systems to shift the paradigm of sustainable design. Regenerative design offers a framework to catalyze this transition by creating models that regenerate life-support systems and resources. In this article, we examine the dynamic between scientists and designers amid ecosystem degradation, emphasizing the role of the biologist designer and living design in shaping a more sustainable future. Within this context, the question that arises is: How can we design in partnership with natural systems? From this perspective, we explore Neri Oxman's thinking by presenting her Silk Pavilion project, which answers this question in a concrete way. With her interdisciplinary group MTG, she has produced new forms of nature that bridge the gap between the digital ecosystem and the natural ecosystem, exploring the bio-digital world and aiming to valorize nature instead of exploiting it.

2. LIVING DESIGN CONTRIBUTE TO CREATING A MORE SUSTAINABLE FUTURE

Designers have embraced the advancements in biology and technology, exploring innovative approaches to living organisms and their processes. They envision new forms of life and create designs that challenge our relationship with nature while incorporating scientific concepts and methods. Thierry Marcou, in his article "Towards a Design of Synthetic Life," introduces the concept of living design, where science becomes a crucial tool in the designer's toolkit [8]. This evolution reflects the fusion of living beings and technology, as designers harness scientific knowledge and biological tools to creatively and scientifically express the potential of living beings in design processes. The designer's role involves coordinating actions carried out by living beings to achieve conceptual objectives, creating living systems and devices applicable on a conceptual level. A new generation of designer-researchers seeks to explore scientific reflection, adopting a research axis that approaches living beings in a way that values nature rather than exploits it. Their aim is to foster symbiosis between human bodies, the microorganisms they host, the environment, and objects. These approaches involve treating the living as a model, collaborator, and hackable system for redesign, by imagining a new form of life created by the designer [5]. This increasing synergy plays a fundamental role in the ecological transition towards "naturalizing" design [3].
Within this perspective, we explore various ways in which the design of living materials and creations can actively engage in the restoration process.

2.1. Biofabrication: a process of reversal

Integrating the living into the heart of design creation, designers have used biofabrication and disruptive living technologies that prioritize process over form [1]. They draw inspiration from biology and exploit biological processes to design sustainable alternatives to conventional materials. Working with for nature, they produce biomaterials from living organisms such as mycelium, kelp, bacteria or yeast, resulting in living objects that

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interrelate with the surrounding environment. dea de reducing negative impact on the environment, duvivant design seeks to promote the regeneration of ecosystems by creating closed resource systems that maximize ecological productivity and actively engage with biological systems. Biomaterials are seen as living entities, growing, evolving and interacting with their environment to create harmonious architectural structures interrelated with natural systems. According to Neri Oxman, this approach is known as "Material Ecology," encompassing a design philosophy, a field of research, and a scientific approach that explores, explains, and expresses the relationships between the building, its environment, and its enrichment [7]. Material Ecology studies the relationship between material production and the environment, considering materials as living elements with a harmonizing and interrelated relationship. This ecological approach focuses on the complete life cycle of materials, from extraction to use and disposal, taking all associated environmental impacts into account. It also aims to reveal the connection between buildings and the natural environment.

2.2. Synthetic biology is the soul of biomaterials

Synthetic biology is an emerging field that combines biology, engineering, and computer science to create programmable and controllable artificial biological systems. This innovative approach aims to design semi-natural biological structures, allowing humans to influence living organisms and their growth processes to develop living biomaterials tailored to our needs and nature's. Carole Collet defines this synergy between design and synthetic biology as a response to the challenges of regenerative design, focusing on integrating natural sciences and humanity to regenerate biodiversity, climate, and communities (14. Central Saint Martins, 2019). Designers seek to develop sustainable solutions that harmonize with living systems and restore environmental balance. Living design, viewed as a key means of achieving restorative and integrated sustainability, allows the creation of objects, buildings, and environments that align with living systems.

2.3. The hybrid nature: restoration process

Figures Designers, architects, and artists are exploring the fusion of biology, digital technology, and nanotechnology to create hybrid organisms that combine living and non-living elements. This convergence of sciences is breaking down barriers between previously separate domains, connecting living technologies with current scientific advancements. By doing so, they are developing a new creative language to illustrate the potential of these hybrid systems for the future [1]. This vision imagines an enhanced nature and explores new definitions of "life," with creators acting as alchemists seeking to combat ecological degradation while enhancing nature. They display a strong interest in ecology and embrace the bio-digital world, where digital programs can help restore nature's place.

Hybridization enables the development of innovative ecological architectural protocols and new composites using living and synthetic materials through techniques like bio-hacking, computational design, and digital prototyping [6].

In conclusion, biomimicry, biotechnology, and co-fabrication are fundamental elements in creating bio-integrated ecological design capable of adapting to future changes and ensuring sustainable living for generations to come. The proposed framework visualizes the various ways in which living design contributes to regenerative design. In this context, living design is envisioned as an operational framework fostering different forms of creation, aiming to give birth to a form of life—a material ecology in interrelation with the environment.

On the other hand, regenerative design positions itself as a theoretical framework guiding and framing the integration of living elements into our designs while respecting ethical principles regarding intervention on the living. The following figure illustrates the interrelation between these two complementary approaches to creating healthy, resilient, and sustainable designs.

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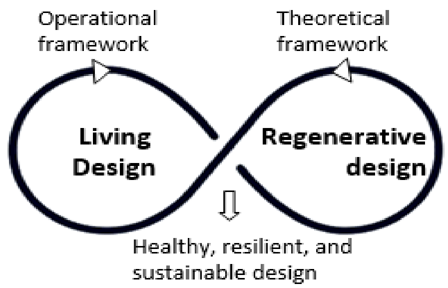

Figure 1: The mutually beneficial relationship between living design and regenerative design for sustainable conception (Personal Work)

3. Bio-Digital Cohabitation: Valuing Nature Instead of Exploiting It - Neri Oxman's Silk Pavilion Project

The Silk Pavilion project, created by Neri Oxman, showcases her research on the ecology of materiality for regenerative design. It explores the potential collaboration between humans and other living species to develop sustainable materials and structures without depleting natural resources. The project's initial experiment in 2013 inspired a second version in 2020, known as Silk Pavilion II, displayed at MoMA in New York, which features a new geometric form achieved through the manipulation of various technological programs while maintaining the same materiality, silk fiber.

Oxman's approach combines nature-inspired design with digital fabrication techniques, rooted in understanding design principles derived from nature, which are then replicated using technological design programs and digitally constructed. These projects are referred to as biologically informed, as they are designed by, with, and for nature.

3.1. Project Presentation

This project aims to integrate kinetic fabrication and biological design, bridging technology and biology by incorporating silkworms into the construction process. The Silk Pavilion II is a 6-meter-long floating structure designed in a horizontal orientation, featuring a downward mechanical kinetic manipulation that enables constant clockwise rotation, facilitating the upward rotational movement of the mulberry bombyx or silkworms.

Figure2: Photo of the Silk Pavilion II (2020) exhibited at MoMA, New York, 2020

The Pavilion's structure consists of two layers of silk threads. The primary structure is tensioned by a scaffolding system of cables, with silk fibers woven by living beings acting as a "biological printer." An intermediate layer of knitted yarns, laid by the Robotic CNC winder machine, provides support for the silkworms, giving them a surface on which to weave their threads

3.2. Materiality: The Living at the Heart of Design.

The decision to collaborate with silkworms was driven by the desired materiality of natural silk fibers, renowned for their lightweight and soft properties. Additionally, silk possesses the unique ability to provide warmth during winter and coolness during summer. Through various biological experiments, it was observed that silkworms are highly responsive to environmental conditions, particularly light and natural heat. Their movement is influenced by these variable factors, causing them to migrate towards darker and denser areas. This natural behavior significantly impacted the geometry of the Silk Pavilion II structure.

Figure3: The silkworm in design conception

3.3. Design Process: Hybridization between digital and biology; biodigital

Although strongly inspired by the first version of the Silk Pavilion in 2013, which employed an algorithm to place a single continuous thread with varying density, this new version exhibits a geometry designed by living beings in response to environmental conditions such as sunlight and heat [9]. In this project, the intermediate layer and scaffolding were the only pre-defined components, while the weave of the primary layer was achieved through numerous experimental attempts, adjusting the structure's orientation and exposure to the sun. As a result, the structure can take on various forms depending on the environmental conditions it encounters [7].

Figure3: The pavilion in the process of weaving by a living organism digitally controlled by humans

This project highlights the significance of both machinery and biology. Both fields are combined to create a seamless fusion, with digital technology replicating and refining existing natural processes. By manipulating environmental factors, it becomes possible to control the actions of living beings within the space. The outcome is a naturally woven silk-fiber structure with variations in density, making this pavilion an experimental project that can be further developed and adapted

3.4. Embracing an Age of Symbiosis for New Material Ecology

This approach opposes the traditional conception of the design object as a mere assembly of parts with distinct functions. Instead, it strives to usher in "an age of symbiosis," moving away from the machine age and embracing materials and life forms designed to interact dynamically and evolve in harmony with their environment [7] Neri Oxman is particularly intrigued by the way form and matter coalesce during the growth process. Rather than merely replicating the form or function of an organism in a material object, it is crucial to comprehend how form and matter harmoniously emerge during growth.
Oxman's Silk Pavilion represents a revolution in the field of architecture, as it merges architecture, machinery, and biology to tackle climate challenges. Departing from the conventional silk industry's exploitative approach to nature, Oxman introduces a new paradigm that seeks to surpass nature through techniques closely aligned

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with the natural environment. Her ultimate aim is to harness the potential of living design to cohabit harmoniously with nature.

4. Conclusion

Viewing her work as a significant scientific contribution to ecological activism, the architect emphasizes the need for a new intelligence in design and prioritizes material quality over quantity, all with the aim of restoring a natural balance—a concept she aptly terms "Nature 2.0."[2].

This response stems from the imperative to design objects and systems in perfect harmony with nature.

These pioneering models thrive on the synergy between digital ecosystems and natural ecosystems, aspiring to achieve biodigital design, where nature's value is renewed and invigorated through digital programs, guided by human control.

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COMPARATİVE STUDY OF ONE-BATH AND TWO-BATH DYEİNG PROCEDURES OF DOUBLE-FACED COTTON/POLYESTER FABRİC

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KeyWords: Double-faced; Dyeing; One-bath; Exhaustion; Kinetic.

1. INTRODUCTION

Double-faced fabrics are used for various aesthetic and functional purposes where one single fabric provides two different characteristics. Double-faced fabrics are those that have a different color, pattern, or texture on the top and bottom layers of the fabric. Woven double-faced fabrics could be composed either by one set of warps and two or more sets of wefts, or by two or more sets of warps and a single set of weft yarns.

Polyester/cotton (P/C) blends posses some challenges to dyer as polyester shows a hydrophobic character while cotton shows a hydrophilic character making it inevitable to dye them with chemically different classes of dyes.

The conventional method of exhaust dyeing for P/C blends is to dye each component separately under its optimum conditions, i.e. in a two-bath process. To address the issue of productivity and raising environmental concerns, several attempts have been made in the past to shorten this to one-bath processes [1]. The one-bath dyeing process uses a separated high pH and low temperature reactive fixation step after the high temperature, low pH disperse dyeing to avoid a high rate of hydrolysis of both disperse and reactive dyes under high temperature, or high pH dyeing environment. The one-bath two-step dyeing procedure is shorter as compared to two-bath method, but the drawbacks are lower dyeability and poor reproducibility. One-bath one-step dyeing process of P/C blends with disperse/ reactive (D/R) dyes has the advantages over the conventional dyeing processes on reducing the dyeing cycle and is far more efficient in terms of productivity and energy conservation. One-bath one-step dyeing of P/C blend with disperse dye after acetylation of cotton was investigated to reduce the dyeing cycle, as well as energy consumption and also the effect of acetic anhydride and time on percent acetyl content at room temperature was studied [2]. Recently, a novel strategy for dyeing P/C blends has been proposed, involving pre-treatment with the biopolymer chitosan and subsequent dyeing using direct dyes [3].

The present work involves a comparative study of three different dyeing procedures of P/C double-faced fabric. The first method is a conventional two-bath two-step dyeing of P/C double faced fabric. The second is a one-bath two-step dyeing of P/C blend fabric. Then, the last technique is a one-bath one-step dyeing process of P/C blend with reactive and disperse dyes.

2. MATERIALS AND METHODS

2.1. Fabric weaving

Double faced P/C fabric was fabricated on a Jacquard loom from DORNIER (BONAS). One set of cotton warp yarns (30 Tex) and two sets of Polyester weft threads (13.5 Tex and 18 Tex) were used to elaborate the double-sided (by weft) fabric. The obtained fabric composed of 35%Cotton/65% Polyester has a weight of 231.8 g/m^2 and a thickness of 0.61 mm.

2.2. Dyes

- The reactif dye used in this study is Blue Reactiv with low substantivity that should be used at high temperature (70-80°C) to enhance its fixation on cellulosic fibers.
- The disperse dye used for polyester dyeing is Coralene Jaune C4G.

2.3. Dyeing processes

- Two-path dyeing procedure: cotton face was dyeing with Blue Reactiv dye at 80°C, then polyester face was dyed with disperse dye at 130 °C.
- One-path two-step (Figure 1.a): cotton was dyed with reactive dye at 70 °C, then polyester was dyed with disperse dye at 100°C.

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- One-path one-step (Figure 1.b).

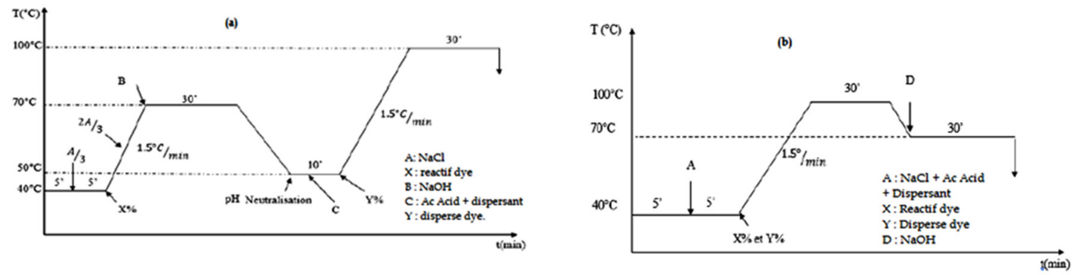

Figure 1 : (a) One-path two-step dyeing; (b) One-path one-step dyeing

2.4. Color strength

The color depth of the dyed fabrics was analyzed by measuring the K/S values of samples. Color measuring instrument Spectrocolorimeter (Data Color) was used to determine the K/S value of fabrics through Kubelka Munk equation as follows:

$$K/S = (1-R)^2 / 2R \qquad (1)$$

2.5. Dye Exhaustion and dyeing kinetics

The dye exhaustion was evaluated by spectrophotometry and calculated according to the following relation:

$$E = (1 - \frac{A}{A_0}) \times 100 \qquad (2)$$

Dyebath exhaustion experimental data were curve fitted using MatLab with Exponential model [4]:

$$E(t) = E_{\infty} - E_{ft} * e^{-K*t} \qquad (3)$$

3. RESULTS AND DISCUSSION

For the two-bath dyeing procedure of P/C double faced fabric, the results showed that reactive dye uptake is divided into two phases: a first long and fast phase and a second phase short but slow. The maximum dyebath exhaustion rate was near 85% and the kinetic uptake time was 0.0419 s^{-1}. The color strength values showed that the fixation is only carried out after the addition of base proving the creation of a fiber-dye covalent bond. Similarly for the disperse dye, the rate of uptake during the first dyeing phase is slightly higher than the average kinetic value (0.0536 s^{-1}) and the exhaustion rate was near 88 %. Unlike reactive dye, the color strength increased gradually for the disperse dye.

For the one-bath dyeing, the results showed that the values of bath exhaustion of the dispersed dye is almost identical to the monochromatic dye procedure, while for the reactive dye the overall kinetics increased and the time needed to fully exhaust the bath decreased.

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THERMAL BEHAVİOR OF POLYMER PELLETS OF VİRGİN POLYESTER COMPARED TO RECYCLED POLYESTER

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ABSTRACT
The thermal transitions and crystalline properties of both virgin polyester (V-PET) and recycled polyester (R-PET) were meticulously examined in this study. The outcomes provide evidence affirming the thermal resilience of R-PET, and the ability to endure high temperatures without significant structural changes or degradation. Furthermore, the research reveals a significant advantage for R-PET, as it demands notably less energy for its production compared to V-PET.

Key Words: thermal transitions, crystalline properties, virgin polyester, recycled polyester

1. INTRODUCTION
Sustainability is an approach that aims to minimize the environmental impact throughout the life cycle of a product, as well as defining practices of how humans should act towards nature [1]. The sustainability of polymers begins with the sourcing of raw materials. Many polymers are derived from fossil fuels, such as petroleum [2]. Eco-friendly practices involve reducing reliance on fossil fuels by exploring alternative feedstocks, such as bio-based polymers, which can be sourced from renewable resources like plants [3]. Additionally, efficient resource management and recycling of polymers help extend their lifecycle and reduce the overall demand for virgin materials.
Recycling polyester (R-PET) from post-consumer polyester waste (PET bottles and textiles scraps), one of the most widely used polymers in the world [4], helps reduce the amount of plastic waste in the environment, thereby contributing to sustainable waste management. The production of R-PET doesn't require a significant energy to manufacture not like V-PET which has a significant environmental impact in terms of greenhouse gas emissions [5].
V-PET and R-PET share many similarities in terms of the basic chemical composition, however there are notable differences in their production processes, environmental impact and properties [6]. Therefore, it is important to recognize that R-PET also possesses commendable strength, durability and other mechanical properties, as this may have implications for its use in various applications [7]. This comparative study between virgin and recycled PET holds relevance due to their thermal behavior.

2. MATERIALS AND METHODS
The polymers studied in this work are Virgin and Recycled Polyester pellets (V-PET, R-PET). The polymers have specific characteristics, including intrinsic viscosity which is 0.64+-0.015 for V-PET and 0.64+-0.02. The PET pellets were characterized by two principal thermal techniques.
Differential scanning calorimetry (DSC) was used to determine the behavior of V-PET et R-PET on thermal and physical properties. This technique could directly measure the heat flowing into or out of the sample means that it indicates the exothermal and endothermal processes in the material [8].
DSC was performed using a SETARAM Type 131 instrument, at a heating rate of 20 °C /min from 20 ° C to 600 ° C, under a nitrogen atmosphere.
Thermogravimetric analysis (TGA) is a commonly used technique for the characterization of materials. It provides precise measurements of the thermal behavior of mass variations in a small sample volume while

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subjecting it to a carefully controlled temperature program [9]. The thermal behavior of the V-PET and R-PET was analyzed by Cahn VersaTherm Thermogravimetric analyzer.
The sample was heated from 20 °C to 600 °C with a heating rate of 20 °C /min at a flow rate of 25 ml/min under a nitrogen atmosphere.

3. RESULTS AND DISCUSSION

Fig.1 shows two representative TGA plots for PET pellets, both virgin and recycled. The curves show a one-step mass loss, signifying a single stage of decomposition. It is noteworthy that the pellets decomposition started from 397 °C, and at 450°C is the final decomposition temperature where more than 98% of the weight has been lost. No additional losses were observed in the R-PET, indicating substantial thermal stability. Consequently, the thermal stability of recycled pellets is comparable to that of their virgin counterparts.

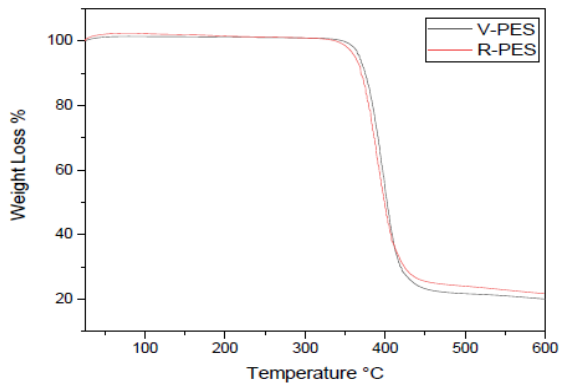

Figure 1. TGA results of virgin and recycled PET.

Differential Scanning Calorimetry (DSC) analysis was used to study and quantify the crystallinity of both virgin and recycled Polyester pellets. Fig. 2 shows the DSC thermograms of V-PET and R-PET pellets at 25 °C/min to 600 °C. In the thermograms we can see that there are two endothermic peaks varying in the range of 40 °C–130 °C. The first endothermic peak is at 31.22 °C contributed to the glass-transition temperature (Tg), the second peak is related to crystallinity temperature 128.60 °C. In the other hand the glass-transition temperature (Tg) crystallinity temperature related to R-PET are respectively 29.60 °C and 125.8 °C. The following table recapitulate the temperatures Table 1. The energy required for crystallizing R-PET is 17.28 J/g lower than that needed for V-PET, which is 78.66 J/g. Therefore, crystallizing R-PET, needs less energy compared to crystallizing V-PET. This suggests that the crystallization process for R-PET is more energy-efficient and requires less heat energy to achieve compared to V-PET.

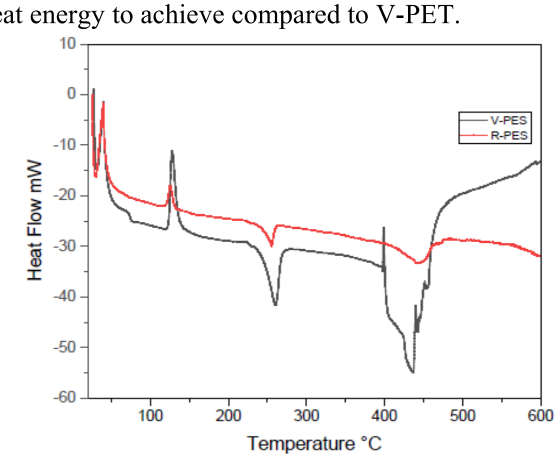

Figure 2. DSC results of Virgin and Recycled PET.

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Table 1. The thermal characteristics of virgin and recycled PET, temperatures and enthalpies.

	Tg (°C)	**Tc (°C)**	**Tm (°C)**	**Td (°C)**	**ΔHm (j/g)**	**ΔHc (j/g)**	**Degree of crystallinity (%)**
V-PET	31.22	128.1	260.24	436.53	78.66	-57.59	97.3
R-PET	29.60	125.81	255.73	445.06	17.28	-15.37	23.3

Tg: Glass temperature Tc: Crystallization temperature Tm: Melting temperature Td: decomposition temperature ΔHm: Enthalpy variation

4. CONCLUSION

In conclusion, the characterization study highlights the positive qualities of R-PET, such as its thermal stability and lower energy consumption in the production process, which further reinforce its standing as a sustainable and resource-efficient material choice.

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COPPER REMOVAL FROM AQUEOUS SOLUTİONS USİNG FUNCTİONALİZED POLYACRYLONİTRİLE FİBERS AND ANTİBACTERİAL ACTİVİTY

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Key Words: Antibacterial activity, Technical textile, industrial wastewater, adsorption, copper

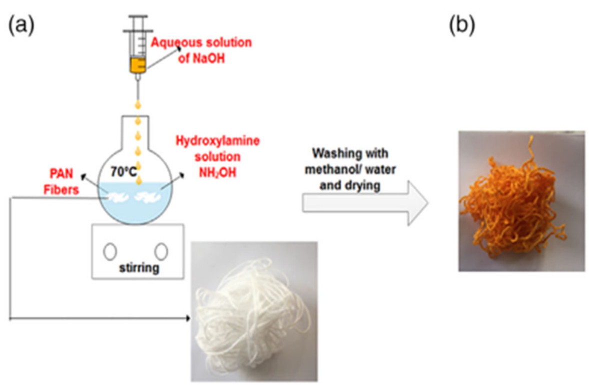
1. INTRODUCTION

Polyacrylonitrile technical fibers (PANF) are have aroused the interest of several researchers, particularly in the treatment of wastewater generated by various industrial sectors [1], [2]. From our part, we assessed the efficacy of the chemically transformed material to an adsorbent for removing heavy metals from polluted industrial aqueous solutions. Our investigation involved the systematic variation of parameters such as pH, adsorbent mass, contact time, temperature, and initial concentration, as well as assessment of the performance of the removal efficiency. The results underscored the significant influence of these parameters accompanied by emphasizing the necessity of an optimization study to achieve the highest possible removal efficiency.

Notably, the unmodified material, when used as a reference without metal, exhibited no discernible effect on E. coli, S. aureus, or Pseudomonas menace. However, the fibers modified to form chelates with Cu^{2+} displayed a potent bactericidal effect, even at low concentrations. These modified materials have the potential to serve as highly effective anti-bactericidal composites, opening up exciting possibilities for future applications in the production of antimicrobial textiles, papers, or polymer materials.

2. Materials and Methods

Surface modification of polyacrylonitrile fiber was achieved through a functionalization reaction using hydroxylamine hydrochloride. This process was undertaken to enhance the surface properties of the support material. The modification of the polyacrylonitrile fiber involved treating it with a 0.1 M solution of hydroxylamine hydrochloride for 60 minutes at 70°C, resulting in a substantial conversion of nitrile groups. Structural characterization confirmed the successful surface modification. Subsequently, we assessed the material's capacity for copper adsorption and its antibacterial activity.



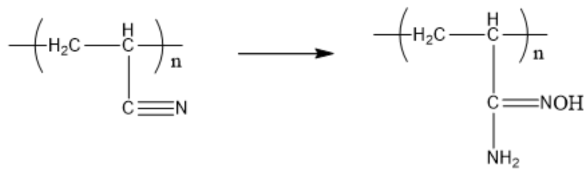


Figure 1: Reaction of the surface modification

3. Results

3.1. Characterization

The modification of nitrile groups into amidoxime groups leads to the appearance of new bands at 1560 cm^{-1} and 1450 cm^{-1} corresponding to the C=N bond deformation and N-H deformation vibrations in an amide group. [3] These vibrations increase in intensity as the reaction progresses. Conversely, the intensity of the peaks at 1450 cm^{-1} and 1230 cm^{-1} corresponding to hydrocarbon vibrations decreases with increasing concentration and duration of the reaction.

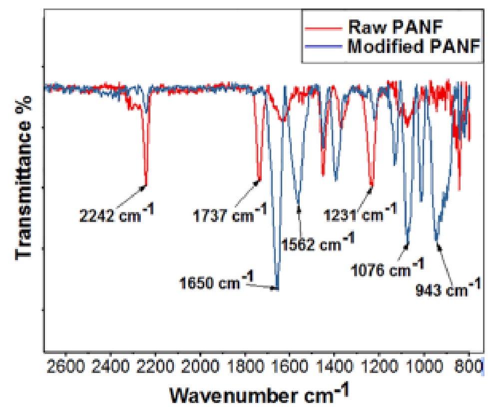


Figure 2: FTIR Analysis

3.2. Evaluation

The maximum percentage of elimination reached 97.63% when the dose of 0.1 g of adsorbent was added. The decrease in adsorption capacity per unit mass was attributed to the insufficient concentration of Cu (II) for the increase in the number of adsorption sites caused by the addition of fibers, and therefore some adsorption sites were not saturated. [4]

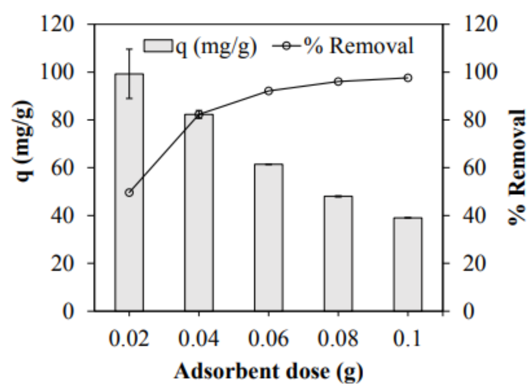


Figure 3: Effect of adsorbent dose on Cu(II) adsorption

3.3. Antibacterial activity

Differences between two groups were tested for statistical significance using Student t-test and differences between more than two groups were assessed by two-way analysis of variance (ANOVA). Differences between groups were significant at a P value of <0.05. All experiments were performed at least in triplicate. The data were analyzed using Excel.

	Cu (50mg/ml)	Cu(100mg/ml)
E.coli	19,3±4,93	22±1,23
Staph	23,2±3,65	24,66±4,72

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4. Conclusion

PAN fibers modified with hydroxylamine hydrochloride were used as adsorbents for the removal of Cu (II) from aqueous solutions. They showed a high Cu (II) adsorption capacity. The percentage of Cu (II) elimination was 97.63%, giving rise to significant antibacterial activity.

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SUSTAİNABİLİTY AND TEXTİLE POTENTİAL OF TANNERY WOOL: FROM CHEMİCAL PROCESSİNG TO TEXTİLE VALORİZATİON AND DYEİNG PERFORMANCE

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ABSTRACT: This study offers a comprehensive exploration of tannery wool, with a primary focus on three essential dimensions: morphology, chemistry, and performance. Wool, as a natural fiber, plays a central role in various textile applications, and gaining insights into these diverse aspects is crucial for maximizing its value.In our examination of wool morphology, we delve into the structure of the fibers, meticulously analyzing the influence of cuticular scales on surface properties. Through scanning electron microscope (SEM) images, we discern subtle distinctions between raw and tannery wool, providing valuable insights into the consequences of the chemical treatment. Turning to the realm of wool chemistry, our analysis of amino acid composition, conducted via High-Performance Liquid Chromatography (HPLC), unravels the effects of the chemical unhairing process. This exploration exposes the chemical modifications resulting from the process, offering a clear picture of how structural changes occur and how they impact wool's morphology. Shifting our attention to moisture absorption and tensile properties, we investigate the pivotal parameter of wool's moisture regain, a critical consideration for its utility in textiles. In parallel, we scrutinize wool's tensile characteristics, drawing connections between moisture regain and mechanical performance. The extensive insights generated by our morphological, chemical, and mechanical characterizations will be instrumental as we proceed to the dyeing phase. Our objective is to evaluate the dye fastness of tannery wool, directly comparing it with the performance of raw wool. In sum, this comprehensive study enriches our comprehension of tannery wool, illuminating its morphology, chemical attributes, and performance. These findings lay a strong foundation for innovative applications in the textile industry, supporting the more efficient utilization of this valuable natural resource.

KEYWORDS: Wool, Sustainability, Chemical processing, Characteristics, Dyeing.

1. INTRODUCTION

The textile industry's commitment to sustainability has sparked a comprehensive exploration of the sustainability and textile potential of tannery wool. Despite its historical classification as waste, tannery wool, distinct from raw wool, has recently gained prominence as a valuable resource. This shift in focus has been driven by the industry's quest for sustainable materials.

Tannery wool is often sourced from undressed hides or the skins of slaughtered animals, making it an unconventional yet promising raw material. Historically, its utilization has been limited due to the perception of lower quality compared to raw wool. This research is dedicated to reevaluating the potential of tannery wool and unlocking its intrinsic value within the textile industry. The study commences with a meticulous analysis of the physical and chemical characteristics of tannery wool fibers. Employing scanning electron microscopy, we investigate the structural integrity of these fibers, uncovering surface scale damage resulting from chemical processing. Additionally, the study delves into the examination of mechanical properties, moisture regain, and a wide range of physical and chemical attributes, providing a comprehensive insight into the material.

Concurrently, our research explores the consequences of the chemical unhairing process on the cysteine content in tannery wool fibers. This examination reveals differences in mechanical behavior when compared to raw wool fibers, shedding light on the impact of chemical processing on the amino acid composition of the material.

Furthermore, the study delves into the dyeing performance of tannery wool, utilizing acid dyes for this purpose. Through a comparative analysis, we assess color strength and chromaticity coordinates, underlining the challenges and opportunities in dyeing this distinctive material.

This multifaceted study not only advances our comprehension of tannery wool but also underscores its potential as a sustainable and eco-friendly material for the textile industry. These findings serve as a solid groundwork for further research and development, emphasizing the valorization of tannery wool fibers in diverse textile applications. In doing so, the industry can reduce waste and foster sustainability, aligning with its evolving commitment to eco-conscious practices.

2. MATERIALS AND METHODS

2.1. A work sample wool

Sheepskins were acquired from the slaughtering process, specifically from male Barbary red-faced sheep (BTR). The wool samples exhibited an average mean fiber diameter of 26.34 ± 1.19 µm [1]. For our study, ten pelts were employed. Each hide was bifurcated into two identical segments. Subsequently, the raw and tannery wool fibers underwent an initial cleansing process using a solution of sodium carbonate (Na_2CO_3) and soap at a controlled temperature of 52 ± 3 °C.

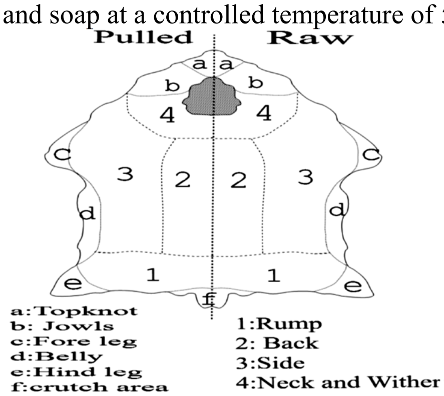

Figure 1: Identical segments of pelt; raw and tannery wool.

2.2. Morphological study

The morphology of the fibers was observed using Scanning electron microscopy (SEM) MEBE FEI Q250 & SPECTROMETRIE EDX ThermoFisher, after gold coating.

Amino acid analysis

The amino acid composition of wool fibers was analyzed using High-Performance Liquid Chromatography (HPLC) from Waters. Wool samples weighing 40 mg were hydrolyzed with 6 M HCl at 110°C for 24 hours in a nitrogen environment.

2.3. Tensile properties

The tensile testing machine used for our tests is a machine of the type LLOYD Instrument with constant gradient rate of 17mm/min and 20 mm length in accordance with the standard ISO 5079:1995(E). For each sample, mechanical properties of 50 fibers were tested and the mean value and the deviation were calculated.

2.4. Dyeing method

Dyeing was performed using Ahiba pots (Datacolor, AHIBA IR®). We used C.I. Acid Blue 25 dye along with unison ALBGAL (CIBA-GEIGY), sodium sulfate, and acetic acid. PH levels of the dye bath were measured using a Calibration Lab Benchtop pH Meter. Both raw and tannery wool yarns were dyed with varying concentrations of Acid Blue 25 in the presence of acetic acid (pH = 4.5), using a liquor ratio of 40:1. The yarns were immersed in the dyeing baths at 40 °C, and the temperature was gradually raised to 100 °C, where it was maintained for 60 minutes. After dyeing, the samples were rinsed thoroughly with cold water and air-dried.

3. RESULTS AND DISCUSSION

3.1. Fiber Morphology Analysis

The surface structure of wool fibers plays a pivotal role in determining their properties. Wool, a natural fiber, inherently exhibits a coarse surface texture. When we examine the scanning electron microscopy (SEM) images shown in Figure 2, we can discern variations in the cuticle layer between tannery and raw wool fibers. In Figure 2a, which illustrates raw wool, the scales feature sharp, well-defined edges, and the cuticle layer maintains a smooth surface. In contrast, Figure 2b displays tannery wool, where the scales of the fiber appear slightly damaged, and the cuticle surface exhibits increased roughness. The observed damage to the fiber's surface is primarily a result of the alkaline unhairing process applied in tanning [5].The tanning procedure encompasses multiple steps, including soaking, unhairing, liming, fleshing, and more. These stages collectively affect the micro-morphology of tannery wool, causing an increase in surface roughness. The use of lime and sodium sulfide, particularly in high concentrations, creates an extremely alkaline environment, leading to the degradation and removal of fibers [9]. To delve into more specific details, let's consider the characteristics of the scale height and scale index. Tannery wool exhibits a scale height of 18.27 µm, while raw wool shows 18.96 µm. The scale index, determined as the ratio of scale height to fiber diameter (FD), is 0.703% for tannery wool and 0.743% for raw wool.

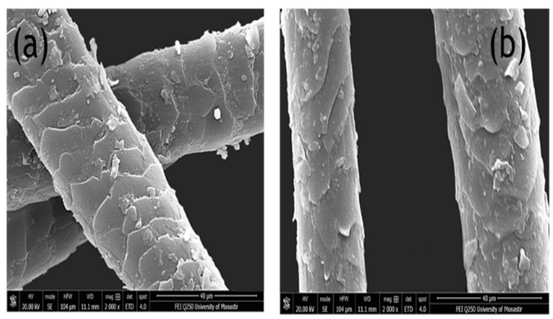

Figure 2: scanning electron micrographs of (a) raw and (b) tannery wool fiber.

In fact, chemical processing changes the scales and expels the splinters without modifying the inner diameter of the wool fibers; therefore, it maintains its initial versatility. From the table above, the average mean fiber diameter of the raw wool samples was 26.34±1.19µm and of the tannery wool samples was 25.62±0.86µm.

Manufacturers must consider the range of fiber length as a crucial factor in their value assessment process. Typically, the mean fiber length is closely linked to the mean fiber diameter, with wool fibers being longer as their diameters increase [3].

Table 1: Properties of raw and tannery wool

	FD (µm)	FL (mm)	MR (%)	T cN/Tex	E (%)
Raw wool	26.34± 1.19	101.7 ± 3.2	14.9± 0.6	22.0± 0.5	31± 0.6
Tannery wool	25.62± 0.86	89.8± 7.8	14.2± 0.7	21.5± 0.6	28± 0.2

According to the Canadian Sheep Federation, wool with a fineness ranging from 26 µm to 30.1 µm is ideally paired with lengths between 75 and 90 mm. In our specific case, the mean fiber length (FL) measured at 89.8 ± 7.8 mm aligns with the appropriate range for the given fiber diameter (FD) of 25.62 ± 0.86 µm. Consequently, the diameter-to-length ratio for the tannery wool samples falls within an acceptable range. This alignment is essential for manufacturers as it influences the quality and value of wool products.

3.2. Chemical characterisations

The amino acid compositions of both raw and tannery wool fibers, detailed in Figure 3, reveal significant changes. Notably, the content of ½ cystine, which includes both cystine and cysteine, exhibited a marked decrease from 9.06 ± 0.06 to 6.24 ± 0.08 (mole %). In contrast, the content of Cysteic acid increased from 0.26 ± 0.01 to 0.35 ± 0.02 (mole %) [8]. These transformations stem from the interaction of NaOH with the disulfide bonds within the wool's protein structure, as indicated by the alkaline hydrolysis of wool with sodium hydroxide (equation1):

$$Na_2S + CaO + H_2O \rightleftharpoons 2NaOH + CaS \qquad (1)$$

This hydrolysis process cleaves both peptide and disulfide bonds in proteins, ultimately yielding amino acids. The alkaline hydrolysis not only alters the amino acid composition but also contributes to changes in the crystallinity of the wool [7]. In wool, crystallinity depends on the regularity of peptidic and disulfide bonds within the fiber's structure. Higher crystallinity implies a greater order and frequency of these bonds, enhancing the stability and strength of the wool fiber. Notably, raw wool demonstrates a crystallinity level of 41%, while tannery wool exhibits a slightly lower level at 34%.

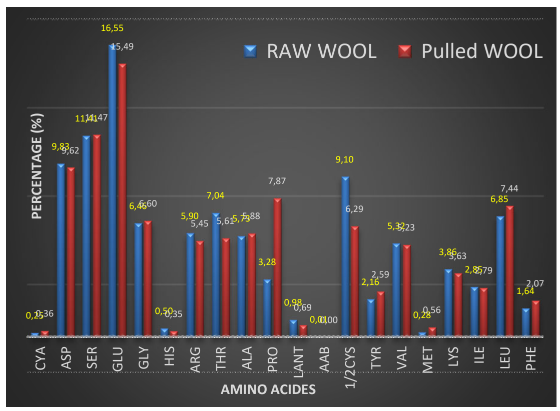

Figure 3: amino acids composition of raw and tannery wool fibers

These variations in crystallinity are a direct consequence of the hydrolysis process initiated by alkali treatment. The changes in amino acid composition and crystallinity significantly impact the physical and mechanical properties of the wool. This interplay between chemical structure, amino acids, and crystallinity contributes to the distinctive properties of raw and tannery wool.

Moisture Regain and Tensile Properties

In accordance with Standard NF G 08-001, the moisture regain (MR) of the samples was tested under standard conditions (25°C, 65% RH). It was calculated using Equation 2.

$$\mathrm{MR}(\%) = 100 * \frac{\mathrm{M_h} - \mathrm{M_s}}{\mathrm{M_s}} \qquad (2)$$

Where M_s and M_h represented, respectively, the dry weight and conditioned weight of samples.

Wool fiber exhibits strong hygroscopic properties. Its surface is notably hydrophobic, allowing it to absorb moisture from the surrounding air in vapor form, while simultaneously repelling liquid water due to the unique characteristics of its cuticles [6]. As indicated in the table above, the moisture regain of tannery wool is 14.2± 0.7%, slightly lower than that of raw wool, which measures 14.9± 0.6%. This variation can be attributed to scale damage, which results in the hydrophobicity observed on the surface of raw wool.

Moisture regain stands as a fundamental property of wool fibers, serving as a measure of their ability to absorb and retain moisture under specific environmental conditions. Wool's inherent hygroscopic nature facilitates the absorption of moisture from the surrounding atmosphere while actively repelling

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liquid water, largely thanks to the distinctive characteristics of its cuticles. A comprehensive understanding of moisture regain is essential for grasping how wool reacts to fluctuations in humidity, subsequently impacting its performance across various applications.
The interplay between moisture regain and the tensile properties of wool fibers is of particular significance. Moisture regain significantly influences tensile strength, tenacity, elongation, and elasticity in wool fibers. These mechanical properties are instrumental in predicting how the fiber responds to various processing conditions and its capacity to withstand diverse mechanical stresses. Notably, the understanding of moisture regain plays a pivotal role in unraveling the intricate relationship between environmental variables and the mechanical characteristics of wool.
In the present study, the average tenacity is assessed at 22.0± 0.5 cN/tex for raw wool and 21.5± 0.6 cN/tex for tannery wool. Although the tenacity values for Barbary red face breed wool are lower compared to the average tenacity of Australian wool, typically around 35 cN/tex, the tested wool samples are considered suitable for use in the textile industry. It's worth noting that wool fibers should possess a minimum tenacity of 6 cN/tex [4] to endure various physical and mechanical stresses, ensuring they do not break during processing.
Furthermore, the results obtained reveal a decrease in fiber elasticity, transitioning from 31± 0.6% for raw wool to 28± 0.2% for tannery wool. According to existing literature [2], cystine, a sulfur-containing amino acid, plays a pivotal role in providing the fiber with high elasticity and resistance to breakage. The reduction in cystine content in tannery wool is a significant contributing factor to the observed loss of elasticity. Tensile properties, which encompass breaking strength, fiber tenacity, and elongation, are key indicators of a fiber's mechanical strength and resilience. Within the context of wool, these properties are critical for predicting how the fiber responds to various textile processes and its ability to endure a range of mechanical forces. Given the intrinsic connection between moisture regain and these tensile properties, a profound understanding of the correlation between environmental humidity and wool's mechanical characteristics is indispensable.
These comprehensive analyses are not only instrumental in understanding the intrinsic properties of the wool but also serve as a solid foundation for our subsequent endeavor: testing and comparing the dye fastness between tannery and raw wool samples.

3.3. Dyeing Evaluation

To further valorize our study, we examined the effect of the chemical unhairing process on the color achieved with Acid Blue 25 dye on wool (Figure 4).

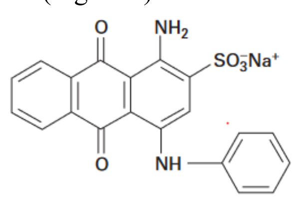

Figure 4: The chemical structure of C. I. Acid Blue 25 C.I 62055

The condition of wool scales, especially their integrity and smoothness, plays a crucial role in the dyeing process. Any damage or disruption to these scales, as observed in tannery wool (Figure 5), can significantly affect the dyeing outcomes. Damaged scales compromise their ability to repel water, making the fiber more receptive to dye. Consequently, this leads to alterations in the dye's behavior on the wool, affecting color intensity and absorption kinetics. These effects of scale damage are especially pertinent in the context of tannery wool, where the chemical processing during unhairing can affect the scale structure. Understanding these effects is essential when evaluating the dye fastness of tannery wool and comparing it to raw wool, as they directly influence the final appearance and color retention of dyed wool products.

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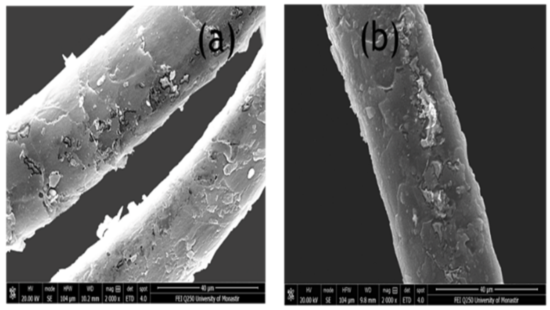

Figure 5: scanning electron micrographs of (a) raw and (b) tannery wool after dyeing.

In our analysis, we conducted an evaluation of the color fastness of wool samples in terms of their resistance to rubbing, washing, and exposure to light. Notably, washing induced perceptible alterations in color shade and fastness properties in dyed wool. Table 2 presents a comprehensive comparison of fastness properties between raw and tannery wool. These findings underscore the significant impact of the tannery process on the dye fastness properties of wool and the associated changes in color retention. Although tannery wool exhibits a noticeable affinity for dye adsorption, allowing dyes to be readily absorbed by the fibers, a key factor contributing to the relatively low color fastness and color retention of tannery wool is the structural alterations that occur during the unhairing process. The tannery process can result in structural modifications in the wool fibers, including the disruption and damage to cuticular scales. These impaired scales no longer effectively repel water; consequently, the fiber becomes more susceptible to dye absorption during the dyeing process. However, these damaged scales may also impede the fiber's capacity to securely retain the absorbed dye molecules. As a result, tannery wool may experience increased dye washout, which subsequently affects color fastness. The observed lower rub fastness and wash fastness ratings in tannery wool, as compared to raw wool, are a reflection of this phenomenon.

Furthermore, the chemical alterations induced by the tannery process can influence the chemical properties of the wool, leading to a reduction in the content of specific amino acids, such as cystine. The loss of these amino acids, which are vital for the fiber's strength and stability, can further contribute to reduced color fastness and mechanical properties. These changes underscore the intricate relationship between the chemical unhairing process in tannery wool and its dye fastness properties, emphasizing the critical importance of considering these factors when optimizing the unhairing process.

Table 2: Fastness ratings of Acid blue 25 dyed wool

Wool	Dye	Wash fastness		Rub fastness		Light fastness
		SC	SW	DRY	WET	
Raw	Acid Blue 25	4/5	4/5	4/5	4	5
Tannery		3/4	4	3/4	2/3	4

4. CONCLUSION

In conclusion, the textile industry's steadfast commitment to sustainability has prompted a meticulous exploration of tannery wool's potential and its role in advancing sustainable textile practices. Historically relegated to the status of waste material, tannery wool has, in recent times, emerged as a precious resource in response to the industry's determined pursuit of ecologically responsible materials. Tannery wool stands as an unconventional yet highly promising raw material. Its association with diminished quality in comparison to raw wool has largely restricted its utilization.

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This research endeavor has been dedicated to the task of unearthing and revitalizing the latent potential inherent in tannery wool and subjecting it to a rigorous reevaluation within the context of the textile industry. The study has inaugurated with a comprehensive analysis of the physical and chemical attributes characterizing tannery wool fibers. Concurrently, it has embarked on a nuanced exploration of the repercussions of the chemical unhairing process on the cysteine content in tannery wool fibers. This thorough examination has brought to light disparities in mechanical behavior when compared to raw wool fibers, thereby illuminating the profound influence of chemical processing on the amino acid composition of the material.

As an application, our study has investigated the dyeing performance of tannery wool, employing acid dyes for this purpose. Through a comparative analysis, we have thereby underscored the challenges as well as the intriguing prospects associated with the dyeing of this distinctive material.

This comprehensive and multifaceted study significantly augments our comprehension of tannery wool, emphasizing its potential as an environmentally sustainable and eco-friendly material ideally suited for a broad spectrum of textile applications. These findings, by providing a robust and comprehensive foundation of knowledge, serve as the cornerstone for further research and development, thus underscoring the urgency and importance of valorizing tannery wool fibers across diverse textile domains. In doing so, the textile industry can contribute substantially to waste reduction and sustainability goals, in alignment with its evolving dedication to eco-conscious and responsible practices.

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A NEW PROTECTIVE TEXTILE BASED ON THE AEROGEL AS CHARGE FOR POLY-COTTON FABRIC

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Key Words: Silicate aerogel, Poly-cotton fabric, Porosity, Hydrophobicity

ABSTRACT

Silicate aerogel has attracted increasing attention in the field of thermal insulation, for its extraordinary properties such as thermal conductivity, fire resistance, hydrophobicity and low density. This work focuses on the development of new insulating material, based on the aerogel as charge for poly-cotton fabric textile. As a result, the introduction of aerogel into the multiscale pores of the poly-cotton fabric favours the creation of nano porosity while minimizing the macro porosity. This promotes the confinement of air in the samples and improves its thermal insulation properties. The surface modification of the poly-cotton fabric has also led to the increase of its hydrophobicity with a high contact angle above 125º. The results obtained from this study can be useful to develop new low cost, sustainable, light, protecting and environmentally friendly materials.

1. INTRODUCTION

Numerous research [1]–[3] have shown their interest on innovative materials with excellent thermal insulation and fire resistance. Aerogels are considered among the most promising high-performance products for various applications due to their low density[4] ,hydrophobicity[5] flame retardancy and low thermal conductivity[6] . However, their low mechanical properties have limited their use [5].

2. EXPERIMENTAL STUDY

2.1. Materials:

Poly-cotton fabric, Tetraethyl orthosilicate (TEOS) (98%, M=208,33 g/mol), ethanol (99.8%, M=46,07 g/mol) and Hydrochloric acid (0.01M, M=36,458 g/mol). All chemicals were purchased from Sigma-Aldrich, they are analytically pure and used without any further purification.

2.2. Methods:

The preparation method used is sol-gel detailed on next figure (figure1):

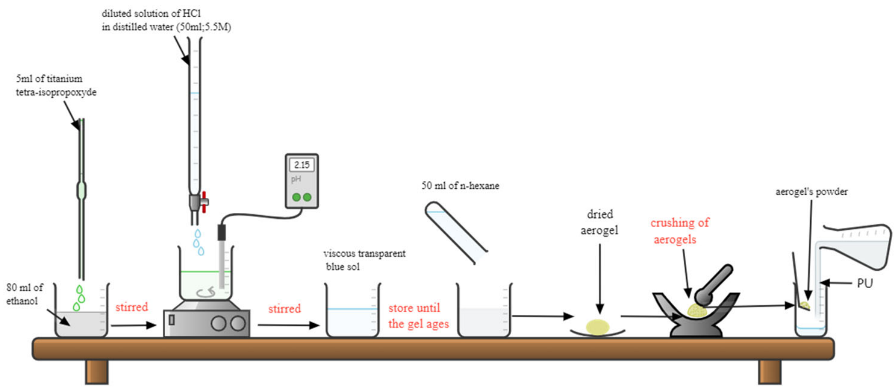

Figure 1: preparation method of silica-aerogel

Finally, the gels were dried at a temperature of 60°C for 48 hours. The samples were developed using a coating process, which uses 5% of silica aerogel and 95% of poly urethane.

3. RESULTS

As a result, the introduction of aerogel into the multiscale pores of the cotton, favors the creation of meso and nano porosity while minimizing the macroporosity. This promotes the confinement of air in the sample, improving its thermal insulation properties. The surface modification of the composite has also led to the increase of its hydrophobicity and fire resistance. The FT-IR of the developed samples showed that the temperature influences the size of peaks between 3000 and 4000 cm^{-1} according to O-H of water. The obtained sample has a good hydrophobicity which the contact angle is 127,9° that improves the SEM results.

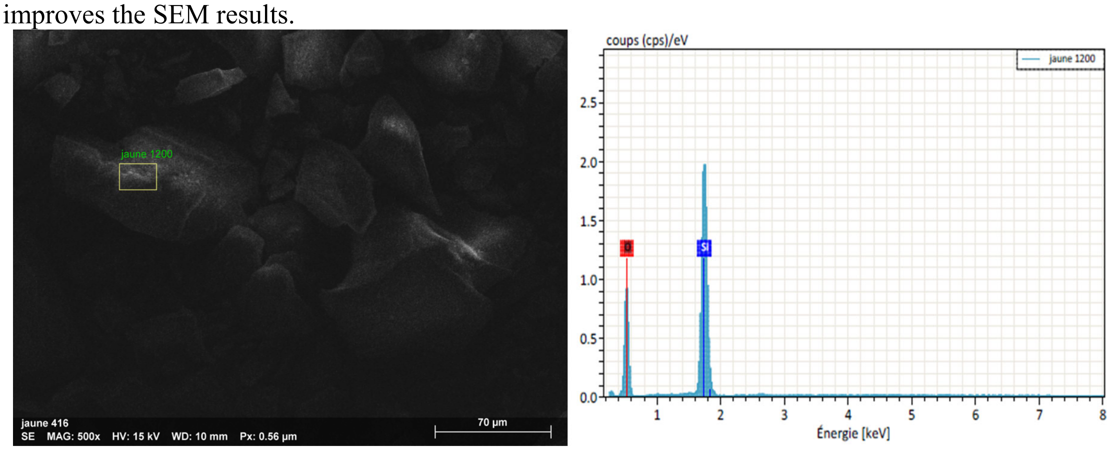

Figure 2: SEM EDX of silica xerogel

4. CONCLUSION

Initial results show good adhesion between the sample components, which has been confirmed by the SEM plates. The exchange as well as the modification has been proven by FTIR spectroscopy, resulting in the hydrophobic behaviour.

The results obtained from this study can be useful to develop new low cost, sustainable, light product, protecting and environmentally friendly materials.

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DEVELOPMENT OF A NEW ECO-FRIENDLY BINDER

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Key Words: Bio-binder; Biopolymer; Crosslinking; Recycling; Textile.

Textile industry has experienced new challenges due to the global open economy and the environmental concerns. To achieve this goal, the diversification of activities and the use of eco-friendly products are necessary.
The work presented in this abstract concerns the study and the preparation of a new eco-friendly binder (bio-binder) which will be biodegradable and/or recyclable.
A bio-binder is a binding material that can be used in various applications and can be broken down into natural substances or recycled after use, rather than persisting in the environment as waste. Binders are materials that hold other materials together, and they are used in a wide range of products and applications, including adhesives, coatings, paints, and textiles [1].
Bio-based binders for textiles offer sustainable and eco-friendly alternatives to conventional petroleum-based binders. In addition, using these binders in products can help companies to reduce their carbon footprint.
Bio-based binders are made from materials that can be naturally broken down by microorganisms, into water, carbon dioxide, and other natural substances. For example, plant-based polymers such as cellulose (CMC) [1], and sodium alginate (SA) are considered like biodegradable binder materials [2] and polyvinyl alcohol (PVAL) is considered like a recyclable binder material [3]. Considering the application, the solubility of CMC-Na, SA and PVAL in water is crucial. It can be modified through chemical modifications and processing techniques to suit specific applications [4]. Herein, a crosslinking process was selected to realize this study.
Crosslinking biopolymers presents numerous benefits across a range of applications. This process entails chemically linking the polymer chains within the biopolymer and forming a three-dimensional network structure. Additionally, it can reduce the solubility of biopolymers in water or other solvents, therby, enhancing their resistance to moisture and environmental deterioration. This characteristic proves advantageous, especially in applications such as the development of water-resistant coatings and durable textiles [4].
In this work, we initially examined a range of biopolymers to identify those that most effectively satisfy economic and environmental criteria, including recyclability, biodegradability, and performance attributes. PVAL, SA, CMC-Na were selected and their solutions were prepared as it can seen in Figure 1. Secondly, we checked various crosslinking agents, such as Benzoyl peroxide (POB), 2,2′-Azobis(2-methylpropionitrile) (AIBN) and calcium chloride ($CaCl_2$) [4] to determine their impact on the final properties and performance.

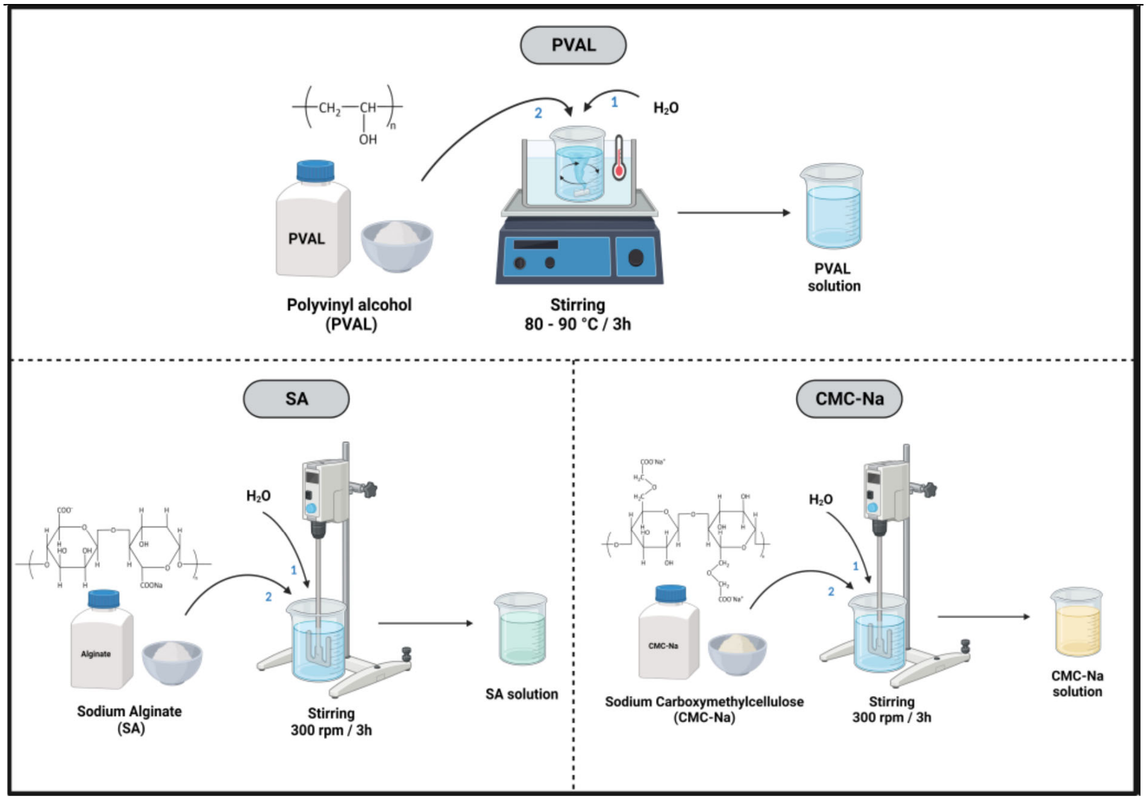

Figure 1. Preparation of biopolymer solutions: PVAL, SA and CMC-Na (made by the author using biorender.com).

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FFECT OF FE2O3/TIO2 ADDITIONS ON MECHANICAL AND CHEMICAL PROPERTIES OF PHOSPHATE GLASS FIBERS

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Key Words: phosphate glass fibers, tensile mechanical properties, chemical durability.

1. INTRODUCTION

Phosphate glass fibers are one of the important materials that can now replace silica-based glass fibers in the fiberglass industry[1]. These materials are water-soluble and their degradation rate can be controlled by modifying their composition[2]. In addition, their low melting point and physical and chemical properties make them a potentially useful material for many applications[3],[4]. The aim of this work is to improve the chemical durability and mechanical properties of phosphate glass fibers by incorporating the elements Fe_2O_3 and TiO_2 into the composition of phosphate glasses. A study of the chemical durability of phosphate glass fibers was carried out on the basis of the weight loss method for phosphate glass fibers treated in a water bath with different pH values (4.5 and 8.6) at a temperature of 37°C. Mechanical tensile properties were determined.

2. MATERIAL AND METHODS

2.1. Phosphate glass and glass fiber Production

Phosphate glasses were prepared by the direct melting method from mixtures of suitable raw materials. The mixtures were placed in crucibles in the electric furnace up to 1200°C. The treated phosphate glasses were transformed into fibers using the melt-draw spinning process (Scheme 1). The spinning temperature was programmed at 600°C, and the fibers were drawn and collected once the glass had become a homogeneous liquid.

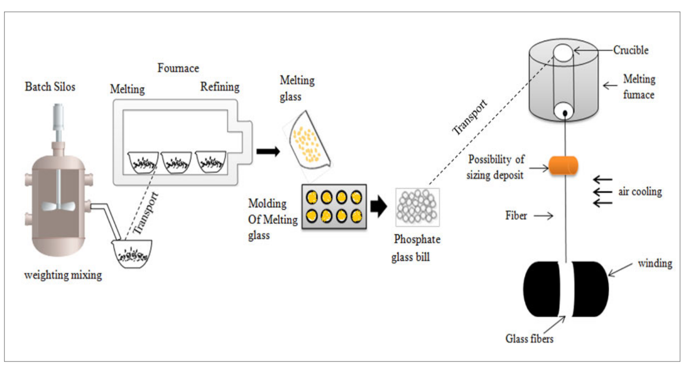

Figure 1: Manufacturing Process of Phosphate Glass Fibers

2.2. Characterization of phosphate glass fiber

The chemical durability of phosphate glass fibers was studied on the basis of the weight loss method in distilled water. 300 mg of 20 mm-long phosphate glass fibers were introduced into glass vials containing 30 ml of buffer solutions of different pH values (4.5 and 8.6). In this case, all flasks containing glass fibers phosphate with distilled water were placed in a bath heated to 37°C at different times between 24h and 360h. The DR dissolution rate of the samples was determined by equation (1):

$$D_R = \frac{(\mathbf{mi} - \mathbf{mt})}{(\mathbf{st} \times \mathbf{t})} \qquad (1)$$

Where mi is the initial mass of phosphate glass fiber sample, mt is the mass of degraded phosphate glass fiber sample, St is the surface area of sample, and t is the dissolution time.

The mechanical properties by traction of phosphate glass fibers were obtained by testing on a single filament. The tests were carried out in accordance with ISO 11566.

3. RESULTS AND DISCUSSION

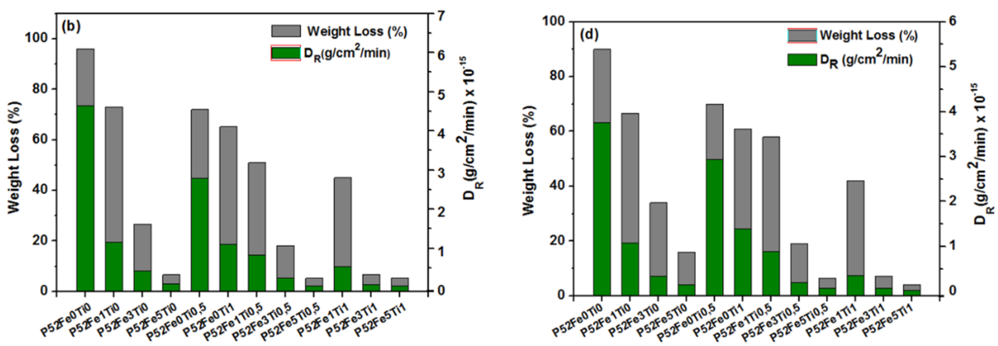

Figure 18: Weight loss Percentage and Dissolution rate DR of Phosphate glass fibers in aqueous medium at pH=4.5 (b) and pH=8.5 (d)

Figure 1 shows that the Fe2O3/TiO2 combination in phosphate glass composition reduces the percentage weight loss and degradation rates of phosphate glass fibers. These results can be explained by the creation of Ti-O-P and Fe-O-P bonds, which are more resistant to hydration than P-O-P bonds.

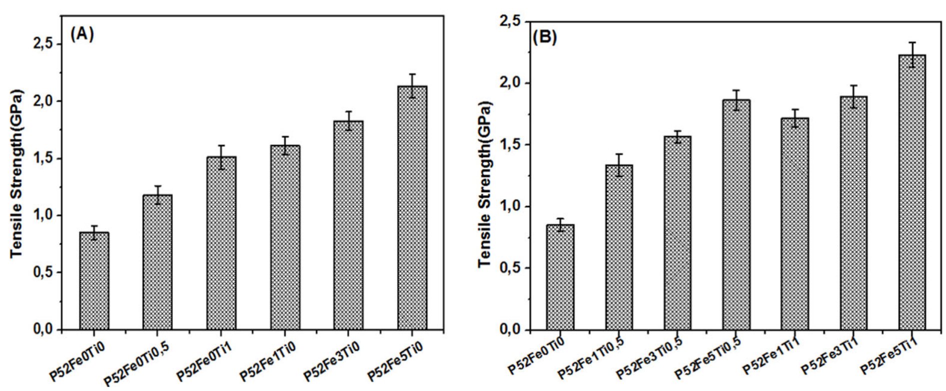

Figure 19 : Tensile strength of phosphate glass fibers

The tensile mechanical properties of the phosphate glass fibers tested show that all developed fibers have stronger mechanical properties and the high tensile strength obtained is 2.2 ± 0.1 Gpa (figure2).

4. Conclusion

The loss-in-mass method has shown that the chemical durability of phosphate glass fibers is increased by adding 1.3.5% Fe2O3 and 0.5.1% TiO2 to the phosphate glass composition. The mechanical properties of the phosphate glass fibers produced were studied on the basis of ISO

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11566. A significant increase in mechanical property values was achieved by adding the elements Fe_2O_3 and TiO_2.

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Bio-based materials and composites

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STUDY OF THE TENSILE PERFORMANCE OF COMPOSITE MATERIALS BASED ON TIRE RUBBER AND NATURAL WASTED FIBERS

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Key words: Composite materials, natural fibers, waste tires, tensile test, behaviour law

1. INTRODUCTION

In recent decades, the rapid growth of the automotive industry has caused major environmental and health issues related to used tires. Approximately 1.5 billion tires are manufactured worldwide annually, which equates to approximately 17 million tonnes of used tires [1]. In Tunisia, the estimate of the national deposit of pneumatic waste amounts to 32,000 tonnes in 2014 and will exceed 2.5 million units in 2025, according to the national waste management agency. [2]. the recovery of this waste has become essential to protect the environment and minimize the cost of storage and reuse. Several ways of recycling used tires are currently possible, such as retreading, energy recovery and recycling. The latter is increasingly suitable for many industrial applications such as road infrastructure, playground filling, civil engineering and many other products. In addition, several studies claim that incorporating these tire wastes into concrete is a good sustainable solution [3].

Currently, the use of pneumatic waste in composite materials is a very promising way. Thanks to their low density, their ease of implementation and their ability to absorb shocks, composite materials represent a real alternative. These materials are often based on a polymer matrix and a fibrous reinforcement. Composites reinforced with natural fibers are of great interest due to their low cost, low density, biodegradability and availability, high specific modulus and recycling capacity. Several studies have demonstrated that natural fibers are good fillers and can yield effective materials with high mechanical, physical and even thermal properties [4].

2. MATERIALS AND METHODS

In our case, the natural fibers used as reinforcement are waste combed flax fibers, carded wool and frayed cotton. As for the matrix used, it is rubber from crushed tires presented in two forms, powders and aggregates. For our study, the implementation of the sandwich composite was carried out through the technique of thermo compression by the fact of distributing the quantity of fibers in a similar way between the two layers of rubber. According to previous research working on the same material [5], [6], a reinforcement rate should not exceed 0.8% for a better result, so we chose to work with three different reinforcement rates 0.3%, 0.5% and 0.7% for a consolidation time of 75 minutes and a temperature set at 180°C, which results in sufficient cohesion to obtain a well-consolidated composite material.

In order to know the influence of the particle size of the matrix on the mechanical properties of the composite material, we varied the type of matrix in powder tires of size less than 0.8mm, in aggregate of size approximately 3.5mm and in mixture of the latter two (with a percentage of 75% powder and 25% aggregates) chosen after a preliminary study carried out.

In order to understand the behavior of the composite material during its use, it is essential to know its mechanical properties. For this, a tensile test was carried out for the different combinations using an LLOYD type dynamometer on specimens prepared according to the ISO 14121 standard.

3. RESULTS AND DISCUSSION

The tensile tests make it possible to draw stress-strain curves for the various composites that have an identical pace that can be divided into an elastic part and a second plastic which differs according to the types and the rates of reinforcements used and which ends in a break.

The results obtained show that the natural fibers favor the properties of the composite such as the breaking strength and the elongation at break.

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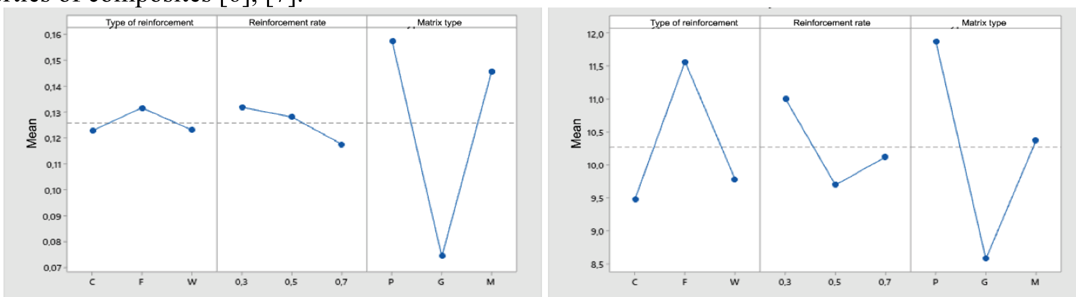
Based on the results obtained, we notice that in general, the lower the reinforcement rate, the better the performance of the composite material, as shown in Figure 1. In addition, this is confirmed by other studies that assert that the reinforcement by these natural fibers shows an impact on the improvement of the mechanical properties of composites [6], [7].



(a) main effects plot for stress (b) plot of main effects for elongation

Figure 1: Main effects plot for stress (a) and elongation (b)

On the other hand, by comparing the three types of matrices used, it can be deduced that the composite materials produced with a powder matrix have a better appearance and a better behavior compared to those produced with a granulated matrix. On the other hand, the samples having a mixed matrix have behavior close to those in powder. This can be explained by the compact surface of the powdered matrices, which justifies the resistance of the material compared to the granulated matrices. Indeed, the larger the aggregates, the more porous and irregular the surface, so the material tends to crack easily, in particular by increasing the reinforcement rate.

By comparing the behavior of the samples studied, it can be seen that the powder matrix composites reinforced with a rate of 0.3% flax fiber have the best strength and elongation values.

Composite materials will be characterized by a behaviour law. This model is used to simulate its response to mechanical stress.

4. CONCLUSION

The recovery of industrial waste is still a trend with major importance for researchers. Composite materials are attractive for applications in various fields requiring lightweight materials and recycling opportunities, with minimum environmental impact and minimization of material cost.

This work focuses on the evaluation of the mechanical behavior of composite materials produced from rubber matrices and fibrous reinforcements. The properties of the composites obtained were compared according to the variations in rate and types of reinforcements as well as the matrix used. Three tire granulometries were used in order to know the influence of the size of the aggregates on the properties of the composite materials. The best results are obtained for composites having a powder matrix with a low reinforcement rate.

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BIODESIGN TOWARDS A PROSPEROUS FUTURE FOR HUMANITY AND NATURE

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Key Words: Sustainable Biodesign, Biobased materials, Composites, White biotechnology, Blue biotechnology.

1. INTRODUCTION

Researchers, artists and specially designers have always observed nature and learned from its forms, processes, functions, and ecosystems to find technical solutions, inspirations, structures and efficient materials adopted by nature in order to maintain its sustainability.
Biodesign as a paradigm that goes beyond imitating natural systems, based on biological processes, seems to be a creative approach that draws on using land and marine ecosystems as a guide to come up with new sustainable creations.
In fact, due to harmful acts to the environment, humanity and nature became more and more endangered which harms life in the near future. Therefore, natural resources become innovative materials used to support and provides utility and value for human life and meet the needs of individuals while preserving nature. In this direction white and blue biotechnology becomes a better technical strategy to generate new materials and products.
So how Biodesign can be a key approach to preserve humanity and nature for brilliant future?

2. Materials and methods:

This article applies documentary and bibliography research, state of the art, and corpus analysis. In addition, it exploits the corpora as argumentation, the Entity Relationship (ER) Diagram and the Porter's Five Forces as explanatory diagrams.

3. RESULTS AND DISCUSSION

Sustainable Biodesign defined as a philosophical approach that aims to enhance the quality of products and biomaterials, in order to reduce or eliminate the damaging impact on the natural environment. Seeing, sustainable Biodesign as a biocentric-approach, that perceives the design process as a healing strategy, ensures responsibility in terms of respect for natural systems and resources, for the human and life cycle and for the world in a holistic perspective.
In fact, Biodesign puts a deep focus on biomaterials while marking a fundamental shift in how designers and researchers in general, apply "living systems". In other terms, using live fungi cells and organisms or fungal enzymes like reactive fungi, made from mushrooms and mycelium, for diverse industrial applications in the framework of white biotechnology, and Seacell made from algae to create the unprecedented as regards of living and biodegradable material in connection with blue technology, seems to be a good ethical approach in Biodesign toward a better world and future. Because, using raw materials as a sustainable bio-based, provide safety and health for humans and for the environment.

4. CONCLUSION

Investing in nature-based solutions provides divers prospects in term of taking care of nature for sustainable ecosystems, and humanity for the wellbeing of humans.
In this sense, the methodology of Biodesign can stimulate deep understanding of issues such as environmental sustainability. Designers, engineers and researchers must have an awareness of the future and must establish new ethical methods and strategies in favor of the environment and the humanity.

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EFFECT OF CHEMİCAL TREATMENT PARAMETERS ON PHYSİCAL AND MECHANİCAL PROPERTİES OF DOUM PALM FİBERS

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ABSTRACT: The aim of this study is to investigate the effect of treatment parameters on physical and mechanical properties of Doum palm fibers. The treatment process which was carried out is a chemical treatment using the sodium hydroxide. First, an investigation of the treatment conditions was undertaken. Secondly, physical (density, diameter, linear density and yield of treatment) and mechanical (tenacity) properties of Doum palm fibers were investigated and an optimization of treatment conditions was undertaken. Finally a comparison with other vegetal fibers was realized.

KEYWORDS: Doum palm fibers, physical properties, mechanical properties, treated fibers and treatment conditions.

1. INTRODUCTION

The growing worldwide concern with the natural resources' preservation has intensified the interest of productive sectors on the use of renewable raw materials, for example, vegetable fibers, for the production of new composite materials and products. Thus, may be considered that these fibers are undergoing a high-tech revolution, in order to replace both synthetic and glass fibers in many applications in the automotive, packaging and construction industry [1], [2]**.** This fact is mainly due to its intrinsic characteristics such as abundant availability, biodegradability, low density, non-toxicity, less abrasiveness to processing equipment, useful mechanical properties and low production cost compared to glass fibers and ohers derived from petroleum [3], [4]**.** Knowledge of the properties and characteristics of plant fibers is essential in order to predict the properties of the finished products made from these fibers. Vegetable fiber is one of the varieties of natural fibers obtained from stems, leaves, roots, fruits and seeds of plants. Vegetation is exploited for its ability to yield fibers directly from wild or natural forms. All the ligno-cellulosic based on natural fibers consist of cellulose micro-fibrils in an amorphous matrix of lignin and hemi-cellulose [5]. As well as, in order to improve the adhesion between vegetal fibers and others synthetic components in composites materials or nonwovens, many chemical treatments were used to modify surface of fibers. These chemical treatments include alkaline, silane, benzoylation, acetylation, permanganate, and peroxide and isocyanate treatment [6]. Furthermore, these treatments show a significant influence in the physical, mechanical and chemical properties of natural fibers which influence the properties of composites or nonwovens. In fact, the effect of chemical treatments on surface morphology, thermal behavior and structure of natural fibers was reported by various authors [7], [8], [9], and [10]**.** Chemical treatments remove the lignin from surface of natural fibers and fiber surface becomes rough. Chemical treatments also reduce the number of free hydroxyl groups of the cellulose, which results in the reduction of the polarity of the cellulose molecules and enhance the compatibility with hydrophobic polymer matrices [11]. So in the present work, we propose to study the effect of treatment parameters on physical and mechanical properties of Doum palm fibers. These fibers are collected from the palm termed "doum palm". It has been chosen in this study, thanks to their abundance and the high diversity of palm trees in Tunisia.

2. MATERIALS AND METHODS

2.1. Materials

The source of the investigated fiber is the foliage of the palm tree in particular from the leaf sheath. The leaf sheath is a part of the leaf of the tree. Indeed, the leaf is divided into several parts: the blade and the leaf axis, the latter is itself divided into a sheath encircling the stem, leafstalk and rachis bearing leaflets [12]. as showing in the figure 1.

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Leaf sheaths (Fig.2) being arranged one above the other along the trunk of the palm. They are obtained after the trimming of the palm tree.
The extraction of fiber from the leaf sheath was performed using two methods: a chemical process (soda treatment) and a combined process (mechanical process and chemical treatment).

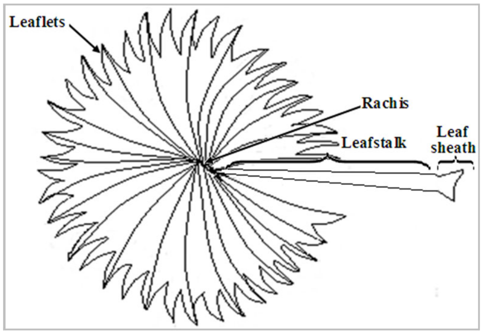

Figure 1: Different parts of leaf of palm tree

Figure 2: Leaf sheath of doum palm

2.2. Methods

2.2.1. Fibers treatment

In a first step, the leaf sheath was cut in rectangular slots which have length ranging from 10 to 12 cm (**Figure 3**). Subsequently, it was boiled in water for 20 minutes, then it was left to cool in this bath for 12 hours. After this prolonged maceration, the well-wet material is brought out, which is more flexible than that in the dry state and which can be brushed with a metal brush in order to release the fibers from it. The fibers obtained (figure 4-a) are dried and subsequently they are treated with soda. After treatment with soda, the fibers are rinsed with water several times and then they are dried at room temperature for 48 hours.

Figure 3: Leaf sheath cut in the form of rectangular slices

(a) (b)

Figure 4: Untreated Doum palm fiber (a), Treated Doum palm fibers (b)

For the sodium hydroxide treatment, we carried out a response surface design type experiment (box behenken). In this case we have the following system and control factors: 1- System: batch of palm fibers obtained from the dry leaf sheath using a retting treatment and wire brushing. 2- Control factors: - Concentration of sodium hydroxide (NaOH) noted C expressed in N - Temperature noted T expressed in °C - Duration of treatment noted D expressed in minutes. These three control factors have the following levels as shown in Table 10.
The treatment bath is as follows:

- 10 g of palm fibers.
- Bath ratio RdB=1/20.
- Temperature from 80°C up to 120°C.
- Duration of treatment from 60 min up to 180 mn.
- Soda concentration from 0.25N up to 1.25N.

Table 1. Features of the box—behenken design

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Factors	**Levels**		
	-1	***0***	***1***
Soda concentration (g/L)	0,25	0,75	1,25
Temperature (°C)	80	100	120
Time (mn)	60	120	180

2.2.2. Fibers characterization methods

The technical palm fibers obtained are characterized by means of physical and mechanical analysis.
The specimens were observed using a Scanning Electron Microscope (SEM) to characterize the morphology of treated and untreated fibers. The Measurement of linear density (title) of palm fibers is described according to the French standards NF G 07-007 (1983) [10]. The test was carried out on a batch of conditioned fibers to a normal atmosphere (relative humidity: 65% ± 4%, temperature: 20˚C ± 2˚C). The density of the palm fibers was determined by the method relating to the French standards NF T20-053 while using the carbon tetrachloride (CCl_4) as reference solution (d = 1.595). The average apparent diameter was measured with the profile projector according to the French standards NF G 07.004. The test is carried out on 100 fibers chosen at random. The tensile test is carried out on a batch of 50 fibers according to NF G07-002 relating to the determination of the strength and elongation at break under tensile stress. The length between clamps is taken equal to 25 mm. These tests were conducted on a LLOYD dynamometer with a constant speed equal to 20 mm/min and a measurement cell of 50 N.

3. RESULTS AND DISCUSSIONS

3.1. Effect of the treatment processes on the morphological properties of Doum palm fibers

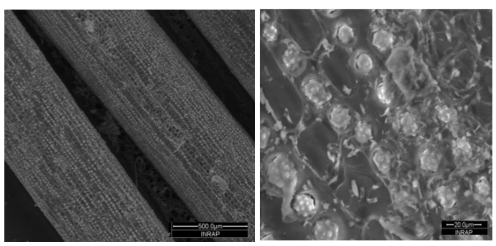

Figure 5: SEM micrographics of untreated palm fibers

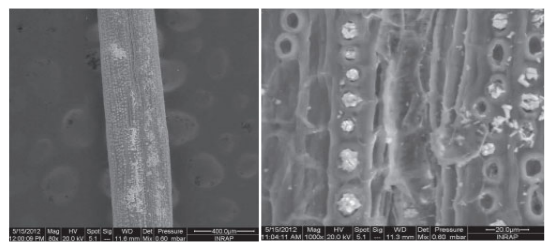

Figure 6: Treated fibers obtained according to the combination (0.25N, 100°C, 60mn)

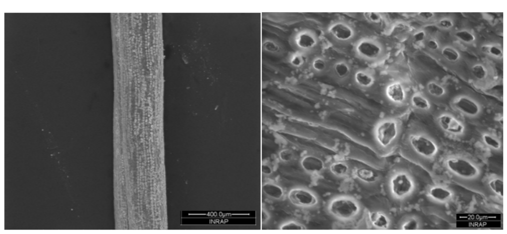

Figure 7: Treated fibers obtained according to the combination (0.75N, 100°C, 120mn)

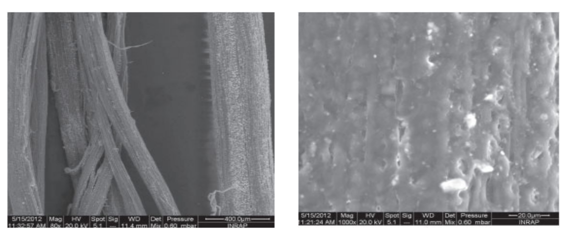

Figure 8: Treated fibers obtained according to the combination (1.25N, 120°C, 120mn)

Figures 5, 6, 7 and 8 represent the longitudinal views of the untreated fibers and those of the treated fibers. By examining these SEM micrographics, we can see that the untreated and treated Doum palm fibers have a composite structure where the ultimate fibers (the cellulose microfibrils) forming the reinforcement are blocked by lignin and other natural substances forming the matrix.
The untreated fibers have a deposit of ligneous matter on their surface (figure 5). After alkaline treatment, this deposit begins to be eliminated by using a low concentration of sodium hydroxide (figure 6). By increasing the concentration of sodium hydroxide, the fibers obtained have a lighter surface (figure 7-a) and pores appear on the surface of the fibers (figure 7-b). By further increasing the treatment conditions, the fibers present micorfibrils on their surface (figure 8-a) and they have a compact structure (figure 8-b).

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3.2. Effect of the treatment processes on the physical properties of Doum palm fibers

To better visualize the effect of treatment conditions on physical properties of treated fibers, main effect plots were drawn.

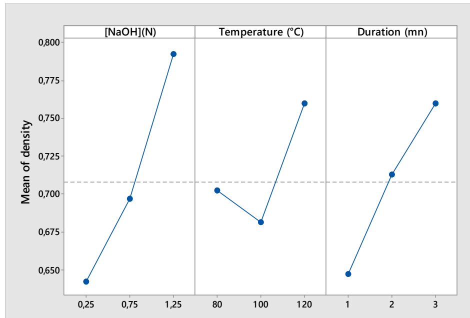
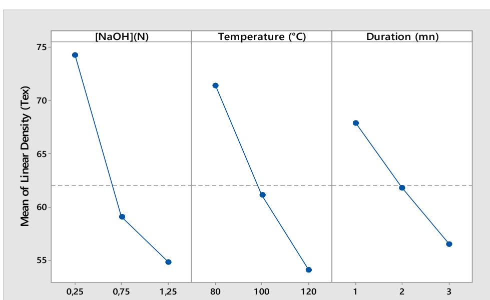
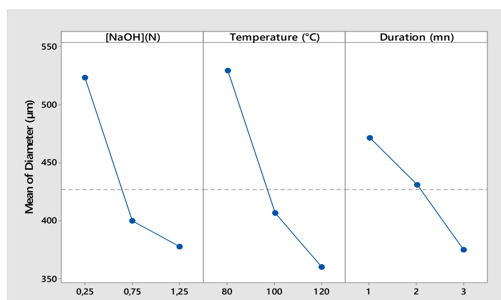


Figure 9: Main effect plot of density

As shown in figure 9, the density increases when increasing treatment conditions (concentration of soda, temperature, duration of treatment). The untreated palm fibers present a density equal to 0.47, however the treated fibers present a density which ranges from 0,51 to 0,97. The increase of doum palm fibers' density after chemical treatment could be attributed to the influence of alkaline treatment on the morphological structure of fibers. It increases the amount of cellulose exposed on the fiber surface [13]. Then the density become close to these of cellulose which is 1,5. Indeed, this treatment eliminates micro voids existing in the fiber and hence the volume decrease and density increase. This is a similar behavior of the sisal [14] and the DPF fibers [15]. DPF fibers [15].



(a)



(b)

Figure 10: Main effect plot of linear density (a) and diameter (b)

As shown in figure 10, the fibers linear density and diameter decrease when increasing treatment conditions (concentration of soda, temperature, duration of treatment). In fact, the untreated fibers present a linear density of 94.27 Tex and a diameter of 689.45 µm. However the linear density of treated fibers ranges from 43,56 to 84,81 Tex and the diameter from 288.6 and 564.9 µm. This reduction in mass per unit length and in section fibers could be attributed to the removal of waxy and gummy materials present between the ultimate fibers. The lower linear density was obtained in the combination (100˚C, 180 min and 1.25 N) which confirms result obtained of diameter. In addition to that, the lower yield obtained in this case (40.26 %) proved this fine structure. As shown in yield main effect plot (Figure 11), higher yields were obtained when proceeding in the lowest conditions of treatment (temperature = 100˚C and soda concentration=0.25N). Then, in these lower conditions this chemical treatment was not effective to remove gummy and waxy materials from technical Doum palm fibers. On the other hand, the removal of foreign substances is improved while increasing temperature and duration of treatment and soda concentration.

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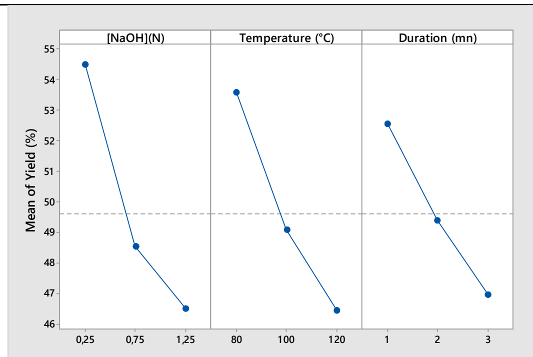

Figure 11: Main effect plot of yield

3.3. Effect of the Treatment Processes on the Mechanical Properties of Doum palm Fibers

According to these graphs, we see that the concentration has an important effect on the tenacity of the fibers. Indeed by increasing the soda concentration the tenacity of the fibers Increases until a soda concentration of 0.75 N is reached. From this value, the tenacity begins to deteriorate. This can be explained by the fact that soda eliminates gum and waxy substances present in the fiber while promoting the arrangement of macromolecular chains and therefore the crystallinity of the fibers hence the improvement of the resistance. By going beyond this threshold value, the resistance of the fibers decreases. This decrease can be explained by the attack on cellulose constituting the fibers by soda at a concentration greater than 0.75 N. Besides we note that the temperature and duration of the treatment has a monotonous and growing effect on the tenacity of the fibers. Indeed, by increasing the temperature and duration of treatment, tenacity increases. Therefore, the temperature and duration of treatment promotes the effect of soda.

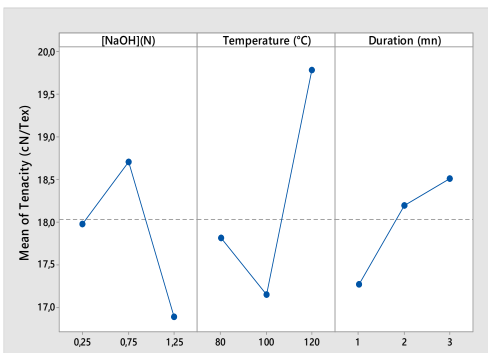

Figure 12: Main effect plot of tenacity (cN/Tex)

3.4. Optimisation of Treatment Conditions

The optimization of treatement conditions related to Doum palm fibers aims to minimize the density, the linear density and the diameter and to maximize the yield and the tenacity as shown in Table 2.

Table 2. The optimum levels of properties

Dependent variables	Objective	Min	Max
Yield (%)	Maximise	40.26	-
Tenacity (cN/Tex)	Maximise	12.02	-
Linear density (Tex)	Minimise	-	84.81
Diameter (µm)	Minimise	-	634
Density	Minimise	-	0.97

The quality of technical Doum palm fibers requires the satisfaction of all properties simultaneously. So, we will try in this part to find the time, temperature and soda concentration parameters that allow us to optimize all the properties at the same time using the desirability functions. The value of the overall desirability determines the quality of the optimum found. Indeed, the closer this value is to one, the better the properties

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will be satisfied. All properties are assigned with the same weight wi =1. The overall desirability equals 90.91. This value reflects the total satisfaction of all the responses simultaneously. The optimum values obtained for each response as well as those obtained for individual desirability are summarized in the following table.

Table 3. Desirability values for the dependent variable

Dependent variables	Value	Desirability (d_i) (%)	Weight
Yield (%)	45.84	63.86	1
Tenacity (cN/tex)	22.32	100	1
Density	0,7	98.19	1
Linear density (Tex)	50,69	97,99	1
Diameter (µm)	317	100	1
Global Desirabiliy (Dg)		**90.91**	

The coordinates of the optimum, normalized and real values for the treatment parameters, obtained for a desirability of 90.91% are represented in Table 4.

Table 4. Optimum values for the dependent variables

Factors	Normalized value	Real value
Soda concentration (N)	-0.33	0.58
Temperature (°C)	1	120
Time (mn)	1	180

The statistical study made it possible to determine the optimal conditions of treatment which are: 120 ° C, as temperature, 0.58 N as soda concentration and for 180 minutes.

3.5. Comparison between studied Doum palm fibers and other vegetal fibers

In technical applications such as composites, the contribution of vegetal fibers is reflected in their low density and resistance. The studied palm fibers have a lower density than those of vegetal fibers such as the flax, the cotton, the jute and the agave Americana L of which the densities are close to 1.5.

The palm fibers obtained by combined and chemical process have both a lower tenacity than the other vegetal fibers such as cotton, jute and agave Americana L. This property is close to that of flax fiber. In order to show up the importance of fibers obtained from the Doum palm plant the tenacity/density ratio of various fibers was carried out (Table 5).

This table illustrates a comparison between Doum palm fibers (treated and untreated) and those commonly used in composites on the level of the τ/d ratio; where τ is the tenacity (cN/Tex) and d is the density. So, we can notice that the ratio τ/d is higher than those of other compared vegetales fibers such as cotton, jute, flax [16] and agave fibers [17]. Also we can note that the τ/d ratio of the treated Doum palm fibers is rather higher than that of Glass E. This shows that the introduction of these fibers (Doum palm fibers) in polymer matrix can provide significant advantages compared to traditional fibers used in composites such as glass fiber.

Table 5. Vegetables fibers compared to **τ**/d ratio

Fibers	Tenacity (cN/Tex)	Density	Ratio (τ/d)
Cotton	26-44	1,5-1,6	17,33 - 27,5
Jute	26-51	1,3	20 - 39,23
Flax	23-24	1,5	15,33 - 16
Agave Americana L	28,3	1,36	20,81
Glass E	75	2,5	30

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Fibers	Tenacity (cN/Tex)	Density	Ratio (τ/d)
Untreated Doum palm	13,2	0,47	28,09
Treated Doum palm	22,32	0,7	31,42

4. CONCLUSION

Using a composite factorial design we have identify the optimum operating conditions (temperature, treatment duration and soda concentration) for Doum palm fiber. The dependent variables were yield treatment, fiber tenacity, fiber diameter, linear density and density.

The optimum treatment conditions were found to be 180 mn as extraction duration, 120 °C as temperature and 0.58 N as soda concentration. The treated Doum palm fibers obtained in these optimum conditions had an average diameter of 317 µm, a linear density of about 50.26 µm, a density of 1.009 and a tenacity of 22.32 cN/Tex. Doum palm fibers could potentially be utilized for many products such as geotextiles, filters, packaging, non woven and composites.

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NANOFİBRİLLATED CELLULOSE FROM NATURAL FİBERS FOR FOOD APPLİCATİONS

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ABSTRACT Interest in Nanofibrillated cellulose has been increasing exponentially because of it's relatively ease of preparation in high yield, high specific surface area, high strength and stiffness, low weight and biodegradability. Due to its renewability, availability and high cellulose content (=45%), Alfa fibers have been identified as a sustainable source for cellulose Nanofiber production. Subjecting raw Alfa fibers to alkali, bleaching and chlorhydric acid treatments allowed producing Nanofiber with high yields. The microscopy test confirmed that Alfa Nanofiber, with average diameter of 12 µm, was successfully obtained after bleaching treatments. Transmission electron microscopy showed that the nanofiber exhibit needle-like shape with an average diameter and length of 5 ± 3 nm and 400 ± 30 nm. These Nanofiber will be explored to synthetise a nanomateriels; paper and paperboard additive, biomedical applications and as food packaging.

Keywords: Alfa ultimate fiber, cellulose, Nanofibrillated, food packaging.

1. INTRODUCTION

Cellulose, the most abundant component of plant biomass, is found in nature almost exclusively in plant cell walls, but also it is produced by some animals, algae and few bacteria [1, 2]. Cellulose is a semi-crystalline polysaccharide appearing in nature in the form of fibres with width ranging from 5 to 20 µm and length in the range of 0.5 up to several millimetres. Over the past decades, natural cellulose materials have been used as an energy source, for building materials, paper, textiles and clothing etc. [3]. However, there are certain drawbacks in cellulosic materials such as incompatibility with hydrophobic polymer which reduced their use as reinforcement in polymers [4]. On the basis of their dimensions, functions, and preparation methods, which in turn depend mainly on the cellulosic source and on the processing conditions, nanocellulosics are classified into three main subcategories as shown in Table.1.

Table 1: The family of nanocellulose materials classified in three main subcategories

Type of nanocellulose	Selected references and synonyms	Typical sources	Formation and average size
Microfibrillated cellulose (MFC)	Microfibrillated cellulose [5], nanofibrils and microfibrils, nanofibrillated cellulose	cellulose (MFC) Microfibrillated cellulose [5], nanofibrils and microfibrils, nanofibrillated cellulose Wood, sugar beet, potato tuber, hemp, flax	Delimination of wood pulp by chemical or enzymatic treatment diameter: 5-60 nm length, several micrometers.
Nanocrystalline cellulose (NCC)	Cellulose nanocrystals, crystallites [6], whiskers [7], rodlike cellulose microcrystals [8]	Wood, cotton, hemp, flax, wheat straw, mulberry bark, ramie, Avicel, tunicin, cellulose from algae, and bacteria	Acid hydrolysis of cellulose from many sources diameters: 5-70 nm length; 100-250 (from plant cellulose) 100nm to several micrometers (from celluloses of tunicates, algae, bacteria).
Bacterial nanocellulose (BNC)	Bacterial cellulose [9], microbial cellulose [10], biocellulose [10]	Low-molecular weight sugars and alcohols	Bacterial synthesis diameter : 20 -100nm; different types of Nanofiber network

The plant source (fiber dimension structure of the cell wall, relative percentage of cellulose, hemicelluloses and lignin) and the extraction method will influence the final nanocellulose purity and properties.

2. Experimental

2.1. Cellulose nanofiber preparation.

Cellulose nanofibers have a high potential to be used in many different areas particularly as reinforcement in the development of nanocomposites. Many studies have been done on isolation and characterization of cellulose nanofibers from various sources. Cellulose nanofibers can be extracted from the cell walls by simple mechanical methods or a combination of both chemical and mechanical methods. In this study the extraction of Alfa cellulose nanofiber involved two steps. It includes pretreatment/bleaching and hydrolysis process.

2.2. Pretreatment and bleaching process of Alfa.

In order to produce high purity of cellulose fiber, pretreatment and bleaching process are required to remove hemicelluloses, lignin and other extractives such as waxes and ashes. In this study, a combined process (the sodium hydroxide and the hydrogen peroxide) was used. In fact, when esparto fibers were bleached with hydrogen peroxide, lignin was not eliminated; the use of sodium hydroxide in this bath can ensure its destruction [11]. For the tests, 5 g of dried technical esparto grass fibers were immersed in a solution containing 30g/L of sodium hydroxide and 35g/L of hydrogen peroxide for 90 min at 120◦C [12].

2.3. Hydrolysis of the cellulose Alfa fiber

Bleached pulp was treated with 10 % HCl (1 N) solution and mixed using ultrasonicator at temperature around 60 $\pm$ 1°C for 2h and 5 h. Finally, the fibers were taken out and washed several times with distilled water in order to neutralize the final pH and then dried. Fibers were suspended in water and continuously stirred with a high-shear homogenizer for 15 min. High-shearing action breaks down the fiber agglomerates and results in nanofibrils (Fig.1)

Figure 1: Hydrolysis method of Alfa fiber; (a): pretreated/ bleach fiber; (b): Ultrasonic cleaner; (c): solution of Alfa Nanofiber

3. Results and discussion

3.1. Cellulose Alfa Nanofiber preparation

Pretreatment and bleaching process produce purer and whiter Alfa fiber strand. The pretreatment process using HCL and temperature are able to explode the fiber so that hemicelluloses and lignin could be removed effectively [13]. The process was called steam explosion techniques that originally developed by W. H. Mason in 1928. A different source of material needs different steam explosion temperature and time of retention. One material might need more retention time and higher temperature than the other. However, previous researchers have confirmed that steam explosion could separate hemicelluloses and lignin effectively which greatly enhance the subsequent process after the pretreatment process [14]. Table 2 shows the composition analysis of cellulose, lignin, hemicelluloses and other extractives using the Technical Association of the Pulp and Paper Industry method which confirmed large fraction of hemicelluloses and lignin was removed during the pretreatment process. The composition of hemicelluloses and lignin was extensively removed by acid hydrolysis of cellulose Nanofiber leaving a higher percentage of cellulose content in the final product.

Component (%)	Untreated Alfa fiber	Pre-treated Alfa fiber	Cellulose Alfa nanofiber
Cellulose	48 [14]	79	87
Hemicelluloses	27	9,4	4,5
lignin	18	3,2	1,3

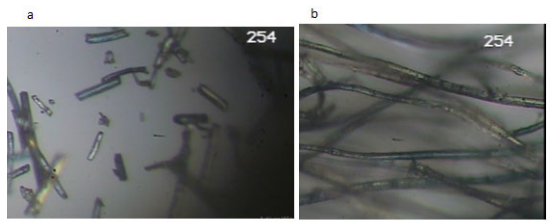

Figure 2: hydrolysis process (10% HCL, 5h)
; (a): Hydrolysis process (10% HCL, 2h)(b)

Figure 2 shown the transmission electron microscopy; illustrate the morphology of the fiber after acid hydrolysis process (chlorohydric acid). The fiber that has undergone an acid hydrolysis process was broken down to nano-size diameter ranged between 2-8 nm. The strong acid cleaved the stack of cellulose microfibrils and produced the fiber with nano-sized diameter.

4. Conclusions

Pretreatment process was subjected to remove hemicelluloses, lignin, and other extractives in order to obtain purer cellulose fiber. The cellulose Nanofiber from Alfa was obtained by the hydrolysis process with chlorydric acid. The optimum condition for effective Nanofiber was detected with 10% of acid chlorydric during 5 hours, the aim of this study was to evaluate the ability of alfa nanofibers to produce new biopolymer-based nanocomposite films.

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MASS CUSTOMIZATION TOOLS : INDUSTRY 4.0 AND 3D SIMULATION

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Key Words: Mass customization tools, Industry 4.0, Body scanner, Virtual fitting room, 3D.

1. INTRODUCTION

There are three previous industrial revolutions before Industry 4.0, which give rise to paradigm shifts in manufacturing: mechanization by water and steam, mass production in assembly lines, and automation using information technology.

Industry 1.0 was launched in the 1780s with the introduction of water power and steam, which contributed to mechanical production, and the considerable improvement of the agricultural sector.

Then, the definition of industry 2.0 is identified as an introduction to the period, during which mass production is the main means of production in general. The introduction of railroads into the industrial system is carried out with the help of the mass production of steel, which consequently ensures the contribution to mass production.

The birth of industry 3.0 during the 20th century is completed with the advent of the digital revolution, which is more familiar than industry 1.0 and 2.0 because the majority of people today live with the knowledge that industries during production are based on digital technologies. So, the development of computer and information and communication technology industries, for many countries, is responsible for the birth of industry 3.0 in a direct way. The illustrative overview of industrial revolutions is presented in the following schematic diagram.

The changes to many professions, are brought by industry 4.0. Learning new daily tasks is an obligation for people, but currently, the use of high-tech gadgets, becomes an obligation and a very important factor in their life functioning.

The presentation of Industry 4.0, as a global change, is described by the digitization and automation of every part of the company, as well as manufacturing processes. The acceptance of the concept of Industry 4.0 and its more competitive performance in the market, by large international companies, which incorporate improvement concepts and high standards, for research and development. This becomes possible, if self-optimization, self-cognition and self-customization are introduced in the industry. Manufacturers are able to maintain communication with the computers, rather than running them.

The relationship between innovation and fashion mirrors the relationship between designers and fabrics. It's why fashion and technology work so well together – and why, with the arrival of fashion bloggers and social media, the fashion industry is exploring digitalization with open arms.

2. Methods and materials

Fashion manufacturers are becoming more and more involved with the digitalization of product development processes. Designers are already using 3D tools to sketch and develop fashion, enabling them to get a faster and better impression of the products. Fits can be tested in advance on digital models, clothing can be adapted more precisely to the wishes of the target group and a more intensive idea of the end product can be conveyed. Especially in the fast fashion sector, the main objectives of digitization are to reduce time and costs by saving on samples and prototypes as well as their logistics, thus achieving a massive reduction in time-to-market. Of course, this also creates an improvement in sustainability for the fashion brand.

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But 3D models also help in downstream marketing processes, can save on photo and video productions, for example, and can also deliver automatically generated content – and very soon in real time and even individualized.

Fig 1. Sketching model

Working in 3D is more sustainable than traditional fashion methods, as designing prototypes digitally means there's no need to mass produce, as items are made only when ordered. That's why we decide to create a 3D avatar to use them in 3D runway thanks to the clo 3D software.

3. Results

For the implementation, the native 3D data of the upstream design – in this case CLO3D – could be used and precisely simulated on the body and prepared for the animation.
Such animations are only one of many possibilities. In addition, images of various types can be produced, such as model images, location images and cut-outs. In addition, possibilities such as AR/VR applications are also possible. All these content forms are based on one and the same digital database.
Virtually, anything is possible. Because of this, we have another avenue of creative freedom at our fingertips. One in which we can present our collections exactly how we want them to be seen. However, using clo 3D to create our personalized models make the runway more creative. We no longer need to have physical space for everyone who wants to attend, and we can implement numerous accessibility techniques including audio description and subtitling to our virtual shows.

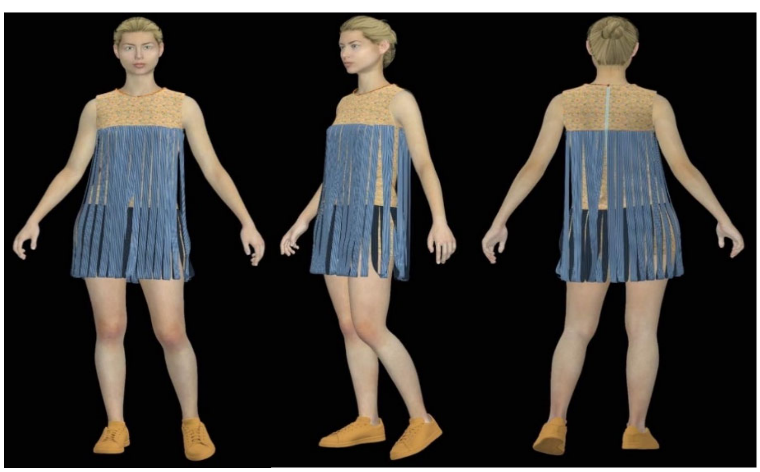

Fig 2. First 3D avatar with personnalized dress

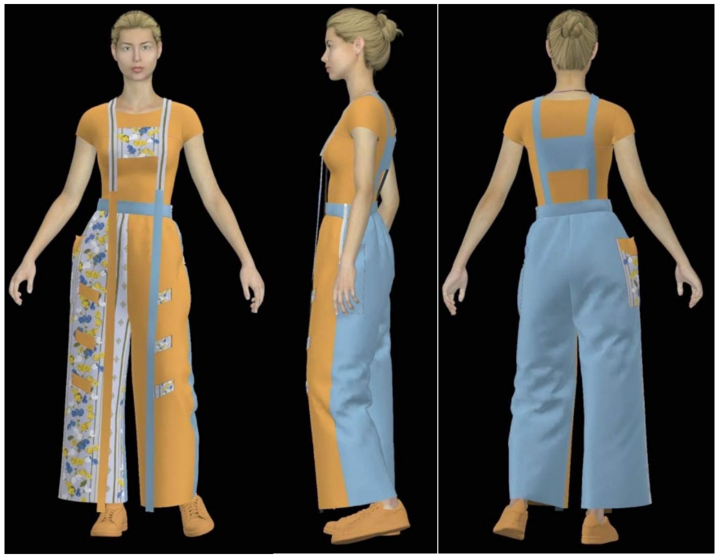

Fig 2. Second 3D avatar with personnalized costume

4. Conclusion

Whilst the virtual runway is still a new experience for some, there are too many benefits for it to be ignored. Patience is key, and with any new technology, there is a learning curve to observe. Fashion has chosen to adapt and embrace a truly modern future. One that combines immersion and engagement, making it easier for people to enjoy and experience.
Another advantage of 3D data generation in the fashion sector is the simplified, faster and better communication channels between brands and their production partners. 3D models are provided online, eliminating the need to send drawings and samples. In modern production facilities, the 3D data can be fed directly into the textile machines. This makes the entire manufacturing process from development to production faster, safer and more efficient.

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SUSTAİNABLE TRANSPORT İN THE APPAREL SUPPLY CHAİN USİNG FUZZY-MODİFİED DİJKSTRA ALGORİTHM

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Key Words: Dijkstra, fuzzy logic, transport, supply chain

1. INTRODUCTION

The path search problem involves finding the optimum path between the present location and the destination under given conditions. Currently, these problems arise in networks such as the highway system, railroads, logistics, and communication networks and cover a wide range of applications [1]. In the literature, numerous studies are concerned with this topic in several fields, but few studies have been published in the textile and apparel field. Shin and Young have used a heuristic algorithm in the fashion apparel industry to solve the problem of restocking and distribution. They have used this approach to reduce the distribution lead time between manufacturers and retailers [2]. Guo et al have used a hybrid intelligent algorithm to optimize production and delivery operations in the apparel supply chain. This approach was used to minimize the total transport cost and penalty cost [3]. Besides, other scientific works dealing with this problem in the manufacturing field are numerous, in this section; we present some of them to highlight the wide variety of applications. Kiani applied a linear programming model for a material replenishing, manufacturing, and distribution network to obtain the optimal transportation pattern for a food processing company to minimize transportation costs [4]. After thorough literature searching, several studies for solving the shortest path problem were found; however, research studies in the clothing industry are still limited. In this paper, we apply the Fuzzy-modified Dijkstra algorithm to find the shortest path between the company and the subcontractors with the minimum cost, the minimum distance, with an optimal number of cars and technicians. The use of fuzzy logic is to determine and estimate the traffic jam frequency, traffic jam time, and car speed during the traffic jam for each shortest path determined by the Dijkstra algorithm.

2. MATERIALS AND METHODS:

FUZZY-MODIFIED DIJKSTRA ALGORITHM:

Computer scientist Edsger W. Dijkstra conceived the Dijkstra algorithm [5]. Since this method is mono-objective, we develop another algorithm complementary to the Dijkstra algorithm that allows us to determine the optimal number of cars and technicians. In another part, fuzzy logic was used to determine traffic jam frequency, traffic jam time, and car speed during the traffic jam. The flowchart of fuzzy-Modified Dijkstra is as followed:

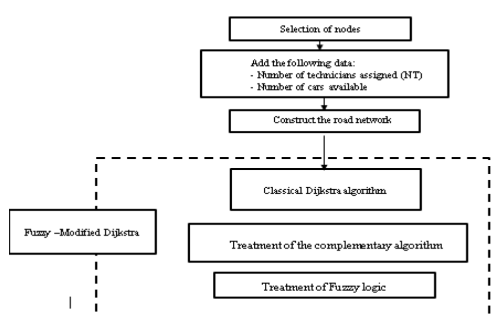

Figure 1. Flowchart of Fuzzy-modified Dijkstra

The treatment of the complementary algorithm is mentioned in the following figure:

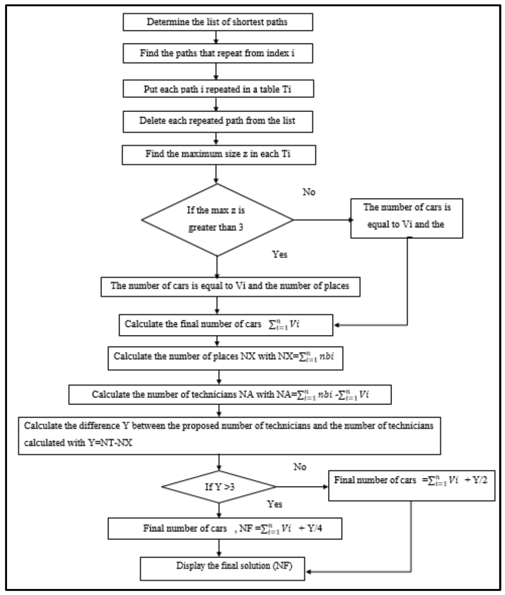

Figure 2. Complementary algorithm of Dijkstra.

3. RESULTS AND DISCUSSION:

In our case, we utilized the Fuzzy-modified Dijkstra method to choose the shortest path from Denim society to the furthest subcontractors, so this network contains 14 nodes; we define the distance between each node in Kilometer. Therefore, node A represents the manufacturing denim products company and the other nodes represent subcontractors. Figure 3 represents the road network of subcontractors

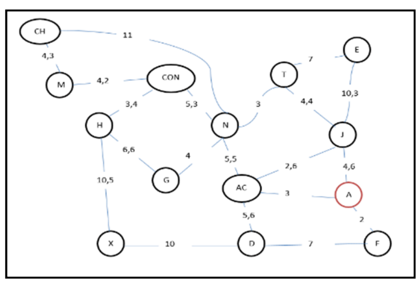

Figure 3. The road network of subcontractors

To evaluate our method, we take six paths traveled daily by the company as a test sample. Then we record the number of cars used, the distance traveled, the cost, the number of technicians assigned, traffic jam frequency, traffic jam time, and car speed. We test these samples in our model. The results are shown in Table 1.

Table 1. The effect of applying the Fuzzy-Modified Dijkstra algorithm
With : Fr: frequency of jam, T: traffic jam time, V: car speed

N°	path	Before applying the Fuzzy-Modified Dijkstra algorithm							After applying the Fuzzy-Modified Dijkstra algorithm						
		Distance (km)	Cost	Number of technicians	Number of cars	Fr	T	V	Distance (km)	Cost	Number of technicians	Number of cars	Fr	T	V
1	A-CH	41	27,65	12	6	8	20	3	19,5	24,15	10	3	2	5	15
2	A-M	36,7	26,95			5	25	2	18	23,90			1	2	10
3	A-E	27,5	25,45			10	15	3	15	23,42			2	2	15
4	A-G	36,1	26,85			10	15	4	12,5	23,01			2	2	15
5	A-H	23,3	24,77			10	15	3	17,2	23,77			2	5	20
6	A-T	19,9	24,22			10	10	2	9	22			1	3	15

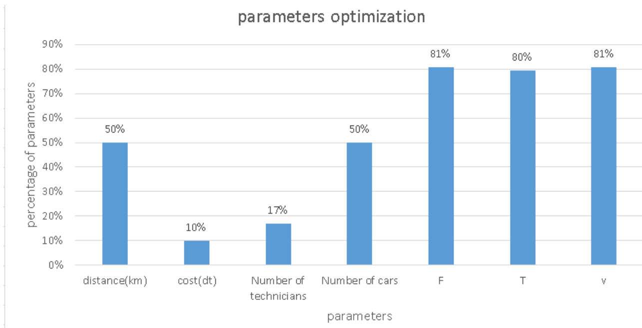

Figure 4. The effect of applying the Fuzzy-modified Dijktsra algorithm on the used parameters

Table 1 and Figure 4 show that we have a good result. We have an optimization in terms of distance, cost, number of technicians, number of cars, frequency of traffic jams, time of traffic jam, and car speed for each path before and after the application of the Fuzzy-modified Dijkstra algorithm. Indeed, we observe a reduction in the distance level with an average value of 50%. This average value shows us that the cost of the distance is reduced by half while the average value of the cost is equal to 10%. In addition, the number of used cars is reduced by 50% and the number of technicians is reduced by 17%. In another way, the frequency of traffic jams is reduced by 81%, the traffic jam time is reduced by 80% and we have an optimization with an average value equal to 81% for the car speed

4. CONCLUSION

In this paper, it has been proved that the Fuzzy-modified Dijktsra algorithm is effective in determining the shortest path, indeed this method shows us an optimization at the distance and cost level with an average value for distances of 50% and with a value average for costs of 10%. A reduction in distances with an equal average value of 50% and a reduction in costs with an equal average value of 10 % have been achieved. As to the number of cars and technicians, the reduction reached values of 50% and 17%. In another way, the frequency of traffic jams is reduced by 81%, the traffic jam time is reduced by 80% and we have an optimization with an average value equal to 81% for the car speed

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Fashion & Comfort

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INFLUENCE OF RELATİVE HUMİDİTY AND STORAGE CONFİGURATİON OF KNİTTED FABRİCS İN A PRODUCTİON LİNE ON THE PHENOMENON OF SORPTİON

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Keywords: Knitted fabrics, relative humidity, drying and storage, adsorption, desorption.

1. INTRODUCTION

Many works have reflected the coupled phenomena of heat and mass transfer in fabrics using the laws of water transport and the phenomenon of vapor sorption. Some have studied the modeling of the kinetics of this phenomenon to determine the diffusion of vapor in the textile. Others have modeled adsorption and desorption isotherms to study the evolution of sorption hysteresis as a function of temperature, textile structure or material history. [1]
The phenomenon of adsorption in an environment characterized by high relative humidity, the water content of the material increases, it is called free recovery. The phenomenon of desorption: in an environment characterized by low relative humidity, the water content of the material will decrease. The amount of water contained in a textile material is highly dependent on the temperature and relative humidity of the surrounding air, the material and its components. [2]
The process that aims to partially or totally remove water from a wet body by evaporating this water is called drying. The wet object in question can be solid or liquid, but the final product is solid (special case of the dehydration of non-volatile liquids: except for oil drying), which distinguishes drying and liquid concentration. Here, the end product is a concentrate. [3]
Drying at high relative humidity creates a "capillary" flow from the inside to the outside of the textile material. Since the continuity of the “capillary” liquid phase is not broken, the movement of water is dominated by capillary pressure. [4]

2. EXPERIMENTAL PROTOCOL

Knitted fabrics always contain a certain amount of water, regardless of their composition. Textiles must be conditioned because their water content fluctuates rapidly and strongly depending on atmospheric conditions. Our knitted fabric is made up of natural fibers of plant origin (cellulose):

Table 1. Characterization of knitted fabrics

Material	Cotton
Type	Jersey
Density (g/m2)	194
Thickness (mm)	0.731
Stitches number along Wale direction (cm^{-1})	21
Stitches number along Course direction (cm^{-1})	14
LFA (mm/stitche)	3.16
Yarn number (km/kg)	50

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Gravimetric monitoring allows us to trace the evolution of water uptake as a function of time. The following figure shows the adsorption curves at a temperature of 20°C (the sample is initially in the dry state).The moisture content of knitted fabric was calculated from the increase in mass of the dried sample within a time interval of 5 min and under laboratory conditions after reaching hygroscopic equilibrium (constant mass) **[5]**. This quantity is calculated according to equation (1):

$$Weq = \frac{Mh - Ms}{Ms} \qquad \textbf{(1)}$$

Weq	= is the moisture content of the sample
Ms	= is the dry mass of the sample
Mh	= is the mass of the sample

3. RESULTS AND DISCUSSION

The experimental knitting adsorption curves obtained are illustrated in Fig 1. They show that for a temperature of 20°C and laboratory relative humidity, the equilibrium water content (dry basis) of the sample increases as a function of time (the measurements of the water content are triggered after one hour and 30 minutes after leaving the oven).
For a test temperature of 20°C, the increase in water mass increases monotonously until a state of equilibrium is reached after a period of approximately 3 hours and 40 min for the three storage ways.
The cotton adsorption phenomenon presents increasing curves as a function of time: the values of the adsorbed water content evolve in an almost identical way for all the storage methods (a rise of 7.48%) and they reach their maximum for the hanging knitted fabric with a value of 11.9%.
We studied the influence of the manner of knitting storage in a highly humid environment (RH=80%) on the phenomenon of desorption at a drying temperature of 60°C. The results of this study are shown in Fig 2.

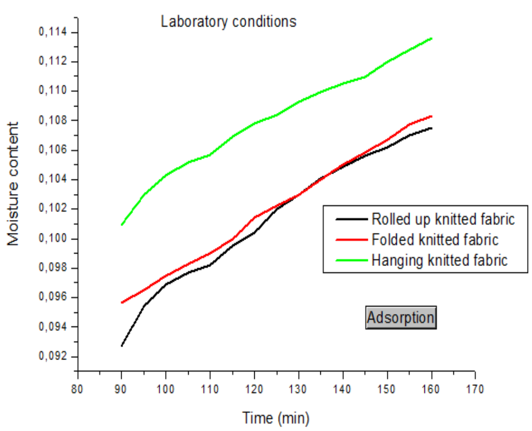

Fig 1. Evolution of the moisture content absorbed by the knitted fabric as a function of time

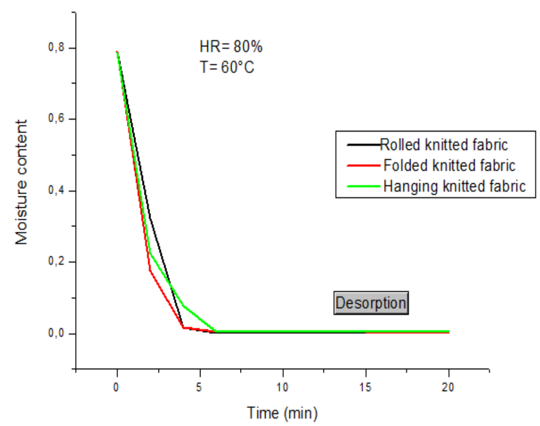

Fig 2. Evolution of the moisture content as a function of time of the different ways of storing knitted fabric at RH=80%

4. CONCLUSION

The research work presented in this paper has made it possible to explain the behavior of cotton jersey knits during the sorption phenomenon by studying the influence of the ways in which fabrics were stored before industrialization.
The experiments carried out in this work in order to highlight the phenomena of desorption and adsorption were all carried out on closely conditioned samples. Therefore, this study makes it possible to choose the most suitable criterion in the organization of fabrics in a storage warehouse.

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STATISTICAL ANALYSIS OF JUDGMENT OF THERMAL WELL-BEING DESCRIPTORS

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Key Words: thermal well-being, cluster analysis, factor analysis.

1. INTRODUCTION:

Today, the well-being of clothing is one of the essential attributes demanded by consumers [1]. However, it is a very subjective feeling. It is a complex and vague concept involving a variety of multidimensional factors.

As one of the aspects of the well-being of clothing, thermal well-being, is associated with the hot/cold sensation. It has been defined, according to ISO 7730, as the state of mind where man expresses the satisfaction of thermal conditions [2].

We should take into consideration the lack of a perfect and unique atmosphere that would satisfy all people in the world at once. This can be explained by the fact that thermal well-being is influenced by changes in physiological variables of the body, such as skin and body temperature, the user's activity level, and the heat transfer and moisture properties of the fabric [3], [4], [5].

Research has separately identified thermal well-being perception factors and sensory descriptors of clothing items. Nevertheless, the contribution of these factors to the perception of overall thermal well-being remains unknown. Following the exploratory analysis of the 12 thermo-physical factors related to thermal well-being descriptors using typological and factorial analyses [6], we seek to identify the relationships between these factors and their relative contributions. Thus, based on the results of these statistical analyses, we will establish descriptors of thermal well-being to best simulate the perception process. These descriptors will then make it possible to predict the overall perception of the thermal well-being of clothing.

2. MATERIALS AND METHODS:

Materials:

For our research, we used several samples of cotton and viscose stretch plain knitted fabrics (422 samples). Thus, we have diversified the construction characteristics (composition, gauge, loop length, etc.) and the finishing treatments (bleaching, dyeing, softening, anti-pilling, etc.)

Test methods:

For the determination of the adiathermic property, we used standard NF G07-107:1985 and the corresponding measuring apparatus. For the measurement of the thermal resistance and thermal conductivity of all knitwear, we used the same device.

3. RESULTS AND DESCUSSION:

The MINITAB software allowed us to perform the expected statistical analyses [6]. The classification of the 12 physical properties related to thermal well-being is carried out in two stages:

1- A typological analysis to build an overview of these 12 properties.

2- A factor analysis to identify the factors explaining the correlation model in a set of variables.

Typological analysis:

The relationships between the 12 physical factors related to thermal descriptors are presented in Figure 1. This figure shows that it is possible to classify the physical factors studied in this case either into 12, 9, 7, 5, 3 or 2 groups. Some assumptions have been taken into consideration, namely that each group must have its own meaning, and that the classification result must be simple. Thus, the most suitable classification available to us is the one with 5 different groups.

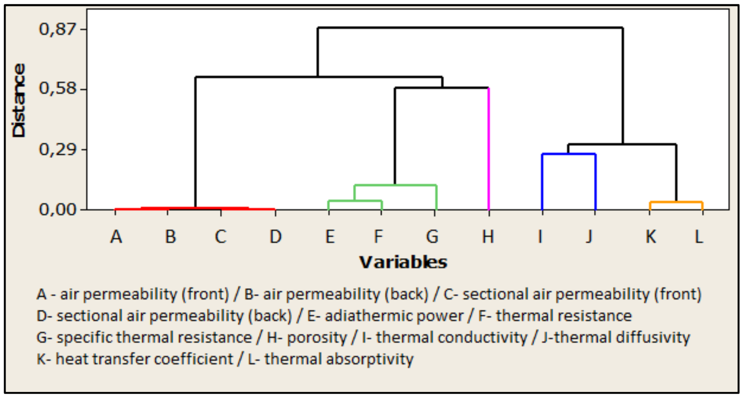

Figure 1. Relationship between physical properties of well-being and thermal descriptors (distance coefficient)

Typological analysis shows, through Figure 1, the general trend in the relationships between these physical factors, however it does not provide precise information on the structure and relationships between the factors as well as on the relative contributions of individual groups. Thus, the use, in the following, of factor analysis will deepen this survey.

Factor analysis

The application of factor analysis aims to identify the relationships that exist between the different physical factors by bringing them together in different thermal factors (descriptor of well-being).

Table 1. Matrix of rotated components (Equamax rotation)

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Air permeability (Front)	0,942	-0,021	-0,319	0,045	-0,029
Sectional air permeability (Front)	0,958	-0,015	-0,266	0,025	-0,053
Air permeability (Back)	0,944	-0,028	-0,315	0,044	-0,017
Sectional air permeability (Back)	0,960	-0,022	-0,261	0,024	-0,040
Adiathermic power	0,003	0,694	-0,326	-0,583	-0,249
Thermal conductivity	-0,198	-0,350	0,711	0,541	0,188
Thermal resistance	-0,085	0,752	-0,072	-0,599	-0,243
Specific thermal resistance	0,192	0,646	-0,589	-0,371	-0,209
Heat transfer coefficient	0,097	-0,433	0,057	0,725	0,244
Thermal absorptivity	0,118	-0,538	0,074	0,790	0,243
Thermal diffusivity	-0,339	-0,014	0,935	-0,024	0,069
Porosity	0,028	0,117	-0,063	-0,117	-0,984
Variance	3,8386	2,3456	2,2593	2,1737	1,2966
% Var	0,320	0,195	0,188	0,181	0,108

Table 1 compares the meanings of the relationships between the different factors with the Equamax rotation. Thus, among the physical factors related to thermal well-being, five main independent dimensions have been identified. The total of the percentages of variance explained by the model amounts to 99.2%. Indeed, 32% of the overall thermal descriptor was explained by the DEST1 factor and so on. Thus, it is evident that the thermal descriptor DEST1 has the greatest contribution to the feeling of well-being from a thermal point of view. We can say that factors related to air permeability and heat conservation were the most prominent aspect for jersey garments vanized with lycra.

4. CONCLUSION

For this work, we carried out an exploratory statistical analysis of properties related to thermal well-being using classification and factor analysis that allowed the identification of the existing relationships between these properties as well as their relative contributions, to best simulate the process of perception

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of thermal well-being.

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BREATHABILITY AND MOISTURE MANAGEMENT PROPERTIES OF A DOUBLE-FACE DENIM FABRIC

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Key Words: Denim fabric, double face weave, breathability, comfort properties, moisture management

1. INTRODUCTION

Denim is now widely used to make a variety of clothing items. Denim is a heavy woven fabric made primarily of coarse indigo-dyed cotton warp. It is most commonly associated with the twill (3/1) and (2/1) weave structures. Denim is available in a variety of weights. Denim's durability is due to the combination of yarn and weave. Wearers today require durability and comfort in their fashion items, including Denim [1,2] which is regarded as a comfortable, fashionable, affordable, and long-lasting clothing item for people of all ages.

The purpose of this research is to compare the moisture management properties of double face Denim fabric and simple Denim fabric in order to assess the clothing comfort of these structures.

2. MATERIAL AND METHOD

In this study, three Denim fabrics were considered. Sample 1 is a classic Denim fabric used as a reference sample. Samples 2 and 3 were double-face denim with all physical and structural properties listed in Table 1.

According to AATCC 195-2009, the moisture management tester (MMT) is used to measure the dynamic liquid transport properties of fabrics in three dimensions. The fabrics' relative water vapor permeability values were determined using the Permetest instrument in accordance with ISO Standard 11092. Furthermore, air permeability measurements are performed using an SDL Atlas Air permeability instrument in accordance with the EN ISO 9237 standard at 100 Pa air pressure.

Table 1. Properties of tested Denim fabrics

Fabric sample	Weave	Warp yarn	Weft yarn	Weight (g/m^2)	Thickness (mm)
1	Simple face (reference)	Cotton	Cotton	350	1.05
2	Double face	Cotton	PES	347	1.28
3	Double face	Cotton	PES	332	1.20

3. RESULTS AND DISCUSSION

Figure 1 shows that double-face Denim fabrics have the highest air permeability. This is due to the loose structure (particularly on the back side) and higher porosity. Reference Because of its compact structure, denim fabric has the lowest air permeability value.

In terms of water vapor permeability, all of the tested Denim fabrics showed a high level of relative water vapor permeability. Figure 2 depicts the effect of the weight of the Denim fabrics on this property. When the weight of the samples was reduced, the relative water vapor permeability increased. The density of the fabric doesn't allow the transport of moisture vapor through the fabric, case of sample 1 and 2 compared to sample 3 which has the highest relative vapor permeability. Thus, sample 3 transport is more breathable than sample 1 and 2.

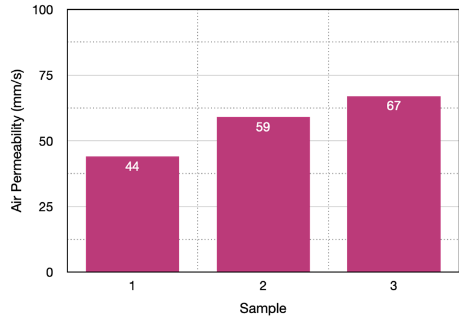

Figure 1. Air permeability of different fabrics

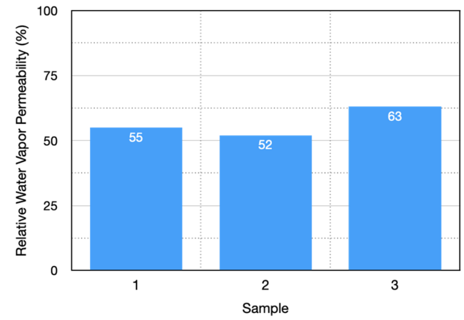

Figure 2. Relative water vapor permeability of different fabrics

Multi-directional liquid moisture transport capabilities of Denim fabrics were measured by the MMT instrument. The moisture management results of different fabrics are given in table 2.

Table 2. Moisture Management properties of different fabrics

Fabric sample	Wetting time (s)		Absorption rate (%/s)		Max wetted radius (mm)		Spreading speed (mm/s)		OMMC	AOTI (%)
	Top surface	Bottom surface	Top surface	Bottom surface	Top surface	Bottom surface	Top surface	Bottom surface		
1	4.36	4.51	33.82	47.75	15	15	2.57	2.58	0.322	206.89
2	4.55	4.60	26.21	28.37	13.33	16.66	2.18	2.70	0.332	135.01
3	6.22	6.77	31.86	29.00	13.66	13.33	2.61	2.29	0.341	256.1

The wetting time of the top surface (WTT) and bottom surface (WTB) are the periods in which the top and bottom surfaces of the fabric just start to get wetted, respectively, after the test begins. Sample 1 and 2 have almost the same wetting time on top and bottom surfaces which is lower than the wetting time of sample 3.
Absorption rates on the top and bottom surfaces (%/sec) are the average moisture absorption ability of the fabric, in the pump time. MWRtop and MWRbottom (mm) are defined as the maximum wetted radius (MWR) at the top and bottom surfaces, respectively. The lower MWRtop means lower wet touch (with the skin) and higher skin comfort. Sample 3 has the lowest MWRtop which indicates its good moisture transport property. Spreading speed (SS; mm/sec) is defined as the accumulative SS from the center to the MWR. Due to the same yarn composition, the SS of samples doesn't change a lot.
The overall moisture management capacity (OMMC) is an index to indicate the overall capability of the fabric to manage the transport of liquid moisture. The higher the OMMC is the higher the overall management capability of the fabric. All Denim samples have almost the same OMMC which indicates a good overall management capacity. Sample 3 has the highest OMMC value.

4. CONCLUSION

The presented study noticed that the weight and composition of tested fabrics influenced moisture management properties, as well as water vapor and air permeability. All of the denim fabrics tested had excellent moisture management properties. However, because of its low weight and higher porosity compared to the other samples, the double face Denim fabric (sample 3) has the best properties in terms of air and water vapor permeability and moisture management, making it the most breathable and comfortable.

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DESİGN OF FLEX FİT WELL-BEİNG DESCRİPTORS

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Key Words: flex fit, well-being, typological analysis, factor analysis

1. INTRODUCTION

Today, anguished by the various pressures of work and everyday life, consumers long resolutely for well-being. This phenomenon continues to grow and take greater dimension day by day. Well-being is a fundamental and universal need for consumers. Hence, research on clothing well-being has a fundamental meaning for the survival of human beings and the improvement of their life quality [1].
Elasticity plays an important role in consumer welfare. Indeed, it provides fabrics with the possibility of elongating according to the movements of the human body, and subsequently returning to their initial dimensions without deformation [2].
Knitted fabrics are widely used in clothing products thanks to properties such as extension, elasticity, hand, and comfort when worn. In the literature, there are also modelling studies that can define some of the characteristics of jersey knitwear [3].
In general, the recovery of the elongation of jersey knitwear is not suitable, this favors the use of elastane to increase elasticity and dimensional recovery. The use of elastane provides more comfort and ensures better maintenance of dimensions without deformation during the life of the garment, [4] [5].
In this work, we propose to carry out an exploratory analysis of 6 factors related to flex fit well-being descriptors using typological and factorial analyses, to identify the relationships between these factors and their relative contributions. Thus, from the results of these statistical analyses, we will establish flex fit well-being descriptors to best simulate the perception process. These descriptors will then predict the overall perception of clothing well-being.

2. METHODS AND MATERIALS

2.1. Materials:

For this work, we used many samples of cotton and viscose stretch plain knitted fabrics (422 samples). Thus, we have diversified the construction characteristics (composition, gauge, loop length, etc.) and the finishing treatments (bleaching, dyeing, softening, anti-pilling, etc.).

2.2. Test method:

To determine the elasticity of the fabrics, we carried out cyclic loading tests in accordance with method 'A' of EN 14704-1: 2005 using an LRX 2.5 K dynamometer (LLOYD, England). These tests are dynamic tests that simulate the deformation exerted on the textile during use.
Different criteria for evaluating the comfort of elasticity are determined, namely:

- Elongation which represents the temporary deformation of the shape of the material under the effect of forces, and which is restored when the effect of these forces dissipates.
- Residual deformation: represents the amount of permanent deformation of the material under the action of the force exerted during a period of time
- Elastic recovery: this is the ability, which the sample has, to cover its initial dimension following elongation.

3. RESULTS AND DESCUSSION:

The MINITAB software allowed us to perform the expected statistical analyses [6]. The classification of the 6 physical properties related to flex fit well-being is carried out in two stages:

3.1. Typological analysis:

The relationships between the 6 physical factors related to flex fit descriptors are presented in Figure 1. This figure shows that it is possible to classify the physical factors studied in this case either into 6, 4, 7, 5, 3 or 2 groups. Some assumptions have been taken into consideration. Thus, the most suitable classification available to us is the one with 3 different groups.

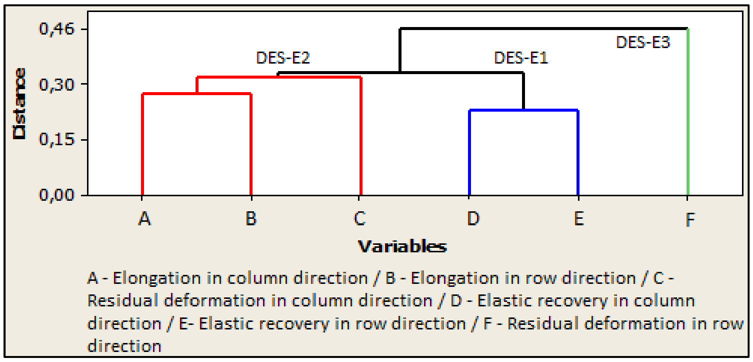

Figure 1. Relationship between physical properties of well-being and flex fit descriptors (distance coefficient)

Typological analysis shows, through Figure 1, the general trend in the relationships between these physical factors, however it does not provide precise information on the structure and relationships between the factors as well as on the relative contributions of individual groups. Thus, the use, in the following, of factor analysis will deepen this survey.

3.2. Factor analysis

The application of factor analysis aims to identify the relationships that exist between the different physical factors by bringing them together in different flex fit factors (descriptor of well-being).

Table 1. Matrix of rotated components (varimax rotation)

Variable	Factor 1	Factor 2	Factor 3
Elongation in column direction	0,477	0,689	-0,121
Elongation in row direction	0,487	0,724	-0,441
Residual deformation in column direction	0,040	0,903	-0,141
Residual deformation in row direction	-0,343	0,093	-0,916
Elastic recovery in column direction	0,899	0,041	-0,005
Elastic recovery in row direction	0,846	0,221	0,422
Variance	2,3375	1,5428	1,5754
% Var	0,390	0,257	0,263

Table 1 compares the meanings of the relationships between the different factors with the varimax rotation. Thus, among the physical factors related to flex fit well-being, three main independent dimensions have been identified. The total of the percentages of variance explained by the model amounts to 91%. Indeed, 39% of the overall elasticity descriptor was explained by the DES-E1 factor and so on. Thus, it is evident that the flex fit descriptor DES-E1 has the greatest contribution to the feeling of well-being from an elasticity point of view. We can say that factors related to elastic recovery in column and row direction were the most prominent aspect for jersey garments vanized with lycra.

4. CONCLUSION

For this study, we realized an exploratory statistical analysis of properties related to flex fit well-being using both typological and factor analysis that allowed us to identify the existing relationships between these properties as well as their relative contributions, to best simulate the process of perception of flex fit well-being.

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SYSTEMIC ANALYSIS OF FACTORS INFLUENCING EFFICIENT GARMENT PRODUCTION IN SOUTHWEST AREA OF NIGERIA.

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Keywords: Efficient, apparel production, socio-technical, clothing.

1. INTRODUCTION

Garment is an integral part of clothing meant for a basic human need. Garment production represents a key composite of fashion design and, a technical accomplishment that necessitate unequivocal creative and technical skills [1]. Garment industry is labor intensive and a source of employment for income generations as well as foreign earning [2], [3]. Recent Nigeria government efforts in solving financial crisis looming the nation includes reinvigorating the textile sector [4]. The industry outputs serviceability was still adjudged low as most citizens preference foreign garments [5]. An efficient garment must appease consumers' satisfaction [6], [7]. Therefore, the main purpose of this paper is to study factors influencing efficient garment production. The paper specifically examined garment producers characteristics, and analyzed socio-technical variables of garment production influencing efficient.

2. MATERIALS AND METHODS

The study was conducted in southwestern region of Nigeria. Three states (Lagos, Ondo, and Oyo) were randomly selected out of the six states in the region. Multi-stage and stratified sampling techniques were used in selecting 1,240 garment producers across the states. Data were obtained between January and April, 2023. A test-retest method was used to test the instruments for reliability within the interval of twelve weeks. Structured and pre-tested interview schedule, questionnaire, focus group discussion guides, observer participatory and interactive system were used in collecting both quantitative and qualitative data. While descriptive statistics were used to summarize and described the data, factor analysis was applied to highlight determinant factors in the efficient garment production.

3. RESULTS AND DISCUSSION

It was established that level of efficient garment production in southwest region of Nigeria was average. While 72.8 percent of the garment producers have tertiary education, 79.1 percent got engaged in garment production due to financial crisis mostly unemployment and, were not satisfied with the monetary benefits-return. The producers displayed low skill practices on fabric preparation process for cutting, an average skill in the assemblage of garment modules and intrinsic details handlings. About sixty four percent possessed low skill on garment finishing techniques. Just few (28.2%) obtained formal training on the job and 71.8 percent have informal. Garment producers (100%) in the study area repeatedly depends on fuel powered generator as main functional and available source of electricity. Eighty nine percent opined that formal and standard garment production training schools were accessible in the area but based in tertiary institutions. Ninety two percent of the studied producers identified standard equipments for garment production as fairly available but less affordable. In support of [8], consumable inputs (fabrics and notions) were moderately available but quality grades were expensive. Results of factor analysis highlighted five factors (technical, visibility, economic prowess, values orientation and, risk control) of garment production as having strong influence on efficient.

4. CONCLUSION

The identified factors are vital determinants of efficient in garment production and training needs program, but there is need to prioritize equipment and, consumable inputs accessibility. It is very essential to establish accessible standard and formal training centers as well as fashion incubators centers for ease of updating and assistance on the job.

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COMPARATİVE İNVESTİGATİON OF CUT RESİSTANCE AND THERMO-PHYSİOLOGİCAL- COMFORT PROPERTİES OF GLOVES

Hafsa Jamshaid , Muhammad Nadeem

Abstract

With the increasing awareness to use personal protective products such as cut resistance gloves to secure hand in accidental injuries. For better performance of user, the comfort properties have become essential need with the functional properties. In many occupations such as in meat cutting process, metal sheet and glass manufacturing units, during the use of sharp and edges tools, workers hand need protection. In this research, development and comparison of comfortable & protective cut resistance gloves were performed by using blends of high-performance fibers, synthetic and regenerated fibers. Fiber used were para-aramid, high density polyethylene, glass fibers to achieve technical properties and mode acrylic, viscose and polyester were used for thermo-physiological comfort characteristics. All the samples physical properties, cut resistance index and comfort properties i.e air permeability, thermal resistance and relative water vapor permeability % were investigated. All the results were analyzed and compare w.r.t comfort characteristics. It was observed that by increasing the percentage (%) of regenerated fiber (mode acrylic, viscose) the relative water vapor permeability was improved while by increasing the percentage of synthetic fiber(polyester) the thermal resistance and air permeability were improved .These gloves will fulfill the customer expected requirements and boost the industrial growth.

Key words: cut resistance gloves, comfort properties, composite yarn, protective textiles, High performance fibers, core spinning

1. Introduction

Protection of hands while performing occupational task in risky positions is prerequisite for the workers. Protective gloves are used in various circumstances such as to safe from burn, chemicals, weathers and cut. By increasing market of these products, customer also demand comfort characteristics with their functional need. Usually cut resistance gloves are used to meat cutting process, metal sheet, glass manufacturing units, and while using of sharp and edges tool in mechanical workshops [1]. Gloves with a knitted structure are common for light assembly activities. These have better fit on hands, short production process and more possibility of using combination of yarns except for using only a single yarn [2].

Alireza Mollaei et al. studied the comparison of coated (casting polyurethane resin) and pure para-aramid weft knitted fabric and ultra high molecular weight polyethylene fabric. They concluded that coated para-aramid has higher cut resistance than the pure [3]. Beena Zehra et al. studied and analyzed the performance levels of the different market available safety gloves that were developed by artificial leather (Polyester), PVC, Kevlar and thermoplastic rubber [4]. Thilagavathi et al. discussed the effect of textile fabric structure on the cut-resistant textiles by making a three-layer laminate composite by knitted Kevlar® fabric as the outside surface, polyurethane foam in center and a nylon knitted fabric as next to skin layer. This showed about 20% rise in cut resistance value when compared to Kevlar® fabric used with the lamination [5].Anum Ali Memon et al. studied about the cut resistance fabric that was made by Kevlar and polyethylene. They concluded that equal ratio of both yarns in composite showed better cut resistance characteristics [6]. Researchers studied about the cut resistance gloves made by ultra high molecular weight polyethylene (UHMWPE) as a covering material on the steel core [7]. Composites yarns are developed by combing two or more than one component. Commonly used blends for composite yarn for gloves are Kevlar®/Dyneema® and steel/glass. Protective gloves made with these yarns have good cut resistance [8],[9]. By using flexible monofilament in the core and covering

of core with Kevlar produces flexible and high cut resistance yarn [10], [11]. Ferreira et al. made DREF-spun compound yarns by coating Kevlar® 29 fibres at the core with wool fibers [12]
Despite improvements in workplace safety, hand injuries remain one of the most frequent accident. One of the reasons is lack of comfort properties in protective gloves due to which wearer remove them. Recently, Mustafa et.al studied about thermal and other comfort properties of protective fabric by developing different types of gloves, by using para-aramid, polyester with cotton, and channeled polyester as a plating yarn. It was observed that channeled polyester yarn sample showed better comfort characteristics [13], [14]. From the literature it can be observed that, intensive research in protective clothing especially protective gloves has been done. Most of the research is intended to improve the performance of the protective gloves and little attention is paid to improve the comfort properties. So, the aim of present work is the development of composites yarns with core spinning technology to improve the comfort properties without comprising cut performance. Glass fiber is used in core and blend of poly-p-phenylenediamine-terephtalamide fibres(PA) Kevlar ®/ High performance polyethylene (HPPE) Dyneema®. /Polyester(PET) /,Viscose(V) / mod acrylic(MA) in the sheath .

2. Material and Method

Core sheath 36.91/2 tex yarn was developed in which glass fiber is in core for all samples and sheath fibers by blending different fibers. Total 4 yarns were developed, in which sample 1 has Kevlar and Polyester in sample 2, Kevlar with Modacarylic , in sample 3 ,Kevlar with viscose rayon and in sample 4 Dyneema with Viscose Rayon. The yarn developed at FEHRER DREFF 2000, 2006 and doubled at the AGTEKS Direct twist- C6 "D6" machine. The manufactured yarn twist checked by direct method according to ASTM D 1423.Four Samples were developed as shown in Table 1 at the Shima Seiki SFG-I, Gauge 13, no. of needles 156, feeder 3, seamless gloves knitting machine at the same settings. The sample coding and sample id is mentioned in table 1. The stitch length was kept constants for all samples i.e 7 mm. The physical properties such as courses, wales, thickness, and GSM according to lab developed method, ASTM D 1777 and ASTM 3776 respectively. The following tests were performed at the standard conditions e.g. Temperature 210 C, Humidity 65%.
The samples were tested for cut level/ performance level as per standards EN-388 -2016 on Coup test tester, Sodamet .In this test circular blade with a fixed load (500g) that is moved back and forth across the fabric to determine ,how long it takes to cut through.
Thermo-physiological Comfort characteristics i.e Air permeability, Thermal resistance and Relative water vapor permeability (RWVP%) were tested. The air permeability was checked on tester M021A, the thermal resistance and RWVP were tested on Permeatest M290 as per standards ISO 9237, ISO11092 respectively. Mean and S.D was taken for all results.

3. Results and Discussion

Physical properties:

The physical properties are given in Table 1

Table 1: **Physical Properties**

Sample Code	Sample description	Arial density	Thickness (mm)	Course (cm)	Wales (cm)
S1	KGP	285	1.15	7	5
S2	KGM	386.4	1.32	7	7
S3	KGV	327.1	1.24	6	6
S4	UGV	404.2	1.39	9	7

From the physical testing results, it was analyze that the sample S4 has highest weight and thickness value. This can be due to Dyneema, which have low fiber density and higher specific volume [11]

Cut resistance:

Cut resistance is the primary factor for protective gloves and it is capability of a material to resist the damage when experienced with sharp edge object [14]. Performance level of all glove's samples were also investigated. All the samples have performance level 5, as all samples has glass filament in the core .Due to ,smoothness and gloss of glass , which help in sliding during application of force [15] .Keeping the cut index level 5 for all samples, breathability of all samples were investigated .If glove

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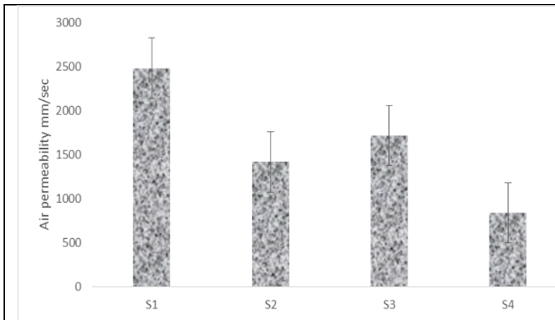
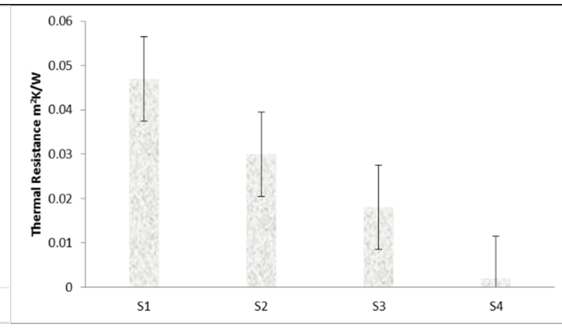
were not breathable , they made hands hot and sticky, which lead to wearer to take them off and the conundrum of cut protection vs comfort began.

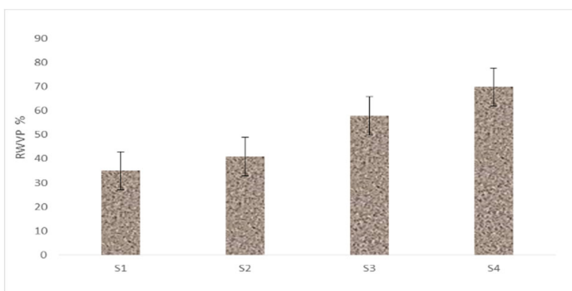
Air permeability:

In the thermo- physiological comfort properties, the air permeability of specimen is the measurement of air passage through it, and often used to evaluate the breathability characteristics [9]. It was observed from Figure 1 (a) that the air permeability of the sample S1 has better than S2, S3 and S4 due to its fiber composition ratios, lower areal density and thickness which are the main factor of air permeability [10]. S4 has minimum air permeability, due to lower fiber density and high specific volume lead more yarns to compact inside the air gap of the fabric as compared to other samples [11].





(a) Air permeability (b) Thermal resistance



© Relative water vapor permeability %

Figure 1: Thermo-physiological comfort properties of gloves samples

Thermal Resistance:

Thermal resistance is the total heat resisted per unit area through the fabric under prescribed conditions. The fabric material type and thickness are such factors that greatly influence on the thermal resistance properties [13], [16]. From Figure 1 (b) it can be seen that S4 sample has lowest thermal resistance. This is most probably due to fiber conductivity. HPPE fibers stay cool against the skin and do not trap air, similarly viscose Rayon is also good conductor of heat. S1 has highest thermal resistance due to their conductivity values, due to more percentage of polyester fiber in blend that is dominant factor, it is considered that polyester fibers keep more air in their structure that make it more thermally resistance [17].

Relative water vapor permeability %:

Water vapor permeability is the ability to transmit vapor from the body and it is an important ability of clothing to transport water vapor for improving breathability. If clothing is unable to escape sweat into the surrounding atmosphere, it will increase the humidity on the surface of the skin which can increases damp and clammy perception for wearer. Liquid transfer through porous structure involve two process, i.e wetting and wicking. Wetting is initial process, as the liquid wets the fibers, and then wicking in it, liquid reaches the spaces between fibers and produces a capillary pressure [18]. When comparing fabrics of same yarn , the water vapor transmission properties dependent on mainly on fabric physical properties [19] but when comparing different materials, kind of raw materials i,e fiber wetting and wicking properties By using blend of hygroscopic and hydro phobic fiber improvement in the moisture transfer rate can be achieved [20]. HPPE also does not absorb water which means it will wick moisture and sweat away from your skin while Viscose rayon absorb water so highest RWVP % is of S 4, followed by S3, S2 and S1 as Kevlar also tend to absorb moisture can be visible in figure 1 © .

4. Conclusion

In this study, the semaless gloves were knitted by different core –spun yarn produced with glass in core and blend of kevlar, polyester, viscose rayon, modacrylic dynema as sheath . All samples were analysed in terms of cut resistance , air permeability, thermal resistance and relative water vapor permeability %. All the samples passed the cut index level 5 .From the results obtained it can be conclude that thermal and moisture management performance of the studied gloves were greatly affected by raw materail properties, which significantly effect the different comfort realted properties evaluted. From the study it is concluded that that the sample S1 is better for the winter seasion due to its better thermal resistance while on the other hand ,the Sample S4 proved better in the summer season as HPPE fibers stay cool against the skin allowing your skin to breathe. HPPE also does not absorb water but with the water loving fiber it can means it wil wick moisture and sweat away from skin.. The present study showed that the synthetic fiber is dominating factor to improve the thermal resistance while regenerated fiber improve the moisture management . This research will be helpful for the worker to perform their task risk free with better thermo- physiological comfort properties. This research work will also prove benificial for the economic groth of protective clothing industry.

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