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FASCICLE OF TEXTILES, LEATHERWORK

STUDY ON KNITTING WITH 3D DRAWINGS USING THE TECHNOLOGY OFFERED BY STOLL

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Abstract: *There are different techniques that can be successfully applied for the production of 3D knitted materials or those with 3D effects on knitting machines with electronic selection. In the present work were treated different aspects of some knits with 3D embossed drawings obtained by making incomplete rows in order to obtain an embossed knit effect. The designed knit was made on the knitting rectilinear machine, CMS 530 HP 7.2, finesse 14". This machine is a new generation machine, a multigauge knitting machine. This means that the machine is of finesse 14 but it is equipped with knitting needles that can be selected so as to obtain knits of finesse 7. The drawing chosen to be embossed on the knit was transposed on a knit jacquard, made in two colors, on a knitting machine Stoll. After importing the image into the M1plus graphic program, which is a design program of STOLL knitting machines, it was placed on a jacquard structure in two colors. In the case of these knits with embossed drawings, 3D increased attention is required to the adjustments made on the knitting machine. The most important adjustment is that of the main and auxiliary pulls of the knitwear, as well as the adjustments of the looping depths for the retained stitches, but also for those made on the opposite cast iron within the incomplete rows.*

Key words: *Knitting, 3D effects, electronic knitting machines.*

1. INTRODUCTION

The brand STOLL, as a part of the Karl Mayer Group, is a leader in flat-knitting machine technology, offering innovative tools and services for the knitting of tomorrow. They have a strong reputation for providing highly sophisticated knitting solutions and also as an independent thinker and developer in the section of Fashion & Technology. With the M1plus® softwear STOLL [1] boasts a well-proven system for creating knitting designs and knitting patterns for making many different structures and designs [1]. Knitting can efficiently fabricate stretchable and durable soft surfaces [2].

Knitting is a process of converting yarn to fabric by forming a series of loops dependent on each other [3].

Knitting is a technical, real and complex system that requires modelling and optimization of encountered problems [4]. The graphic representation of the knitwear structure consists of transposing by drawing the position of the thread and the shape of the component elements (normal stitches, elements with modified evolution, additional threads), from yarn with the same colour or from threads of different colours [4].

Knitting by shape is an important feature of the knitting technology because it allows the formation of knits modelled in 2D and 3D sizes [5]. At the moment there are various techniques that can be successfully applied for the production of 3D knitted materials or those with 3D effects [6] on electronically selected knitting machines. The 3D fabrics or fabrics with 3D effects exhibit a higher thickness, compared to the single yarn diameter [4]. The flexibility of the knitting process in combination with the possibility of integrating reinforcing threads into the fabric structures captures the attention of many researchers [7]. In addition, textiles with excellent comfort properties still remain a challenge for quarrels [8].

2. EXPERIMENTAL PART

The process of knitting has several important phases, and one of them is the design stage of the pattern [9]. In the case of computer-controlled knitting machines, the models are developed on special modelling stations, using a programming language [9] specific to each manufacturer brand of knitting machines.

In the present work, different aspects of some knits with 3D embossed drawings obtained by making incomplete rows in order to obtain an embossed knit effect, were treated.

The designed knit was made on the knitting rectilinear machine, CMS 530 HP 7.2, finesse 14". This machine is a new generation machine, a multigauge knitting machine and this means that the machine is of finesse 14 but is equipped with knitting needles, that can be selected so as to obtain knits of finesse 7.

Fig. 1*: Knitting machine Stoll*

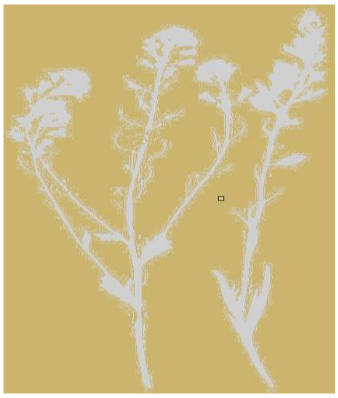

Fig. 2*: Implemented drawing*

The drawing chosen to be embossed on knit was transposed on a knit jacquard, made in two colours on a knitting machine Stoll. **Fig. 1.**

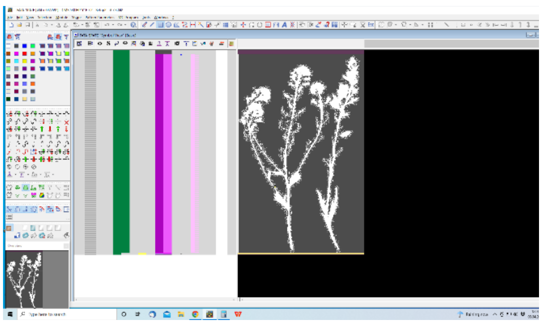

Fig. 3*: Importing the drawing into the program*

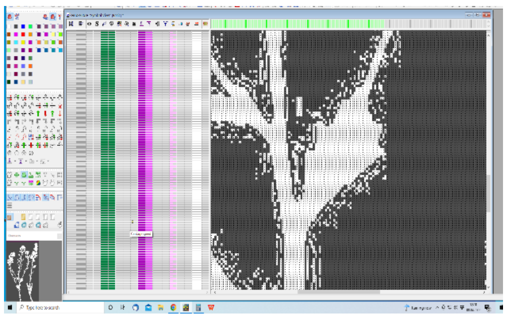

Fig. 4*: Placing the drawing on the jacquard structure*

In the next step, the import of this drawing was made (.jpg) **Fig.2**, in the graphic program M1plus **Fig.3**, which is a design program of knitting machines STOLL. After importing the image, it was placed on a jacquard structure in two-colours. **Fig 4**.

Considering that this design program, Stoll M1plus, works on two monitors, on the first monitor we have presented jacqard structure, in the section rows of stitches and on the second monitor we have presented simulation of the layout of the image in knit. **Fig 5.**

The imported image in the graphic program M1plus can be put on a knit intarsia or a knit jacquard. The difference between the knit intarsia and the knit jacquard, is given by the final thickness of the knit. Thus, intarsia knits are characterized by fields of different colours, joined together by structural elements with modified evolution and in the case of jacquard knits it is a simultaneous evolution of all the threads that make up the drawing of the knit. In the case of jackard knits this change of appearance of each color on the knit's front, is made according to the drawing, the other colours are arranged on the back of the knit.

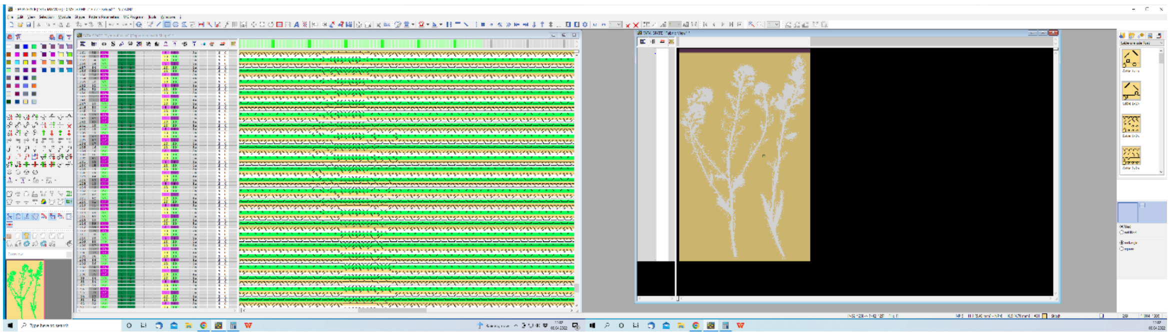

***Fig.** 5: Representation of the jacquard structure and simulation of the layout of the image*

5. CONCLUSIONS

In the case of these knits with embossed drawings, 3D increased attention is required to the adjustments made on the knitting machine. The most important adjustment is that of the main and auxiliary take down of the knit, as well as the adjustments of the looping lenghts for the retained stitches, but also for those made on the opposite cast iron within the incomplete rows.

A take down too big can lead to the breakage of the knit on the knitting machine, while a take down too small can lead to accumulations of thread, incomplete or not at all knitted stitches and even dropped stitches.

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ANNALS OF THE UNIVERSITY OF ORADEA
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INNOVATIVE RESEARCH AND APPLICATIONS IN YARN WINDING/DYEING

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Abstract: *The yarn dyeing process has a large part in the coloring of the product. The most important factor in evaluating the quality and efficiency of dyeing in the yarn dyeing process is the quality of the winding process. Combining technology with traditional bobbin dyeing processes results in higher quality and lower cost production processes and products. In this study, the determination of optimum points in parameters such as winding properties, density, density and yarn count were investigated in order to ensure high quality dyeing and reproducibility. It is aimed to develop a test device to analyze the cone technical information with the image processing method and to technologically examine the cone winding process before cone dyeing. Image processing technique was used to add a technological perspective to the winding measurement process. Density measurements made with the developed device and the traditional method were archived and compared. The measurements made with the traditional method and the values measured by the software were compared and it was determined that the system performed these measurements with an error margin of approximately 2.42%. Cone winding density measurements were made with the device designed to minimize dyeing errors caused by cone winding. In the bobbin dyeing unit, the difference between the windings is determined with this device and checked before starting the production.*

Key words: *Cone dyeing, winding density, image processing, density measurement*

1. INTRODUCTION

Dyehouse is important for businesses in the supply chain in the textile industry. The yarn dyeing process has a large part in the coloring of the product. The dyeing of the yarns (bobbin dyeing) is advantageous due to the high production capacity and the easier transition to the production stages to be made after dyeing. The most important factor in evaluating the quality and efficiency of dyeing in the yarn dyeing process is the quality of the winding process, which is the initial stage of bobbin dyeing. The quality of the winding of the bobbins obtained at this stage affects the correct dyeing and repeatability of the yarn dyeing [1].

Yazir, in his study in 2003, carried out experimental studies to determine the effect of the winding density of the cone and the structure of the pattern on dyeing. As a result of the studies, color difference was observed to be lower in bobbins with winding density of 0.41 and 0.43 g/cm3 during dyeing at 2 bar pressure. It has been observed that the color difference that occurs during the use of the dyeing pattern with a high useful surface coefficient is less than the use of the existing coating with a low useful surface coefficient [2].

In his study conducted in 2008, Tomruk stated that the most important factor in evaluating the quality and efficiency of bobbin dyeing is the quality of the winding process, which is the initial stage of bobbin dyeing. The quality of the winding structure of the bobbins affects the highly efficient dyeing of the yarn during dyeing. In this study, the winding structure of the bobbins prepared for dyeing was examined from a technical point of view [3].

In Yeltekin's (2016) study, it was aimed to estimate the ster value of the tree-laden vehicles on the scales with computerized systems using image processing techniques. A special real-time software has been developed using various image processing techniques. While the calculations were made, the pixel/cm calibration was determined as 521/470 [4].

Praček and Pušnik (2019), gave a simple mathematical model for simulating the unwinding process. Simulation studies was done with experimentel studies in the scope of explaining between the angular velocity of the yarn and the tension [5].

In their study, FETTAHOV et al. investigated the overlapping winding errors in the windings of the coils mathematically. Using two different methods, turns of package per double traverse were calculated and no big differences were observed. Calculations were used to determine possible belt formation diameters on the spinning machine. [6].

2. MATERIAL AND METHOD

In this study, brand name of SSM winding machine (Figure 1) and the most requested yarn numbers (such as 16/1 Ne, 12/1 Ne, 20/2 Ne) were used. The cabinet design was made with a three-dimensional printer in our R&D Center, the software was developed by our research team using MS Visual Basic C# software language and a cone density measuring device was designed with image processing technique. Density measurements of ready-to-dye coils were made with the developed image processing device. The study was carried out under three headings, which is given below, respectively.

1. Implementation of software for density measurement with image processing and cabin design with 3D printer.
2. Using the density measuring cabinet and saving data.
3. Optimization studies in the yarn dyeing process

Fig. 1: *SSM winding machine*

3. RESULTS AND DISCUSSION

3.1. Implementation of software for density measurement with image processing and cabin design with 3D printer.

Software of the density measurement was done with the MS Visual Basic C# software language. After the cabinet design was done Solidworks, cabinet parts were printed by 3D printer. The design of the density measurement cabinet given in Figure 2 was done with Solidworks.

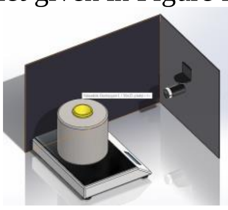

Fig. 2: *Virsual of cabinet basic design*

3.2. Using the density measuring cabinet and saving data.

After the software, design and 3D printing studies were completed, pre-studies were begun. While the system was calculated volume of the bobbin with image processing, weight of the bobbin was taken by weighing machine, which was under the cone. Density was calculated by using d =m/v equation. Software visual was given in Figure 3 when measurement of density in the cabinet. The lower and upper limits of the coil from the video frames taken from the cabinet were determined in pixels and converted to cm values with software. The real data along the measured cones were compared with the values measured by the software and it was determined that the system performed these measurements with an error margin of approximately 2.42%.

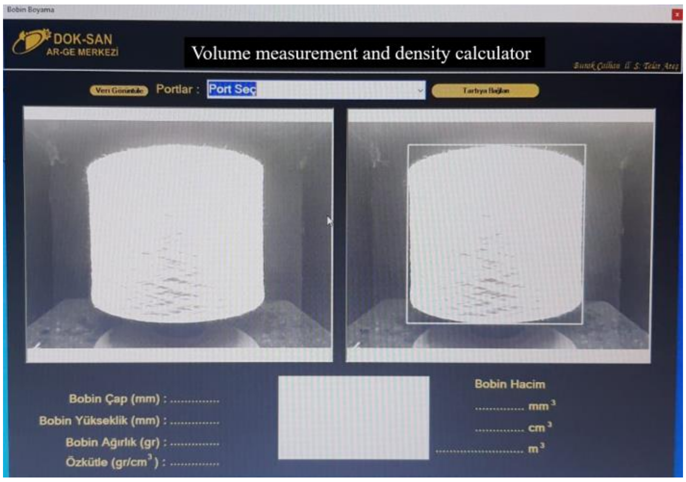

Fig. 3: *Measurement of density in the cabinet*

3.3. Optimization studies in the yarn dyeing process

With the help of the device developed by our researchers, the density measurements of the bobbins were made before dyeing. Research was done in light color dyeing studies in our enterprise. In addition, measurements were made according to different yarn counts and types. The lower and upper limit bobbin density values that will provide the maximum dyeing efficiency have been determined. Yarn tension values that meet these density values were defined to the winding machine. The data obtained in this study were given in Table 2.

Table 2: *Lower and upper limit values of density for different yarn counts and types*

#Yarn (Ne)	Yarn type	Density (g/L)		Tension (cN)
		Lower limit	Upper limit	
6/1	Ring	400	410	18
12/1	Low twist	420	445	15
	Open end	400	430	12
	Ring	410	420	12
16/1	Open end	430	450	10
	Ring	390	405	20
20/1	Organic	410	430	12
	Ring	375	390	15
20/2	Open end	385	395	27
	Carded	390	405	35

5. CONCLUSIONS

A system has been designed by our R&D center in order to reach optimum data on dyeing performance in the yarn dyeing department. Optimum points in parameters such as winding properties, density, density and yarn count were investigated in bobbin dyeing pre-preparation processes. While doing this, it has benefited from 3D printing and image processing to add a technological and different perspective. First of all, a cabin design was made with the help of a 3D printer. On the other hand, software studies for image processing continued. The main topic in the software was on the volume calculation of the cone. The weight of the cones was recorded with the help of the scale in the designed cabin. Density calculation was made by dividing the weight taken from the scale by the volume calculated with the help of image processing. For the field studies, the most used yarn types in the enterprise were measured before dyeing. Optimum bobbin densities with high dyeing efficiency were classified.

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RESEARCH ON OPTIMIZING THE CONSTRUCTION OF TROUSERS FOR PEOPLE WITH AMPUTATIONS USING 3D SIMULATION

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Abstract: *The construction features of waist support products depend on current fashion trends, the specific requirements imposed on the products by potential wearers and the characteristics of the materials used and of course the methodology for developing the basic construction. In the case of people with lower limb amputations, the construction also depends on the type of prosthesis and its size. The paper presents the results of the study to optimize the construction of trousers for men with amputations in the leg. The topicality of the theme is determined by the alarming increase in the number of amputations and the increased interest of specialists in creating clothing for people with disabilities. The paper aims to identify the methodology for improving the construction of the product of trousers for people with amputations of the lower limbs, using 3D simulation. The general objective of this paper is to propose a succession of optimization of the basic pattern in order to be able to be customized according to the type of amputation. The paper presents the initial data necessary in the elaboration of a customized construction. Also presented are the stages of optimizing the construction of the pants and the simulations on the body of the avatar of the pattern, even after performing the optimization. The use of 3D software allows obtaining the wearer's avatar and assigning unique features, which are taken into account when designing custom clothing products. They also allow you to check the position of the products on the body of the avatar and modify them according to the requirements.*

Key words: *3D simulation, clothes for people with disabilities, men's trousers.*

1. INTRODUCTION

While wearing trousers, the man performs a series of movements of various complexity, which act on the clothing product. Static positions also make their mark on the trousers, which are subject to various types of deformation. [1]

The prosthesis is also an important factor that acts on the positioning of the pants on the wearer's body, because its type and size were not taken into account in the design process. In order to obtain an optimal construction for the development of trousers for people with amputations of the lower limbs, 3D simulation will be performed.

2. DETERMINATION OF INITIAL DATA

As initial data for the design of clothing products with waist support are examined general data about the clothing product, its shape and data about the conformation of the human body, presented by a series of dimensional characteristics. [2]

The whole research process was simulated in a 3D software, CLO3D, because it allows obtaining the wearer's avatar with individual or standardized dimensional characteristics, using a wide range of materials, importing or developing the basic and model construction, checking the positioning of the product on the body in static and dynamic, etc.

Clothing product data:

The information presented in Table 1 is used as the initial product data.

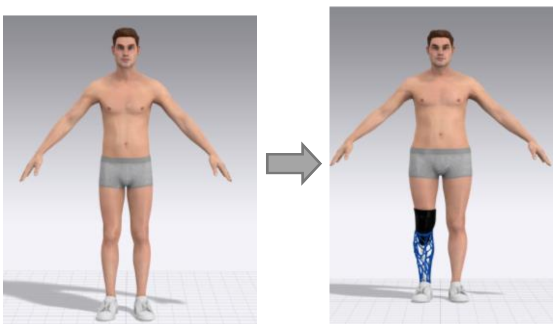
Table 1: *Characteristic of the external shape and construction of waist support clothing products*

Type of clothing product	Destination, season	Size	Silhouette	The characteristic of the cut					Fabric
				Degree of adjustment		Waist line level	The means of creating form		
				at the hip line	at the end and knees		The front element	The rear element	
Men's trousers	Every day, Spring-Fall	176-100-88	Semiadjusted	Medium	Medium	Descended	Tweezers	Tweezers	Cotton blend

Data about the wearer:

Initially, as the standard avatar offered by a 3D software was selected, which was later modified according to the characteristics of the wearer, namely the male gender and the age that is between 18-35 years. Subsequent changes were primarily related to the presence of lower limb amputation in the calf (Table 2). The avatar was also assigned the values of the dimensional characteristics taken from the literature. These values allowed the avatar to be modified and the required size obtained. [3]

Table 2: *Data about the wearer/avatar involved in the research*

Avatar	Criteria	Date
	**Gender**	male
	Age	18-35 ani
	Amputation type	inferior limb
	Amputation level	calf level
		

3. STEPS OF CONSTRUCTION OPTIMIZATION

In order to obtain an optimal construction, research has been carried out which includes an analysis of the existing methods of elaborating the construction patterns of of elaborating the construction patterns of the men's trousers product. For this purpose, the constructions of the patterns were elaborated by 4 graphic-analytical methods of calculation: Muller & Sohn, the English method after Winifred Aldrich, of the Russian author I. Grișpan and MUPI CAER. [4]

These methods are distinguished by the methodology of elaboration of the construction, the number and type of dimensional characteristics used in the calculation of the construction, by the way of presenting the parts in print, etc. [5-8]

The following are the steps to optimize the construction of men's trousers made by the MUPI CAER method.

Step 1. Development of the basic pattern. At this stage, the construction of the clothing product is elaborated. Figure 1 shows the pattern developed according to the MUPI CAER method.

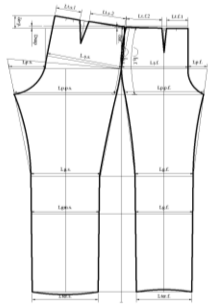
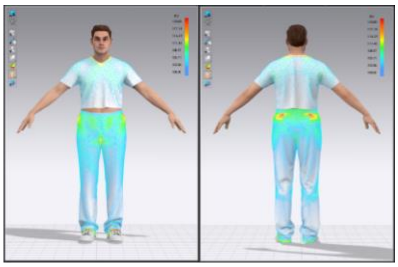
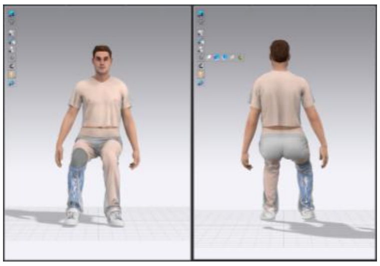
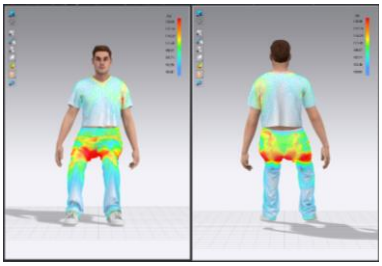


Figure 1: *Basic pattern developed according to the MUPI CAER method*

Step 2. Initial 3D simulation of static pants product - standing and sitting. This stage allows visual verification of the product's positioning on the body and analysis of critical areas of clothing fit (Table 3).

Table 3: *Simularea inițială 3D a produsului pantaloni în statică*

Front and back view standing	
	
	

Front and rear view seated	
	
	

Step 3. Defect identification and removal. The analysis of the initial simulation identified the appearance of some defects. Their detection allowed the selection of the removal method by modifying the construction (table 3).

Table 4: *Defect identification and removal*

Nr. d/o	Construction defects	How to remove the defect
1.	Long product length	Reduce the length of the product by 5.0 cm
2.	Pronounced hip line adjustment	Increase the value by 1.5 cm on the hip line
3.	Oblique skin on the back of the thigh	Changing the lower balance by 1.0 cm
4.	Skin oblique on the front and back mark	Deepening the curvilinear segment of the symmetry line of the rear element by 2.0 cm and the front by 1.0 cm
5.	Visualization of the leg prosthesis through the fabric of the part	Increase the width at the knee, leg and end line by 1.0 cm on the front mark and 1.0 cm on the back mark

By detecting and removing defects, this step allowed to modify the construction of the product. Figure 2 shows the modified construction of the product pants intended for people with leg prosthesis.

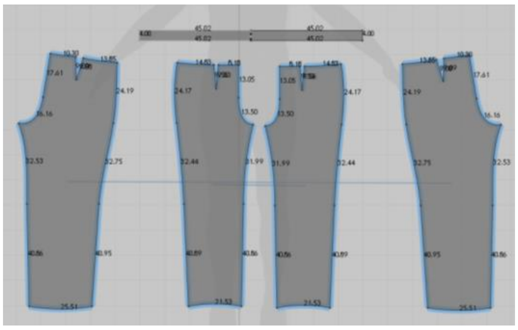
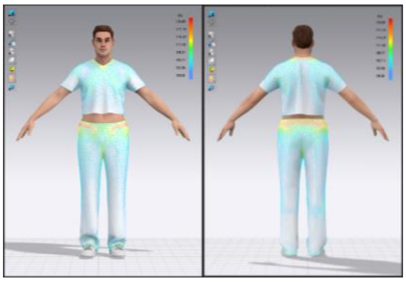
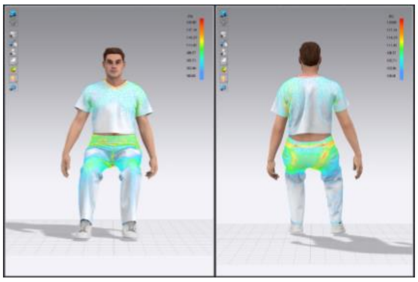


Figure 2: *Basic pattern of trouser product after removal of defects*

Step 4. Repeated 3D simulation of the pants product in static - standing and sitting. Repeated simulation allows to verify the positioning of the product on the body of the wearer and the confirmation of obtaining an optimal construction (Table 5)

Table 5: *Repeated 3D simulation of static pants product*

Front and back view standing	
	
	
Front and rear view seated	
	
	

The same sequence of analysis was applied to the other design methods mentioned above.

5. CONCLUSIONS

The research carried out made it possible to identify the main stages in order to obtain an optimal construction. The following can be seen:

- The construction of the basic type must be carried out taking into account the individual dimensional characteristics of the wearer, the presence of a disability or a prosthesis;
- The initial simulation allows to establish the mismatch of the construction of the product pattern with the shape and sizes of the wearer;
- Identifying defects and removing them allows obtaining an optimal construction;
- Repeated simulation confirms the achievement of an optimal construction and its correspondence with the shape and size of the carrier.

These steps can be applied to patterns made by various construction methods used to make garments of various shapes and purposes. Thus, we can obtain optimal constructions of functional products for people with disabilities.

Identifying the optimal construction of the men's trousers product will allow you to create a collection of models for people with limb amputations. As a further research direction, it is proposed to develop such a digital collection for people with amputations of the lower limbs using various 3D software.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

FLEXIBLE PANEL ASSEMBLY TECHNIQUES USED IN THE CONSTRUCTION OF AERODYNAMIC DECELERATOR

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Abstract: *A combat aircraft is stabilized by the parachute during its dangerous maneuvers such as spin, loss of speed (at low angles of incidence), vibration of the wings (at very high speeds). For the braking on landing of aircraft that have certain operational characteristics, recovery systems are used with the help of parachutes, in which the veil of the main parachute is cross, and the fabric is made of 100% para-aramid yarn. In order to meet the typical design criteria of such a decelerator assembly, related to: stability, operational safety, mass, volume, forward resistance coefficient, shock at opening, a special mechanical-textile processing technology must be used, for which it is it is necessary to intervene in the flow, especially when sewing - assembly by sewing. The paper presents the achievements of the specialists from INCDTP regarding the types of seams and the subassemblies used for the realization of the drag parachute veil. In order to assemble the para-aramid panels, coats thread brand para-aramid with continuous filament were used. In order to stabilize shape, it was used French seam double top stitch 2x301. Some rows of stitches have been used because the efficiency of the seams for thread and para-aramid materials is lower than those of thread and materials obtained by polyamide or polyester that are used to obtain deceleration systems for other aircraft, with a distinct configuration. The technique used to assemble fabric panels made of 100% para-aramid yarn with a length density of 220dtex/134f coincide with the field of use.*

Key words: *para-aramidic yarn, drag parachute, subassemblies, operational characteristics, supersonic aircraft*

1. INTRODUCTION

Currently and globaly, the approach to speed performance requires new research directions, because not only is the sonic thresholds important, but also the way the aircraft runs on the runway, because the impact with the ground and braking raises equally big problems as big as the flight itself. The first known attempt to use a parachute as a landing brake was made in 1923, using a standard human parachute to reduce the landing path of a Havilland biplane [1].

In 1933, systematic studies were carried out at the Aeronautical Institute in Stuttgart, Germany, in order to make a parachute with very good aerodynamic and static qualities. Thus, a parachute with circular slots and a parachute "made of strips" were developed. In 1939, a Junkers W-34 made its first landing using a "strip" parachute as a landing brake. This test, as well as the ones that followed, proved that the parachute is stable, opens slowly and evenly, produces a minimal shock when opened, does not impede the controllability of the aircraft, is a good supplement to the brakes of the landing gear. However, the most important use of braking parachutes came with the construction of high-speed jet aircraft. The loading of the wings of supersonic aircraft resulted in high landing speeds and long landing distances, which necessitated finding means to reduce runway taxiing. [1,2,3]

Currently, the stabilization of a combat aircraft is done with the help of the parachute during its dangerous maneuvers: spin, loss of speed (at low angles of incidence), vibration of the wings (at very high speeds). For these critical situations, the parachute is disengaged and the aircraft has a normal flight attitude. Braking is performed when the aircraft is in flight, or on landing, to reduce the braking distance, but also to spare the brakes and wheels. The parachutes used as brakes must be very stable, as they must not disturb the control of the aircraft. They must be very strong, but they must develop a shock load at low opening.

Worldwide, two types of braking parachutes are known, namely:

- for braking and controlling the aircraft during flight, known as the approach parachute.
- for braking the aircraft on landing, known as the landing brake parachute (fig.1).

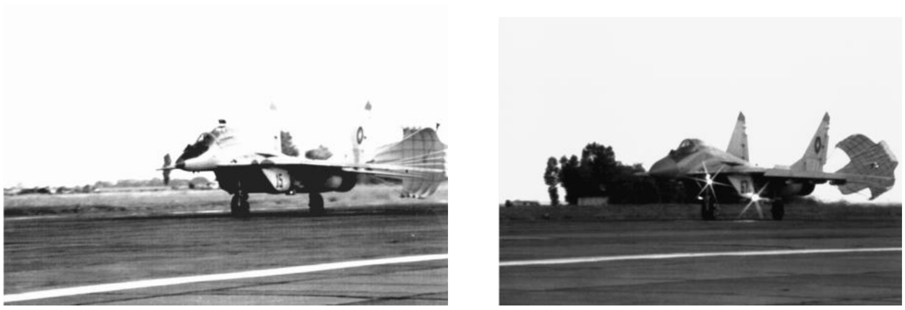

Fig. 1: *Deceleration at landing*

This type of parachute is used, along with aerodynamic and mechanical devices (flaps, aerodynamic brakes, spoilers, lift destroyers, attack flaps), to brake the aircraft during taxiing on landing, producing the highest braking force at speed at which the plane reaches the ground, when the brakes are practically ineffective. In addition to a reduction in landing distance, the system ensures increased safety in flight in hazardous conditions (for example during landing with brakes not acting), during unsuccessful take-offs, during forced landings on short runways, on icey or wet runways. The typical design criteria for a drag parachute are [1,2]:

Operational safety of the system - the most important criterion. A technical reserve of at least 31 consecutive landings for space shuttle landings and a high rate for airborne troops must be provided.

Mass and volume are considered important. The parachute system is about 5% of the weight of the air vehicle (for light vehicles) and 3-4% for vehicles with a mass greater than 1000 pounds (454 kg). A complete recovery system shall include the buoyancy, positioning and restraint assembly and shall have 10 ± 2% of the total mass of the air vehicle. [1,4].

Stability is the main selection criterion for the system. Drag parachutes, drag-deceleration parachutes require a high level of stability, a requirement that automatically eliminates many parachutes that have a high coefficient of resistance to advance (so-called solid parachutes) [3,5,6]. For a final lowering parachute, a small diameter, i.e. a small mass and volume, is required, even if the stability leaves much to be desired (oscillation angles of ± 10º). For a very fast descent, the large oscillation can be eliminated by using a parachute beam [2, 3, 7].

The coefficient of resistance to high advance is very important in the selection of downhill parachutes [1, 2]. A good evaluation is also determined by the efficiency of the mass $(C_xS)_0/M_p$, which shows how much of the resistant surface $(C_xS)_0$ is produced on the mass of the parachute M_p.

The reduced opening shock is an important criterion for the selection of parachutes without delayed opening, where the delay device controls the force-time ratio for the parachute opening process.

Increasing potential is important in design [1, 3, 5]. A smooth landing requires a lowering speed, which in turn increases the size of the parachute and at the same time increases the mass and volume of the parachute assembly.

All these features have been taken into account for the design of the drag parachute of the MiG 29 Sniper aircraft and, in addition, special attention has been paid to the types of assemblies of the component subassemblies.

2. MATERIAL AND METHOD

2.1 Materials used to make the main parachute canopy

For landing braking of aircraft with certain operational characteristics (wingspan - 11 - 12 m; length with LDPE arm - min. 17m; height - min. 4m; wing surface - 38 sqm; with single or double control; 2 turbojet engines) with water injection during landing); engine mass - 980 kg; empty aircraft mass - 10900kg; maximum take-off mass - 18500kg; combat load - 3000 kg; maximum flight speed - 2.3M, ground - 1300km / h; take-off speed - 220km / h; landing speed - 235 km / h, equipped with cannon-type weapons, bombs or ground-to-air weapons; medium-range missiles, etc.) are used used cruciform braking parachutes made 100% para-aramid yarn fabric because it must meet the following requirements:

- temperature resistance developed behind the aircraft engines: min. 260 ° C;
- maximum force that the veil must withstand: 7500 daN;
- resistance to difficult weather conditions;
- resistance to joining by sewing: min. 60% of the value of tensile strength;
- small mass and volume, determined by the aircraft configuration.

The diagram of the braking parachute assembly from the aircraft recovery system component is presented in **Fig.2**.

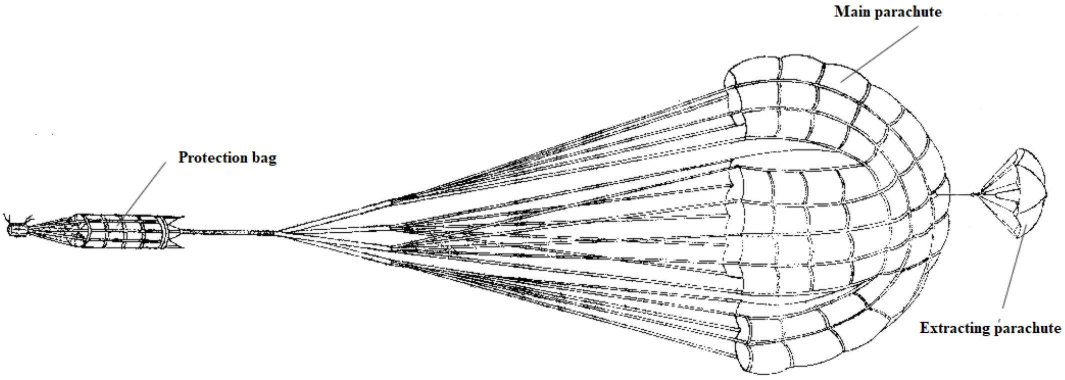

Fig. 2*: Diagram of the braking parachute assembly*

The specialists from INCDTP designed and made a woven structure made of 100% para-aramid yarn with a length density of 220dtex/f134 and which presents the physical-mechanical characteristics presented in **table 1**. The images obtained by scanning electron microscopy are present in **Fig.3**.

This fabric has been tested for seaming to determine how it will break. To assemble the para-aramid panels, it was used coats thread brand para-aramid with continuous filament - needle size 140/22 and Pfaff 2235 sewing machine with Ecodrive servomotor. It was also used French seam double top stitch 2x301, to stabilize shape.

The configuration of the MIG21 Sniper supersonic aircraft requires the use of a High-Tech yarn with a temperature resistance of at least 300 degrees Celsius, which is proven only for the para-aramid yarn. It is well known that the restrictions imposed on the woven structure are also due to the aerodynamic configuration.

The 2x301 stitch is the only one that can be used, given the restrictive control of the overall permeability. Also, this type of seam ensures that the strength of the stitch is maintained (60 percent of the value of the breaking strength of the fabric) without affecting the aircraft's attitude when landing.

These results were obtained for the first time in Romania, all the results being strictly used for supersonic aircraft with Vtaxi of 350km / h and cruising speed of 2.2M

Table 1: *The physical-mechanical characteristics of the fabric obtained at INCDTP*

Characteristics	Values
Mass, g/mp	88
Tensile strength, daN U/B	309/308
Elongation at break, % U/B	8.4/6.2
Slip resistance of yarns, daN U/B	37/40
Tear resistance, daN U/B	60/55

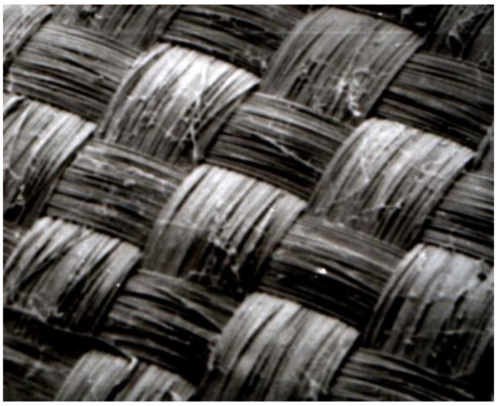

Fig. 3*: Electron microscopy images for the obtained fabric (40X magnification)*

A zig-zag seam was applied over the two-needle seam, a p-aramid yarn, the thread used for both types of seams being Nm 40/3 -100% Kevlar para-aramid. The type of joint used for joining the panels and making the seams is shown in **Fig. 4**, and the physical-mechanical characteristics of the subassemblies used in the assembly are presented in **table 2.**

Several rows of stitches were used because the efficiency of the seams for thread and para-aramid materials is lower compared to those of thread and materials made of polyamide or polyester which are used to make deceleration systems for other aircraft, with a different configuration (for example MiG 21-LanceR). The small elongation of the thread and implicitly of the fabric determines a reduced capacity of the assembly to take over the shock loads, therefore the length of the resistance seams, on the para-aramid fabric was increased by approx. 15% compared to polyamide or polyester. In all the samples taken, the joint was made without any technological problems.[6]

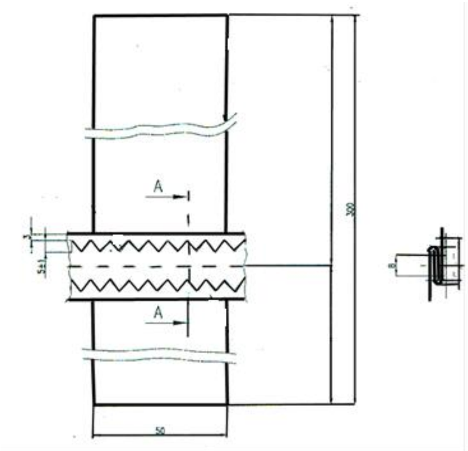

***Fig. 4**: The type of joint*

The panels joined by sewing were tested in the accredited laboratories within INCDTP.

***Table 2** Physico-mechanical characteristics of the subassemblies used to join the panels*

Subassembly	Characteristics
Para-aramid tape 25-1000 S.T.2 (90851)	Width, mm: 25±1; Mass, g/m : 11,5; Breaking resistance, min, daN: 1000; Elongation at break, min, % 3,5
Para-aramid strap 43-5500 S.T.3 (90852)	Width, mm: 48±2; Mass, g/m : 52 Breaking resistance, min, daN: 5500 Elongation at break, min, % 3,5
Para-aramid thread Nm 40/3 S.T.4 (90853)	Length density, Nm: 40/3 Breaking resistance, min, daN: 9 Elongation at break, min, % : 5
Para-aramid thread Nm 40/3 S.T.5 (90854)	Length density, Nm: 20/3 Breaking resistance, min, daN: 15 Elongation at break, min, % : 5

3. RESULTS

The results obtained after testing the joint of the panels with dimensions of 5 cm X 30 cm are presented in **table 3**, compared to the tensile strengths of the finished fabric.

***Table 3** Comparative values of the tensile strengths of the finished fabric and the joined panels*

Characteristics	Values	
Mass, g/mp	U	B
Tensile strength, daN	309	308
Breaking elongation, % U/B	8.4	6.2
Tensile strength of fabric, joined by two-needle stitching, with zig-zag stitched tape, daN	235	228

It can be appreciated that:

- the assembly will be able to withstand the shock loads that will occur during taxiing of the aircraft, although the tensile strengths of the fabrics joined with zig-zag stitching, compared to the tensile strengths of the fabric without joining are 24% lower in warp and with 26% in the weft.[8,9]

- during the strength tests, it was found that in all the tests the fabrics broke near the joint, which is important because it is preferable for the fabric to break instantly, at a certain value (even small, but sufficient to take over the overall shock load) rather than slipping long before breaking, as an area of airflow may occur during operation and the parachute may not open. The phenomenon is particularly dangerous, because it can occur at any time and not being a clear break, it cannot be noticed in time by the personnel in charge of the maintenance of the recovery system with the help of the parachute.

4. CONCLUSIONS

The technique developed by INCDTP specialists and used to assemble fabric panels made of 100% para-aramid yarn with a length density of 220dtex/134f corresponds to the field of use, the whole recovery system with the help of the parachute having the ability to withstand the shock loads that will occur during taxiing on the runway of the aircraft when it is in the landing configuration.

Breaking the fabric exactly at the joint eliminates the possibility of air leaking during the operation of the recovery system, which could lead to the main parachute not opening. In addition, this clear rupture can be noticed immediately by the personnel in charge of parachute maintenance.

ACKNOWLEDGEMENTS

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CHARACTERIZATION OF FIBER EXTRACTS FROM IMMATURE COCONUT HUSKS WASTE ALONG THE KENYAN COASTAL REGION

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Abstract*: This paper presents a study on the characterization of fiber extracted from immature coconut husk waste that was collected along the costal region of Kenya. The husk wastes were naturally dried and fibers mechanically extracted. Fiber extracts were treated using 20% NaOH for 3 hours. The thermogravimetric analysis, Fourier transform infrared spectroscopy, and morphological analysis, using scanning electron microscopy of the fiber were investigated. From the results obtained, the alkali treatment of fiber extracted from immature coconut husks waste presented nearly minute changes in Fourier Transforms Infra-Red spectra for treated coir fibers. The thermal stability of the treated immature coconut fibers was improved after the alkali treatment because of the elimination of hemicellulose and lignin. Immature treated fibers display a minor peak centered at 100℃ as a result of water loss. The untreated fibers display two minor peaks centered at 100 ℃ and 295 ℃ due to moisture loss and hemicellulose decomposition respectively. The surface morphology of the untreated fibers reveals a fine and smooth surface where as that of treated fibers shows a rough and fine surface as a result of the removal of impurities. Treatment also decreases fiber diameter and results in a rougher surface. Fiber alkali treatment appeared to slightly enhance the properties of the fibers in comparison to the untreated fibers.*

Key words: *characterization; coir fiber; extraction; surface morphology; FTIR; TGA*

1. INTRODUCTION

Coconut palms are abundantly grown in tropical nations, particularly along the coasts of Asia, Africa, and Latin America**.** Coconut (*Cocos nucifera L.*) belongs to the *Arecaceae* family (Palmae) and to the *Cocoideae* subfamily and has its origin in Southeast Asia [1]. It is one of the most economically significant crops in the tropics, used as a significant food source, thirst-quencher, medicine, fuel source, and material for construction. In Kenya, coconut trees are majorly grown for the production of coconut oil, wine, and wood as a construction material. Consumption of tender coconut water along the Kenyan coastal region has significantly increased over the years resulting to the generation of green husk wastes.

Mombasa town which is a tourist town leads in tender water consumption and green husk waste generation especially during holidays. One of the reasons for increased green husks waste generation perhaps is the higher economic return compared to cost of matured coconut fruit. The second evident reason is the considerably shorter harvesting time of immature coconut compared to matured which remains longer in the case of matured coconut. This increases the generation of byproducts as wastes majorly the husks which according to [2]; [3]; [4] correspond to approximately 85% of the fruit weight. The purpose of this work was to extract and characterize fibers from immature coconut husks waste along the Kenyan coastal region. Fourier transform infrared spectrophotometry, thermal gravimetric analysis and scanning electron microscopy (SEM) were used for the characterization of coir fiber for structural, thermal and morphology properties.

2. MATERIALS AND METHODS

Immature coconut husks were collected from Mama Ngina drive, Mombasa town CBD, Mtwapa and Kwale which are proximally located. The three locations were selected Firstly, because it is a representative of the four counties in the Kenyan coastal region with significant coconut farming according to the Agriculture and Food Authority (AFA) report of 2016. Secondly, Mombasa town is a converging zone for coconut tender water vendors, consumers as well as the suppliers from North and South coast regions. The samples were then dried in the sun for a period of three months. Coconut fibers extracted from immature coconut husk wastes were treated using 20% NaOH for 3 hours. There were two categories of samples with the following notations, IM_untreated for immature untreated coir fibers and IM_treated for immature treated coir fibers. The fibers were extracted using a mechanical decorticator.

3. CHARACTERIZATION OF COCONUT FIBERS

Raw and treated samples from both immature and matured coconut fibers were analyzed by infrared spectroscopy (FTIR) using JASCO FT/IR-6600 type with a wavelength range of 7,800 to 350cm^{-1}. TGA was performed using a PerkinElmer STA 6000 thermogravimetric analysis instrument, in a Nitrogen atmosphere, at a heating rate of 20°C/min from 25°C to 700°C to obtain derivative curves for the fibers. Surface morphologically was analyzed using TESCAN VEGA 3 scanning electron microscopy. Tensile strength was determined from the breaking load and elongation at break of single fiber performed using Electronic single fiber strength tester Model YG003E. The pulling force, speed, and gauge used were 100cN, 200mm/min, and 100mm respectively.

4. RESULTS AND DISCUSSION

4.1 FTIR Characterization

Figures 1 show characterization using FTIR spectrophotometer for raw untreated coir fiber and alkali-treated coir fibers extracted from immature coconut husk wastes. The notation used for immature coir fiber is IM_untreated and IM_treated for raw untreated and alkali-treated fibers respectively. The broadened bands at around 3300 cm^{-1} in both Fig 1 and 2 were observed in all spectra, indicating the presence of -OH groups in the structure which suggests OH stretching vibration from the cellulose and lignin structure of the fiber [5]; [6]; [7]. Figure shows bands at 1030 cm^{-1} and 1048 cm^{-1} for raw untreated and treated immature coir fibers and Figure 2 bands at 1024 cm^{-1} for both raw untreated and treated mature coir fibers. These peaks are attributed to the existence of C-O-C stretch, which arises from cellulosic characteristic peaks [8]. The peak in Figure 1 and 2 at around 1400 cm^{-1} in all spectra corresponds to the water absorption. The peaks were attributed to the stretching of hydrogen bonds and bending of hydroxyl (OH) groups bound to the cellulose structure. According to [9], these results are an indication that the cellulose component was not removed during the chemical treatment carried out on the immature coconut fiber. [10], reported that the vibration at 2900 cm^{-1} to 2850 cm^{-1} shows the existence of –CH groups, where the lignin and waxes were eliminated after the different chemical treatments. The peaks at 1823 cm^{-1} for raw untreated fiber and 1786 cm^{-1} for treated fibers as shown in Figure 1 are distinctive of the carbonyl group found in coconut fiber. The respective peaks for raw and treated coir fibers are 1799 cm^{-1} and 1769 cm^{-1}. These peaks were attributed to C=O stretching of the ester linkage between the carboxylic groups of lignin and/or hemicellulose.

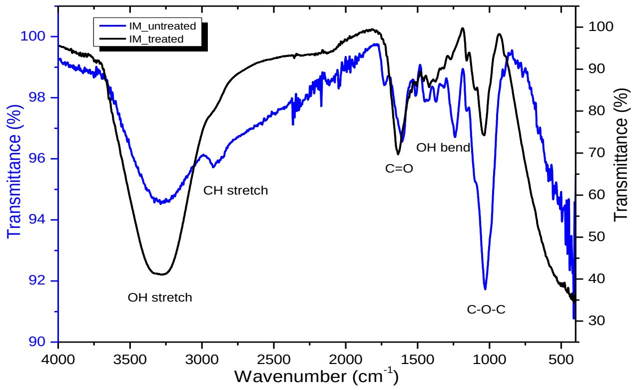

Fig 1. *Comparison of IM_untreated and IM_treated*

A decrease in the C=O peaks was observed following the chemical treatment. As reported by [11] the decrease was likely due to the partial removal of hemicellulose and lignin, confirming the efficacy of the treatment.

4.2 Thermal Gravimetric Analysis

Figures 2 and 3 show the TGA thermograms and DTGA curves for treated and untreated immature fibers respectively. The immature fibers both untreated and treated show initial degradation of 75 - 210℃ that is a result of loss of volatilities and moisture as shown in Figure 2. The treated fibers tend to have a high percentage loss of moisture due to the numerous OH groups in the cellulose structure that form hydrogen bonds with water. The untreated fiber displays the second degradation in the range 280 - 310℃ associated with hemicellulose decomposition. The third degradation appeared in the range 315 - 350℃, which is due to the decomposition of cellulose. In the immature treated fibers, there is an exothermic peak which is followed by second stage degradation between 280 - 350℃ associated with cellulose decomposition. Lignin decomposition occurs in the range of 250 - 450℃ because it is a stable constituent, therefore, not easily degraded [12]. The residual ash content was found to be 40 and 32% for immature untreated and treated fibers respectively as shown in figure 3. The treatment affected the removal of volatile, organic matter, hemicellulose, and lignin causing a decrease in the ash content [13]. The removal of the lignin and hemicellulose result in the exposure of the cellulose, which was easily decomposed.

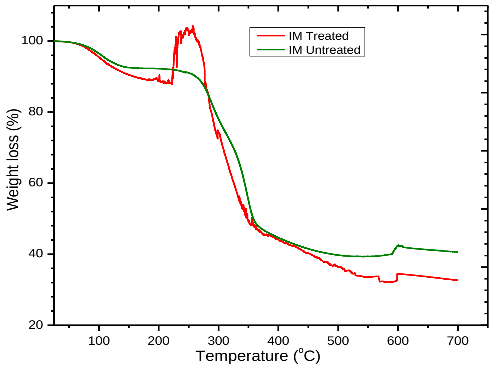

Fig. 2: *TGA thermograms*

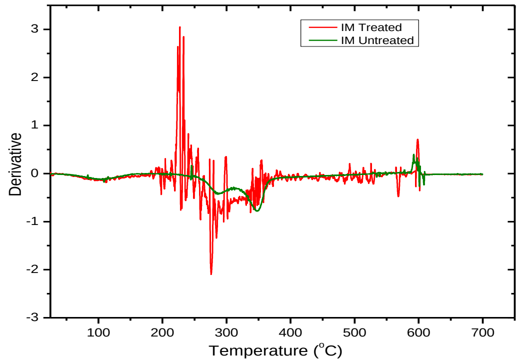

Fig. 3: *DTGA thermogram*

The thermal stability of the treated immature coconut fibers was improved after the alkali treatment because of the elimination of hemicellulose and lignin [14]. The DTGA thermograms of immature treated fibers in figure 3 display a minor peak centered at 100°C as a result of water loss. There are many irregular endothermic and exothermic peaks due to cellulose and hemicellulose decomposition. The untreated display two minor peaks centered at 100 °C and 295 °C due to moisture loss and hemicellulose decomposition respectively. The major peak centered at 345°C was attributed to cellulose decomposition [15].

4.3 Scanning Electron Microscopy analysis

The SEM micrographs of untreated and treated immature fibers are displayed in Figures 4 and 5 respectively. Figures 4b and c display the morphology of the untreated fibers with smooth surface unlike the rough surface displayed by alkali-treated fibers shown in Figures 5b and c. The untreated coconut fibers contain wax, lignin, cellulose, hemicellulose, and other impurities; therefore, a fine structure is observed in Figure 5c. The treated coconut fibers show the effect of the alkali treatment which disrupted the fine surface revealing rough surfaces. The cellulose surface was revealed. According to [18], alkali treatment yielded better interlocking sites and a large cellulose volume. The rough surface of the fiber after alkali treatment differs greatly from that of the untreated fibers. Elevated surface roughness of coconut fiber as a consequence of enhanced cellulose exposure [16]. The diameter of the untreated immature fibers decreased after alkali treatment. The treated fibers had a diameter ranging between 150 – 167 µm (Figure 2a) while that of untreated was 190 – 260 µm (Figure 1a).

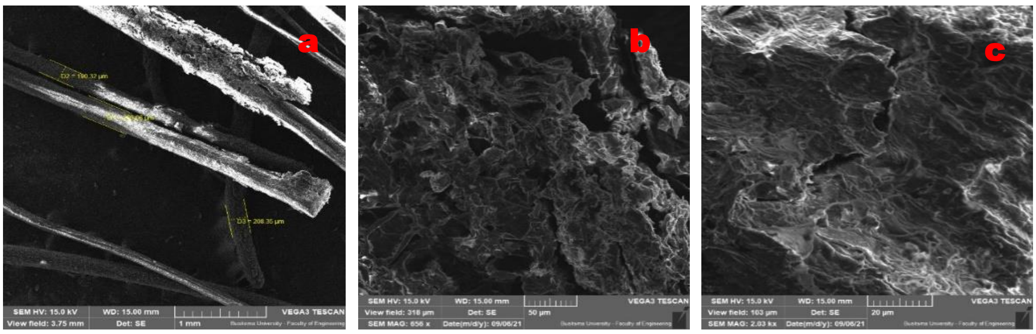

Fig. 4: *SEM micrographs of untreated immature coconut fibers*

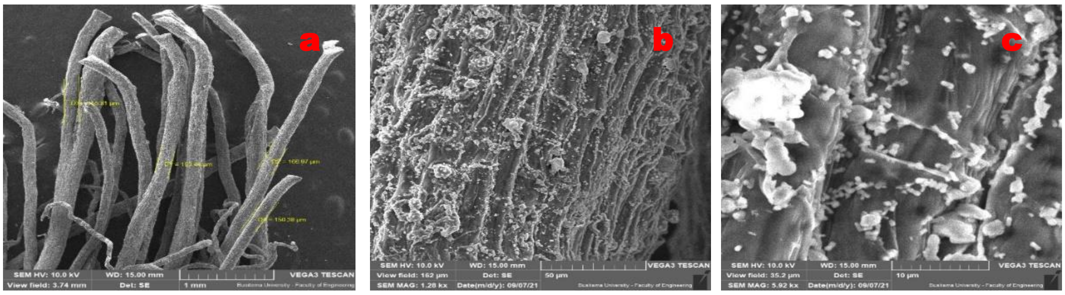

Fig. 5: *SEM micrographs of treated immature coconut fibers*

5. CONCLUSIONS

The alkali treatment of fiber extracted from immature coconut husks waste presented some little changes in FTIR spectra for treated coir fibers. The thermal stability of the treated immature coconut fibers was improved after the alkali treatment because of the elimination of hemicellulose and lignin. Immature treated fibers display a minor peak centered at 100℃ as a result of water loss as shown by DTGA thermograms in Figure 3. There are many irregular endothermic and exothermic peaks due to cellulose and hemicellulose decomposition. The untreated fibers display two minor peaks centered at 100 ℃ and 295 ℃ due to moisture loss and hemicellulose decomposition respectively. The major peak centered at 345℃ was attributed to cellulose decomposition. The surface morphology of the untreated fibers reveals a fine and smooth surface where as that of treated fibers shows a rough and fine surface as a result of the removal of impurities. Treatment also decreases fiber diameter and results in a rougher surface.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

WAYS TO IMPROVE PROTECTION AGAINST UV RADIATION FOR CLOTHING PRODUCTS

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Abstract: *Worldwide, recent years are characterized by an increasingly acute manifestation of the ecological phenomenon, seeking solutions for obtaining products that are based on natural components, as well as the safe use of products. In this respect, in the textile industry, the concept of eco-fashion has developed: manufacturers and designers increasingly using eco-friendly materials and technologies. Ecofashion aims at protecting user's health, maintaining and securing the integrity of the environment, as well as improvement working conditions for service staff in the textile industry.*
Taking into consideration the natural changes that occurred in these last years (reduction of the ozone layer, solar flares, global warming), it was observed that solar UV radiations determine a series of negative effects on the human body, increasing the overall risk of some severe diseases. In this context the protective function of clothes worn during the torrid periods or on snowy winters has a greater importance than ever.
Clothing products create a "barrier" between the skin and the UV solar rays and can provide the most efficient protection through design, type, structure, color and humidity level of the material.
This paper presents the different ways in which clothing products can influence the Solar Protection Factor.

Key words*: ecology, protection, sun, clothing, radiations.*

1. INTRODUCTION

Achieving and continuously improving the ecological function of clothing products is a major requirement, being addressed in both research and production.

The ecological function is in a relationship of interdependence with the comfort functions (thermophysiological and sensorial), the ergonomic function, the safety in use and the availability function. The ecological function expresses the ability of a product to not affect the health and life of the user and to protect the environment by:

- ✓ the product's capacity to withstand the action of contamination factors;
- ✓ product resistance to ignition;
- ✓ product resistance to the action of biological factors;
- ✓ product's ability to degrade in the natural environment.

Depending on the nature of the raw materials used, application of special processing and finishing treatments, the ecological function can be divided into four components, corresponding to its production, product, its maintenance and the possibility of recycling or degradation of the product into the environment [1].

2. UV RADIATION CHARACTERISTICS AND EFFECTS

Solar radiation contains infrared, visible light and ultraviolet radiation. Although ultraviolet radiation (UV) represents only 5% of the solar radiation that reaches the earth's surface, it holds an important role in regard to biology because it has the greatest energy in the optical spectrum.

Taking into consideration the increase in solar activity during the last years and the reduction of the ozone layer, it is primordial to know the effects of ultraviolet radiation on the human body, as well as means of protection against them.

Solar light is electromagnetic energy that propagated through electromagnetic waves. In regards to health, the most important parts of the electromagnetic spectrum are:

- Ultraviolet radiation (UV), invisible to the human eye;
- Visible light enabling us sight;
- Infrared radiation that constitutes the main source of heat, also invisible to the human eye.

UV radiations have enough energy to cause photochemical changes that can initiate biological effects, possibly negative, sometimes referred to as "actinic effects". Solar radiation is heavily deflected by the Earth's ozone layer, limiting terrestrial UV radiation to wavelengths of about 290 nm. Measured UV radiation with a similar response on the human skin, are named erythemic active UV radiation (UVE) [2] and are used to calculate the UV Global Solar Index (UVI), in order to inform the large population. Often it is necessary to monitor total UV radiation, represented by the UVA and UVB component together. On the earth surface UVA radiation usually exceeds the UVB by 15-20 times. Dependent on the biological effects it causes, especially on the DNA, the UV spectrum is divided in radiations: UVA, UVB and UVC. Their characteristics and possible effects on the human body are presented in table 1 and figured 1. In figure 2 is represented the percentage variation of solar protection depending on the value of the solar protection factor (FPS) [2].

Table 1: *Correspondence between UV radiation type and the effects on human body*

UV radiation types	Characteristics and effects of radiation on human body
UVA **Wavelenghts between 315 – 400 nm**	All of them reach the earth surface. Take part in the tanning process. Can determine photosensitivity to solar rays. Can have effects in the DNA through direct or indirect mechanisms (free radicals) – figure 1. Can have detrimental effects on the skin and eyes. Increase premature skin ageing and the appearence of visible signs (lines, spots, freckles, dry skin).
UVB **Wavelenghts between 280 – 315 nm**	Partially deflected by the ozone layer. Have detrimental effects especially during the summer months, at mid day (hours 10-16). Increase with 10% per 1000 meters' altitude. Their effects are amplified by reflection on water, sand or snow. Take part in the activation of provitamin D, but can lead to skin lesions, producing burns, genetic mutations and carcinogenesis. Can determine photosensitivity to solar rays.
UVC **Wavelenghts between 100 – 280 nm**	Absorbed entirely by the atmosphere.

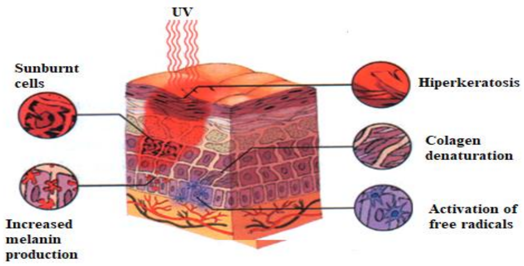

Fig. 1 *UV radiation effects on the skin*

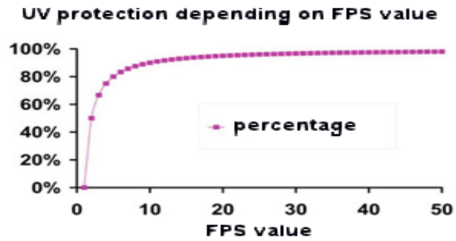

Fig. 2 *Solar protection depending on FPS value*

3. FEATURES THAT INFLUENCE SOLAR PROTECTION

Clothing creates a barrier between the skin and the solar UV radiation and can offer the most efficient protection. While usual clothing offers a feeble protection of only 7%, “anti radiation” clothing products offer a protection up to 97% [3, 4]. In order to protect against radiation, clothing must have inscribed on their label a protection factor of at least 15. The American foundation for skin cancer research recommend clothing with a protection factor of 30, underlining though that those with over 50 factor are the most efficient because only 2% of the ultraviolet radiations can penetrate the attire. In order to evaluate the capacity of a clothing product to offer UV protection, researchers in different countries (Australia, USA, Spain) have established a system of reference indicators: UPF (UV Protection Factor) – evaluates protection against UVA and UVB, and SPF (Sun Protection Factor) that allows evaluating the protection against UVB radiation.

SPF represents the measure of time until the apparition of solar burns on the skin treated with a protection factor. UPF represents the efficiency of a material to block/deflect UV rays, the measurement of transmitted UV radiation being realized with a measuring instrument (Spectrum-radiometer) and an artificial source of light. The results are translated into a mathematical equation based on “erythema active spectrum” (solar burns sustained by an unprotected skin). The reference values of UPF [4, 5] are presented in table 2.

Table 2: *Reference values of UPF*

UPF Value	Protection type	Blocked radiations percentage [%]	Efficiency of penetrant radiation [%]
15 – 24	Good	93,3 – 95,8	6,7 – 4,2
25 – 39	Very Good	95,9 – 97,4	4,1 – 2,6
40 – 50	Excelent	97,5 – 99 +	2,5 – 0
50 +			

From the table above we can see that UPF values are directly proportional with the protective capacity offered by the material or textile product. The efficiency represents the percentage value of radiation that penetrates the clothing. In the case of 2% efficiency products, on the respective label will be inscribed “UPV 50 +”. This number attests an almost total protection, when a maximum 2% of radiation can penetrate the clothing.

3.1 Characteristics of clothing products that influence the protection against UV radiation

Clothing products possess specific characteristics that can be managed according to usage conditions, by choosing the characteristics of raw material, structure and structural parameters and finishing processes. Their efficiency against UV radiation is dependent upon [3, 6]:

- clothing design – through coverage degree and adjustment on the body;
- component material – though the fibrous composition and yarn count, type, structure, count, tightness, elasticity, color and humidity degree of the material;
- finishing treatments applied to the fiber, yarn or textile material.

In table 3 is presented the way in which a series of characteristics of the product can influence the protective function again UV radiation.

Table 3: *Influence of textile product characteristics on the protection against UV radiation*

Product characteristics	**UV protection function**
Type and fibrous composition of the yarn	
Cotton, flax	Low protection without additional finishing treatment (optic whitening, thickening, etc.). Unbleached cotton offers a better protection (contains lignin that has the propriety to absorb ultraviolet radiation). Materials that contain mainly yarn of natural cellulosic fibers offer a lower protection against UV, compared to those of protein (silk, wool).
Wool, silk	Moderate protection. By chemical treatment with satinizing substances the protection improves. Satin silk offers an optimal protection because it reflects the solar rays.
Polyamide	Good protection
Polyester	Very good protection because it reflects solar rays. The protection increases with the sheen intensity.
Elastomer	In materials in a relaxed state, the protection is very good because of the thickness degree. In stretched materials the protection decreases significantly because of the reduction of thickness and count.
Structural parameters of the material	
Density, thickness, count, low value mass	Reduced protection, because of reduced covering capacity.
Density, thickness, count, high value mass	Good protection. With the increase of thickness the protection becomes very good (high covering capacity).
Color	
Light colors (white, yellow) or pastel	Low protection. *Example*: a white T-shirt has SPF = 7 – 8, a yellow one SPF = 15, and a red one SPF = 20.
Dark colors (dark blue, black)	Better protection with the darkness of the color or intensity. It was observed that the best protection is offered by dark green or dark blue. Black, dark blue or green velvet has a protection factor UV 50. The type of dye used can modify the UV protection; some dyes can deviate the UV rays and others can increase their absorption. Improving the UV protection can be realized by washing with special detergents (type “Sun Guard” [7]) and by treating the material with chemical substances with screen role against UV.
Humidity	
Any wet or moist material has a vulnerability increased with 50% towards UV rays. Repeated washing and wearing of clothing products can lower the thickness of the material, thus affecting the protective role.	
Tailoring line	
Loose and low degree of body coverage	Low protection
Adjusted and high degree of body	Good and very good protection. In the case of adjusted clothing made out of polyester or polyamide materials is necessary to create models that allow the

Product characteristics	UV protection function
coverage	ventilation of the body (holes, flaps, openings).

3.2 Technical solutions applied to ensure product quality

In order to answer the explosive rise in demand and taking into consideration the ecological problems, research has progressed more and more. The most dynamic sectors are interdisciplinary, combining the research in medicine, textile industry, metrology, transport etc. New generation textiles and "anti-radiation" clothing have become more solicited. Research regarding the improvement of protective functions and ecology of clothing product had as objectives:

Objectives	Accomplishment
• **using of natural fibre** (cotton, flax, silk, wool, etc.) **organically cultivated**, with the capacity to absorb and remove moisture, air penetrable, thermal regulation capacity (cooling sensation, respectively warming according to extern temperature), protection against bacteria and UV protection, contributing to the increase in environment and life quality [8];	**Bamboo fibres** are fabricated out of 100% **bamboo** pulp. Being completely biodegradable and sustainable, the bamboo is the most ecological material of the 21st century. Materials made out of bamboo fibres have antibacterial, anti-allergic, antiperspirant and absorptive proprieties. Articles realized from these material (example – figure 4) are light, nice to touch, natural sheen, don't cause allergic reaction, but protect the skin from UV rays perfectly (reflecting 98% of damaging rays). They have antibacterial proprieties and prevent the development of pathogenic organisms, fungi and acariens (on a bamboo fibre, 70% of bacteria is killed), and keep these proprieties even after a hundred washings. **Articles realized from Cocona (derived from coconut husks).** In figure 5 is presented as example the Power Dry blouse [8], which combines the principles of UV protection improvement and the following characteristics: - Fabricated from Cocona and PES with Polartech Power Dry technology – a material that is part of the Next to Skin category, with absorptive capacity and humidity removal, air permissive and thermal regulation capacity; - Anti-odorizing natural treatment, without involving any chemical antibacterial treatment; - Offers resistance and good protection to UV rays; - Knitted structure type mesh, and the tailoring of the product is adjusted, with a high coverae degree of the body. **The products based on biodegradable vegetable fibers type PLA** (contain poly-lactic acid, polymer extracted from corn) offering a very good protection by blocking the UV rays. **Meryl products** (Rhône Poulenc France – are made out of polyamide PA 6 and PA 6, 6 type fibres. The sheen of Meryl products can be: shiny, semi-matter and ultra- matte. From Meryl type yarn can be realized materials wind and waterproof, with goo thermal isolation, good behaviour in humidity and OV radiation protection. It is used mixed (with wool, rayon, or other types of fibre) with varied systems or yarn under the trademark Nylstar® that has loose and comfort qualities. There have been realized varied fibres Meryl®: Meryl anti UV, offers protection to UVQ and UVB; Meryl Satine, creates a light reflective effect, Meryl Tango, for weaves with a natural silk aspect etc. **MERINO Perform™ products** (23% wool and 77% PES).
• **using ecologic, biodegradable or recyclable fibres,** with antibacterial effects, auto-sterilizing and auto-cleaning, with high UV radiation protection;	
• using a mix of natural, ecologic and synthetic fibres that will offer superior quality characteristic tu products and high UV radiation protection;	
• **using yarn realized through performant technologies** to insure protection against insects, bacteria, fungi and acariens and UV protection;	
• **washing the materials with special detergents** or treating them with chemical substances with UV screen role, but at the same time reducing the waste of chemical treatments.	

In figures 3 - 8 are presented other products with UV protection, intended for children. It is worthy to note that all of them have a high degree of body coverage, for an efficient UV protection.

Fig. 3 *Blouse - (Bambus) UPF 80*

Fig. 4 *Blouse PowerDry - (Cocona si PES) UPF 15*

Fig. 5 *Blouse Montane Bionic (Merino Perform™), UPF 40+*

Fig. 6 *Kids shirt "roto.red" – UPF 80*

Fig. 7 "*Deep sea****"** *trousers (PES 100%) – UPF80*

Fig. 8 *Kids clothing product - UPF 80*

4. CONCLUSIONS

In these conditions of climate changes and increase in solar radiation, the protective function against ultraviolet radiation and thermo-physical comfort of clothing products becomes a priority.

In order to evaluate the capacity of a clothing product to offer UV protection were established systems of reference indicators: UPF – evaluates protection against UVA and UVB representing the efficiency of a material to block/deflect UV rays and SPF (Sun Protection Factor) that represents the measure of time until the apparition of solar burns on the skin treated with a protection factor.

Anti – UV radiation protection exerted by the clothing products is determined by multiple factors presented and analyzed in this paper (fibrous composition of the yarn, compact structure, color and humidity degree of the material, product tailoring line). From this point of view, the clothing preferred must have a higher degree of body coverage, a compact structure, dark colors and not be used in excessive humid places. This paper presents the ways in which clothing products can influence the value of Solar Protection Factor.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

DEVELOPMENT OF ANTIMICROBIAL COTTON FABRIC THROUGH APPLICATION OF DYE EXTRACTS FROM GALINSOGA PARVIFLORA PLANT LEAVES.

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Abstract: *The present study involves the aqueous extraction of dyes, optimization of dyeing conditions (Extract concentration and dyeing temperature), application of extracted dyes onto cotton fabrics using optimized conditions, SEM analysis of treated fabrics, assessment of their antibacterial activity, and wash durability. Using Central Composite Design (CCD), the optimized dyeing conditions were selected as 39.14 percent and 70^{0}C based on the lowest bacterial count demonstrated by the dyed cotton fabric samples. Results of Analysis of Variance (ANOVA) confirmed that extract concentration has a more significant statistical influence compared to dyeing temperature. Treated cotton fabrics at optimized conditions together with alum as a cross-linking agent exhibited a 98.54 and 97.96 percent reduction in the bacterial count against Staphylococcus Aureus and Pseudomonas Aeruginosa bacterial strains respectively. The retention of the antimicrobial activity of treated fabrics was found to be more significant even after 5 washes thus confirming that Galinsoga Parviflora extract is a potential source of finishes capable of improving antibacterial resistance of cotton fabrics for a longer period.*

Keywords: *Antibacterial activity, Central Composite Design, Cotton fabrics, Galinsoga Parviflora, Optimization.*

1. INTRODUCTION

Cotton materials owning desired characteristics and their proximity to the human body act as a potential medium for adherence, transfer, and propagation of several microbes that cause diseases and infections among people in hospitals and other healthcare-related environments. More so, these microbes lead to detrimental effects like bad odors, color deterioration, and loss of fabric aesthetic properties [1]. As a way of rectifying these shortcomings, natural plant antimicrobial finishes are increasingly being preferred since they are non-toxic, non-allergic, and biodegradable compared to synthetic ones [2]. The application of these natural finishes requires a mordant to improve their bonding capabilities thus enhancing their wash durability [3]. Galinsoga Parviflora is a traditionally known plant that is capable of treating beetle bites and wounds. It belongs to the Asteraceae family and contains many Pharmacological as well as Phytochemical properties [4]. To efficiently benefit from these natural medicinal products, their application parameters are normally optimized using different techniques among which include Central Composite Design of Response Surface Methodology (RSM) and Single-factor design [5]. The current study, therefore, was focused on extracting dyes from Galinsoga Parviflora plant leaves, optimizing the dyeing conditions, analyzing the surface morphology of the treated fabrics, assess their antimicrobial resistance and wash durability.

2. MATERIALS AND METHODS

2.1 Materials

A mercerized, scoured, and bleached 100 percent woven cotton fabric was acquired from Rivertex Limited, Kenya. Galinsoga Parviflora plant leaves were sourced from the wild in the Western part of Uganda. All other requirements were bought from INDO Kenya Enterprises limited.

2.2Methods

2.2.1 Preparation of the dye extract

The collected and dried Galinsoga Parviflora plant leaves were coarsely grounded and weighed. Maintaining the Material to liquor ratio of 15:250w/v were subjected to aqueous extraction by maceration process [6]. Then, the extract was filtered, concentrated, and stored at 4^0C.

2.2.2 Microorganisms and culture condition

Following the SOPs, the Gram-positive and Gram-negative bacterial strains viz. *Staphylococcus aureus* and *Pseudomonas aeruginosa* of ATCC grade were recovered from the storage media and maintained on Muller Hinton medium.

2.2.3 Dyeing of cotton fabric samples and testing for their antibacterial efficacy

Using the material to liquor ratio of 1:40, 3g/l alum concentration at 70^0C for 40min, cotton fabric samples were dyed with extracted dyes, excess dyes removed by padding mangles, and dried under the shade. In optimizing the dyeing process, concentration and temperature varied from 15 to 35% and 60 to 80^0C respectively. Antimicrobial tests were done on dyed fabric samples against selected bacterial strains. Based on the combination that demonstrated the lowest bacterial count was noted as the optimum condition using Central Composite Design.

2.2.4 Central Composite Design (CCD) and Statistical analysis with ANOVA

Using Central Composite Design of Response Surface Methodology [5], dyeing conditions for the plant extract from Galinsoga Parviflora were optimized. Experimental variables, their coded and actual levels are illustrated in Table 1.

Table 1: *Experimental variables and their levels*

Variables	Levels				
	-α	-1	0	1	α
Conc (%)	10.86	15	25	35	39.14
Temp (^{0}C)	55.86	60	70	80	84.4

After testing dyed cotton samples against selected bacterial strains, bacterial count values obtained were considered as the response variables. Using the Design Expert 7.0 software package [7], all the design and analysis of experiments were done. Then the adequacy of the developed model and its statistical significance were checked using ANOVA and Response surface plots drawn to analyze the interaction among several independent process factors and their effect on the bacterial count

2.2.5 SEM analysis, Antimicrobial resistance assessment and wash durability tests of dyed cotton fabrics with optimized values.

Using Tescan Vegas 3 control software at 3kV and a scale of 20µm, SEM analysis was done for the treated and untreated (control) fabrics. The antimicrobial activity of cotton fabrics was tested against selected bacterial strains based on AATCC Test Method-100:2019 and the microbial inhibition was calculated as a percentage reduction in the number of Colony Forming Units (CFU) with respect to untreated control samples after inoculation and incubation as per the stated formula; R = [(B-A)/B]*100. Where; R- Percentage reduction in Microbial colonies, A – CFU/ml for the treated fabric samples after 24hrs incubation, B – CFU/ml for the untreated fabric samples after 24hrs incubation under the same conditions. For wash durability, the dyed cotton fabrics were investigated after one and five washes following the AATCC-100 test method [3].

3. RESULTS AND DISCUSSION

3.1. Central Composite Design and Statistical analysis

From Table 2, bacterial count values reduce as extract concentration and temperature increase although the reduction in bacterial count varied which may have been influenced by the different bacterial strains used since they are known to have different bacterial structures [8]. Then Figure 1 clearly indictated that there was a reduction in bacterial count values for treated cotton fabric at optmum conditions in relation to untreated one.

Table 2: *Bacterial counts at varying dyeing parameters*

No.of Runs	Conc. Of Extract (%)	Temp. (^{O}C)	**Bacterial Count (CFU/ml)**	
			Cotton fabric	
			Staphylococcus aureus	*Pseudomonas Aeruginosa*
1	25	70	2.0×10^5	2.92×10^5
2	25	70	1.94×10^5	2.94×10^5
3	15	60	4.23×10^5	4.98×10^5
4	35	80	6.64×10^4	1.43×10^5
5	10.86	70	5.06×10^5	5.62×10^5
6	39.14	70	**2.56×10^4**	**6.96×10^4**
7	25	84.14	1.61×10^5	2.48×10^5
8	25	70	1.98×10^5	2.94×10^5
9	25	55.86	2.08×10^5	3.19×10^5
10	25	70	1.98×10^5	2.91×10^5
11	25	70	1.96×10^5	2.90×10^5
12	15	80	4.01×10^5	4.61×10^5
13	35	60	9.12×10^4	1.70×10^5

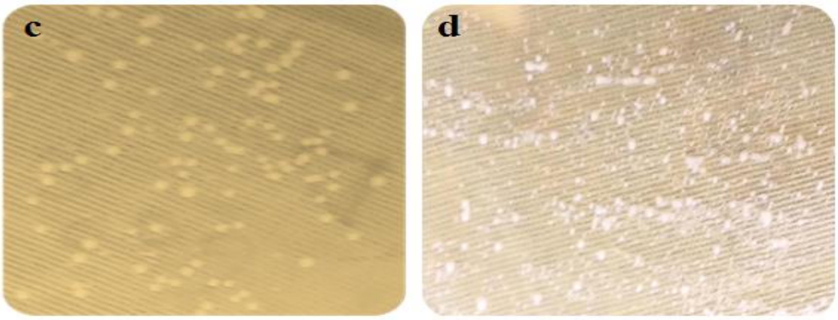

Fig. 1. *Shows the reduction in bacterial count of the treated cotton fabric* ***(c)*** *at optimum conditions based on the number of colony forming units (CFU/ml) as compared to the untreated cotton fabric* ***(d)****.*

Table 3 illustrates the ANOVA results for the bacterial count values against Staphylococcus aureus and Pseudomonas Aeruginosa whereby both models (‘Y_{cs}’ and ‘Y_{cp}’) are significant with a p-value = 0.000. Also, the linear and square effects of extract concentration for both models are significant while only the linear effect of temperature is significant for all models thus confirming that a change in extract concentration has a more significant effect on cotton dyeing for antimicrobial resistance as compared to dyeing temperature.

Table 3: *ANOVA results for the bacterial count values at different dyeing variables on treated cotton*

		Staphylococcus aureus		*Pseudomonas Aeruginosa*	
Source	DF	F-Value	P-Value	F-value	P-value
Model	5	370.00	0.000	276.79	0.000
Conc.	1	1751.59	0.000	1352.46	0.000
Temp.	1	12.55	0.009	20.19	0.003
Conc*Conc	1	83.52	0.000	10.96	0.013
Temp*Temp	1	0.10	0.757	0.00	0.970
CONC*Temp	1	0.01	0.919	0.16	0.699
Error	7				
Lack-of-Fit	3				
Pure Error	4				
Total	12				

The second-order regression equations (1 & 2) were generated to model the relationship between bacterial count (Response ‘Y_{cs}’ & ‘Y_{cp}’) and dyeing variables of extract concentration (A) and Temperature (B) for cotton fabric samples. The R^2 and adjusted R^2 were 99.62% and 99.35% respectively for the Y_{cs} model and then for the Y_{cp} model, R^2 and adjusted R^2 were 99.50% and 99.14% respectively. This implies that 99.62% and 99.50% variations in the data sets can be explained by the models. For the unseen data sets, the adjusted R^2 for each model is 99.35% and 99.14% respectively. The interaction effects of the dyeing variables are represented on the three-dimensional graphs, response surface plots in Fig. 1

$$Y_{cs} = 885425 - 36114\ A + 672\ B + 394.1\ A^2 - 13.9\ B^2 - 6.0\ AB \quad \textbf{(1)}$$

$$Y_{cp} = 1010908 - 26682\ A - 26682\ B + 161.9\ A^2 + 1.9\ B^2 + 26.0\ AB \quad \textbf{(2)}$$

Whereby;
Y_{cs} & Y_{cp} are the bacterial counts of the dyed cotton fabric against *Staphylococcus aureus* and *Pseudomonas Aeruginosa* bacterial strains respectively

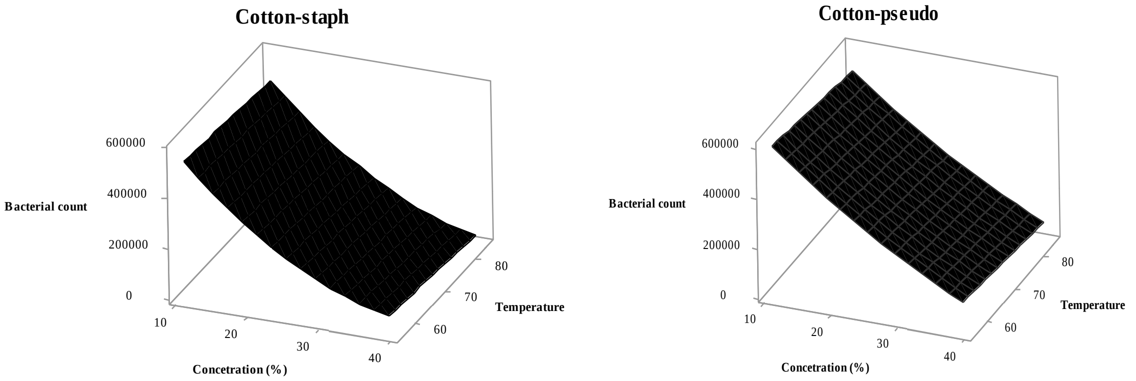

Fig.2. *Effect of extract Concentration and dyeing temperature on Bacterial count for dyed cotton*.

As presented in Figure 2, extract concentration has proved to be a key factor for dye application onto cotton fabric for improved bacterial resistance as opposed to dyeing temperature. The optimized values were found to be at 39.14% and 70^{0}C. Also, it was observed that at lower extract concentrations and temperatures, there was a slight decrease in bacterial count values. This could have been attributed to the low concentration gradient of the extract and the inability of the fibers in the structure of the fabrics to swell [9]. Then at very high concentrations and temperatures, the bacterial count values rise more due to dyed fabric saturation and a decrease in dye molecule stability [10].

3.2 SEM analysis, Antimicrobial resistance assessment, and wash durability tests of dyed cotton fabric with optimized values.

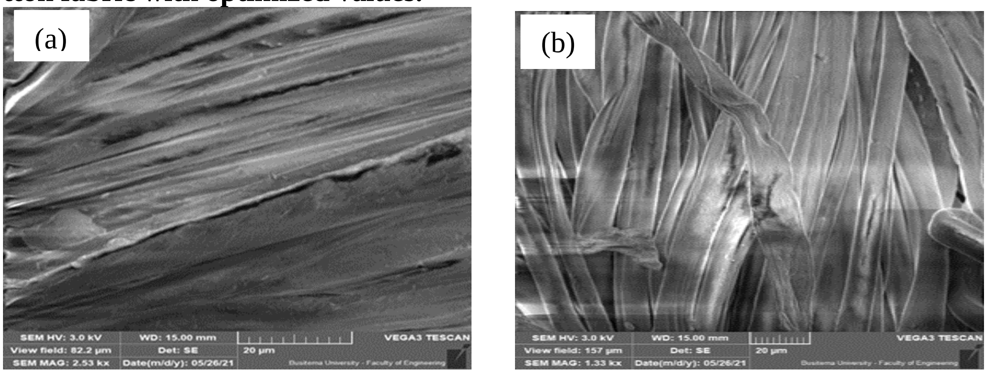

Fig 3: *SEM pictures indicating the growth of bacteria on (a) undyed cotton and (b) dyed cotton fabric at optimized conditions.*

Table 4: *Antibacterial efficacy of dyed cotton.* **Table 5***: Dyed cotton fabric retention of antimicrobial Activity*

Plant extract	**Reduction in Bacterial Count (%)** Cotton fabric	
	Staphylococcus aureus	*Pseudomonas Aeruginosa*
GP	98.54	97.96

Bacteria	**Cotton fabric**	**After 1 wash**		**After 5 washes**	
		R (%)	A (%)	R (%)	A (%)
S.aureus	Control	Nil	Nil	Nil	Nil
	Dyed	96.3	97.76	85	88.7
P. aeruginosa	Control	Nil	Nil	Nil	Nil
	Dyed	92.7	94.8	78.56	85.8

GP - Galinsoga Parviflora, R - Reduction in CFU, A - Activity retention.

As shown in Figure 3 and Table 4, dyed cotton fabrics exhibited a bacterial count reduction percentage of 98.54 and 97.96 against Staphylococcus aureus and Pseudomonas Aeruginosa bacterial strains respectively. This result demonstrated a significant antibacterial effect against the selected bacterial strains which may have been attributed to the higher level of medicinal dye uptake [11]. The study further confirmed that due to differences in chemical compositions of their cell walls, the percentage reduction was much higher in the case of Staphylococcus compared to Pseudomonas bacterial strain. The results of wash durability as illustrated in Table 5 showed that even after 5 washes, the dyed fabric was able to retain over 85% activity which may have been a result of a mordant used that improved the dye fixation into the fabric structure [12].

4. CONCLUSIONS

The optimized dyeing parameters were 39.14% and 70^{0}C for extract concentration and temperature respectively. However, extract concentration was found to have more effect on the antimicrobial activity of the finished cotton fabrics. At optimized conditions, a 97.96 to 98.54% reduction in the bacterial count against both bacterial strains was realized. Durability studies showed that even after 5 washes, 86-98% activity was retained thus confirming that it is possible to develop cotton fabric materials with durable antimicrobial properties using Galinsoga Parviflora plant extracts.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

RESEARCH ON THE CUSTOMIZATION OF THE DESIGN METHODS OF THE POST-MASTECTOMY BRA PRODUCT

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Abstract: *It is known that the functionality of the product is determined by its structure, namely the textile structure, the constructive solution, the processing technology. The present paper concerns the aspect of the reasoned constructive functional design of the post-operative bra type products. The methods used to refer the matter included researches in the field using the specialized literature, patents, scientific articles, discussions with colleagues and specialists in related fields, as well in the medical field. The paper presents the results of the analysis of constructive statistical parameters of post-mastectomy bra type products, comparative analysis of the values of the constructive parameters of the patterns with the dimensions of the mammary gland and external breast prostheses. The actuality of the theme is determined by the lack of researches that would be the basis of the functional constructive design of the clothing products intended for women with amputations of the mammary glands. The work aims to identify the design method of bra products that allows the adaptation of the construction algorithm to the requirements and the characteristics imposed on the post-operative bra product and the development of the custom design algorithm. For the constructive parameters specific to the studied product, the statistical parameters are calculated. The results obtained are summed up by analyzing them in the form of graphs The study includes the identification of the initial data that need to be included in the design algorithm of the construction of the basic printing for main elements of the post-operative bra. The results of the study, the elaborated design algorithm will be used to elaborate the constructions necessary for further experiments.*

Key words: *Constructive parameters, post-operative bra, design algorithm, functional design, customization.*

1. INTRODUCTION

In the previous studies, a comparative analysis of the basic patterns' construction methods for the bra product has been performed. The following aspects were analyzed: the initial data necessary for the construction; stages of construction; the number of the basic construction patterns details; values and variation of the constructive parameters on the front symmetry line, the symmetry line of the cup, the lateral line, below the IV bust line, on the rear symmetry line. [1-3]

At this stage, the being solved problem is the identification of the bra products designing method which allows the adaptation of the construction algorithm to the requirements and characteristics imposed on the product post-operative bra and developing the custom design algorithm.

2. CONSTRUCTIVE STATISTICAL PARAMETERS OF THE POST-MASTECTOMY BRA PRODUCTS

At the stage of carrying out the construction of the basic pattern, it is necessary to solve the problem of ensuring the dimensional correspondence between the body and the product, by obtaining the constructive elements that correspond to the specific functions, requirements and characteristics imposed on the type of product designed. [4-6]

In the previous studies, the constructive parameters specific to the analyzed product have been identified: the height of the bra cup on the front symmetry line, the height of the bra cup on the symmetry line of the cup, the height of the bra cup on the side line, the width of the supporting element of the bra cup below the bust line, the width of the supporting element on the front symmetry line, the width of the rear part on the sideline, the width of the rear symmetry mark on the rear symmetry line. [2]

The methods selected for the study carried out above are distinguished from each other by the number of anthropometric dimensions used in the calculation of the construction, the type of calculation formulas of the constructive segments, the construction stages of the patterns.

At this stage for the above-mentioned constructive parameters, the statistical parameters shall be calculated, the results obtained will be presented in Table 1.

Table 1: *Bra type product constructive statistical parameters*

Statistical parameters	Dimensiuni ale detaliilor, cm						
	cup			cup support element		back	
	On the centre front line	Centre cup line	On the sideline	Below the bust line IV	On the centre front line	On the sideline	On the centr back line
Arithmetic mean	12.85	23.98	12.83	1.52	10.12	14.93	5.83
Standard error	1.30	1.06	1.95	0.65	2.63	1.95	1.27
Minimum	9.60	21.40	7.50	1.00	10.20	7.60	2.50
Maximum	18.60	28.40	17.90	4.00	22.60	22.00	11.00
Amplitude	9.00	7.00	10.40	3.00	12.40	14.40	8.50
Median	12.4	23.75	13.5	2.05	13.95	14.85	5.2
Average quadratic deviation	3.19	2.60	4.78	1.30	5.26	4.78	3.10
Dispersion	10.17	6.77	22.87	1.70	27.71	22.86	9.63
Coefficient of variation	0.25	0.11	0.37	0.86	0.52	0.32	0.53

Considerable amplitude value 9.0 cm for cup height on the front symmetry line, 7.0 cm on the cup symmetry line, 10.4 cm on the side line; 3.0 cm the width of the supporting element of the bra cup below the bust line, 12.40 on the front symmetry line; 14.40 cm width of the rear marker on the side line, 8.50 cm on the rear symmetry line - high values for the analyzed constructive parameters for a product that will meet the requirements of shape-size-body-product correspondence. The value of the coefficient of variation indicates the average height of the cup on the symmetry line, for the height of the cup on the face symmetry line the average value is sufficiently representative, and for the rest of the analyzed indicators the arithmetic mean is not representative.

In order to summarize the values of the measured constructive parameters, they are represented in the form of graphs (fig. 1-3).

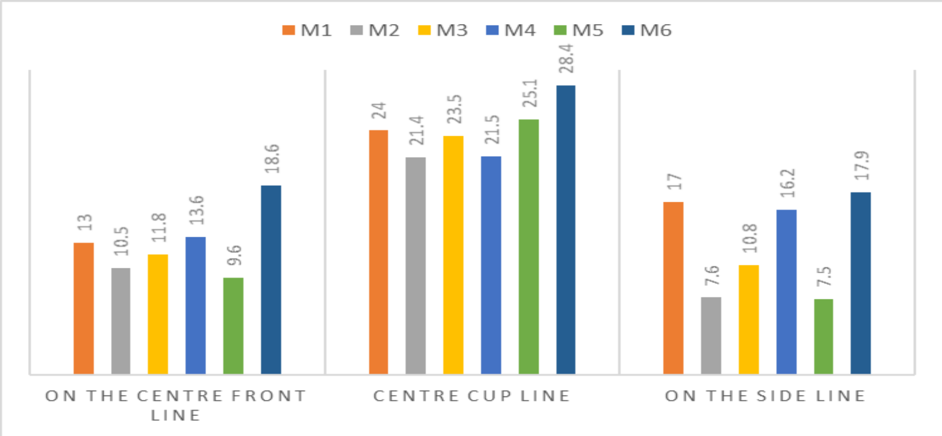


Fig.1 *Variation of the constructive parameter values characteristic of the bra cup*

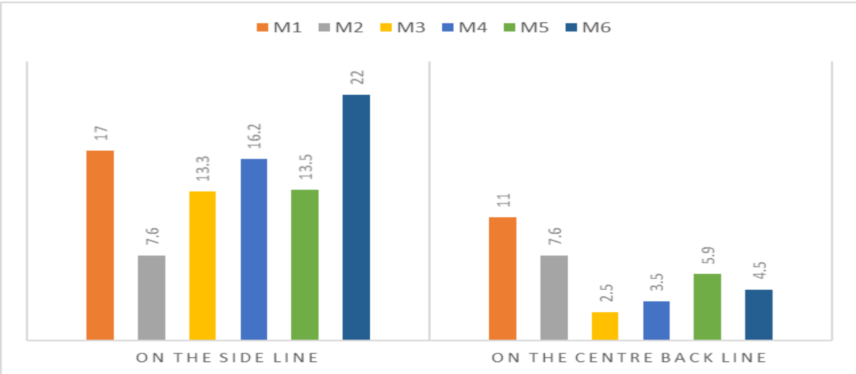


Fig. 2 *Variation of the constructive parameter values characteristic of the support element of the bra cup*

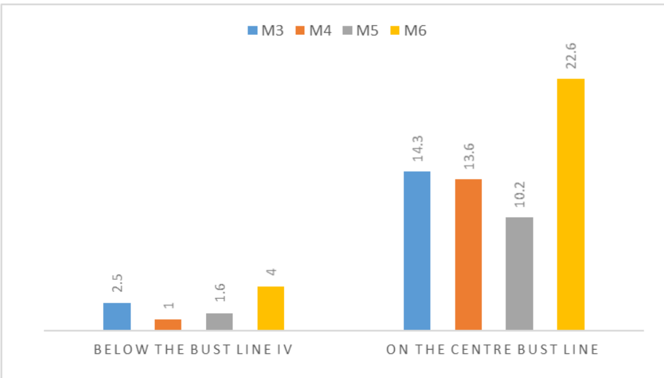
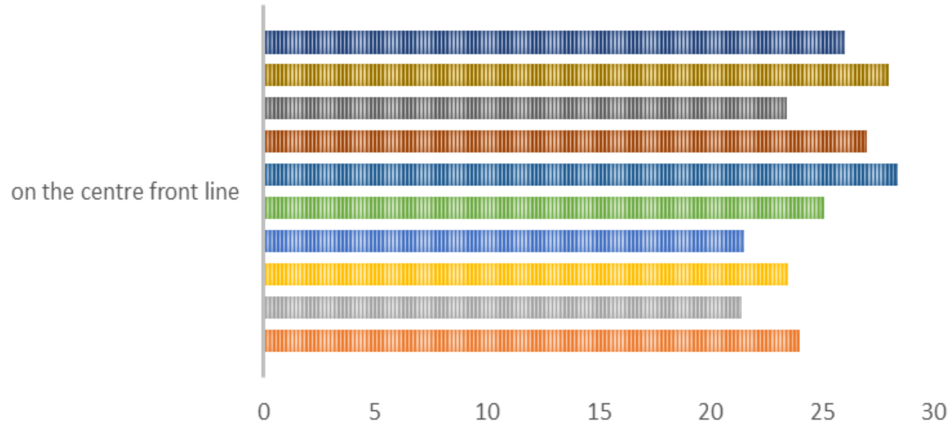


Fig. 3 *Variation of the constructive parameter values characteristic of the rear landmark of the bra*

The values of the print constructive parameters, obtained by the method of the Russian author L. Serova, have maximum values except for the width of the rear reference mark on the symmetry line, which recommends the method in order to personalize the construction of the post-mastectomy bra pattern.

Figure 4 shows the results of the comparative analysis of the bra cup height on the symmetry line with values of the dimensions of the mammary gland, prosthetics, and dimensions of a pattern selected for comparison.



	on the centre front line
The prosthesis vertical arch (the prosthesis shape -Triangle)	26
The prosthesis vertical arch (the prosthesis shape -Drop)	28
The mammary gland vertical arch	23.4
Model for comparison	27
M6	28.4
M5	25.1
M4	21.5
M3	23.5
M2	21.4
M1	24

Fig. 4 *Variation of the constructive parameter values height of the bra cup in comparison with the dimensions of the mammary gland, external breast prostheses.*

The value of the parameter height of the bra cup on the symmetry line is close to the dimensions of the mammary gland in the case of the English Winifred Aldrich method, the method of construction in radial networks, the TNIISHP method and the method of the Russian author L. Serova. In the case of the method of the Russian author L. Serova, this value is also close to the values of the parameter of the model for comparison, but also of the breast prostheses.

3. CUSTOMIZATION OF THE BASIC PATTERN CONSTRUCTION METHOD FOR THE POST-MASTECTOMY BRA PRODUCT

Taking into account that the functional and ergonomic design of clothing products for people with special needs involves the customization (individualization) of the methods of clothing design, according to the requirements of the wearer (type of disability, anthropometric peculiarities) as well as the characteristics of the field of use (environmental and body condition), it is proposed to adapt the construction algorithm by the method of the Russian author L. Serova to the requirements and characteristics imposed on the product post-operative bra (table 2).

Table 2: *Elaboration of the custom construction algorithm for the construction of the post-mastectomy bra product pattern*

Classical (initial) method	Custom method (adapted)
Initial data	
Data on the wearer: Conformation group Bust semiperimeter II – S_{bII} Bust semiperimeter IV – S_{bIV} The distance between the breast points – D_{pm} **The mammary gland vertical arch– Av_{gm}** The bethel width – l_{bet}	Data on the wearer: Conformation group Bust semiperimeter II – S_{bII} Bust semiperimeter IV – S_{bIV} The distance between the breast points – D_{pm} **The mammary gland lower vertical arch – $A_{v.s.g.m}$** **The bra upper cup lifting value – $A_{v.i.g.m}$** **The bra upper cup lifting value – $Val_{rid.cup}$** The shoulder strap width– l_{bret} The bethel width – l_{bet}
Data on the prosthesis: –	Data on the prosthesis: **The prosthesis shape** **The prosthesis upper vertical arch – $A_{v.s.p.m}$** **The prosthesis lower vertical arch $A_{v.i.p.m}$** **The breast prosthesis horizontal arch – $A_{o.p.m}$**
Bra construction algoritm	
Bra cup construction algoritm: $Ba=Cd = D_{pm}-1,0cm$ $Ab=bD=1/2\ AD$ $a_1a=aa_2=b_1b=bb_2=d_1d=dd_2=e_2e=ee_1=1/2\ S_{bII}/10$ **$Ak=3,0...4,0cm$** **$kk_1=1,0...2,0cm$** **$Bk_2=3,0...4,0cm$** $Dk_3=1,0cm$ $k_3k_4=1,0cm$ $Ck_5=3,0...3,5cm$ – *on the angle bisector C*	Bra cup construction algoritm: $AB=CD=S_{bII}/2$ $AD=BC=$ **$A_{v.s.g.m}$+ $A_{v.i.g.m}$+ $Val_{rid.cup}$** $Ba=Cd = D_{pm}-1,0cm$ $Ab=bD=1/2\ AD$ $a_1a=aa_2=b_1b=bb_2=d_1d=dd_2=e_2e=ee_1=1/2\ S_{bII}/10$ **$Ak=4,0...5,0cm$** **$kk_1=2,0...3,0cm$** **$Bk_2=4,0...5,0cm$** $Dk_3=1,0cm$ $k_3k_4=1,0cm$ $Ck_5=3,0...3,5cm$ – *on the angle bisector C*
Construction the cup support: $e_2P=e_1k_2$ **$PP_1=0,5...1,0cm$** P_1P_3 – *min 3,0cm below the waist line* $P_3P_4 = PP_1 + Cd_2 + d_1\kappa_4$	Construction the cup support: $e_2P=e_1k_2$ **$PP_1=2,0...3,0cm$** **$P_1P_3 = l_{bet}$** $P_3P_4 = PP_1 + Cd_2 + d_1\kappa_4$
Construction of the back landmark: $A_1B_1 = D_1C_1 = S_{bIV} - P_4P_3$ $A_1D_1 = B_1C_1 = P_5P_4 + \kappa_4b_2 + b_1\kappa_1$ $D_1A_1=3,0cm$	Construction of the back landmark: $A_1B_1 = D_1C_1 = S_{bIV} - P_4P_3$ $A_1D_1 = B_1C_1 = P_5P_4 + \kappa_4b_2 + b_1\kappa_1$ $D_1A_1=$ **l_{bet}**
External prosthesis pocket construction algorithm	
–	**$A_bB_b=C_bD_b= A_{o.p.m}$** **$A_bD_b=B_bC_b= A_{v.s.p.m}+ A_{v.i.p.m}$** **$B_ba_b=C_bd_b = A_{o.p.m}$** **$A_bb_b=b_bD_b= A_{v.s.p.m}$** **$a_{1b}a_b=a_ba_{2b}=b_{1b}b_b=b_bb_{2b}=d_{1b}d_b=d_bd_{2b}=e_{2b}e_b=e_be_{1b}=1/2\ S_{bII}/10$** **$A_bk_b=4,0.cm$** **$k_bk_{1b}=2,0cm$** **$B_bk_{2b}=4,0cm$** **$D_bk_{3b}=1,0cm$** **$k_{3b}k_{4b}=1,0cm$**

	$C_b k_{5b}$=3,0cm – on the angle bisector C

Based on the proposed custom algorithm, the necessary constructions for further experiments will be elaborated.

4. CONCLUSIONS

The values of the constructive parameters of the print obtained by the method of the Russian author L. Serova have maximum values except for the width of the rear mark on the symmetry line, which recommends that method in order to personalize the construction of the post-mastectomy bra type product pattern. Patterns of the basic construction for a wide range of sizes, necessary for further experiments, will be developed using the Software application for the design of the functional-adaptive postoperative bra type product. The elaborated basic patterns are to be used for further research in view of the adaptability and functionality of post-operative bra products.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

THE USE OF TEXTILE FIBRES IN PADDING CAR DASHBOARDS – STUDY CASE –

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Abstract: *The paper presents the advantages and disadvantages of using textile fibres for the dashboard padding of cars. The car dashboard had throughout time a constant evolution in relation to the use of new technologies and materials, offering users not only a good visibility on the tool panel and a good ergonomics on the commands, but also a good protection in case of impact by integrating the airbags and by using soft, deformable materials, for an eventual contact with the passengers. The metal structure has gradually been replaced with reinforced fibre glass, with plastic such as ABS and PVC, the outer layer of the dashboard being able to be covered in polyurethane foam with a finishing made of PVC foil or leather in case of the luxury vehicles and PVC in case of the medium level ones. The Romanian car producer Dacia brings for the first time textile fibres for the padding of the central panel of the dashboards of the models Logan and Sandero, which will represent the topic of a study case.*

Key words: *textile fibres, car dashboard, textile insertion, technology.*

1. INTRODUCTION

The car became a common presence in big urban centres since the half of the 20th century, this knowing a constant technical and aesthetic evolution in relation to the new materials and technologies used in the industry. The growths of the reliability, of the manoeuvrability, of the interior comfort are only a few of the preoccupations of designers and engineers in the auto industry, the safety of passengers becoming a priority in the contemporary period, when the number of cars has grown significantly. Besides the active protection systems, sensors, traction control, braking assistance, steadiness control, passive protection systems also have a really important role, such as seatbelts, headrests, airbags and, last but not least, the parts designed to absorb the force of the impact, protecting the integrity of the cabin. Using plastic has generated notable results in impact tests, features such as elasticity, resistance to a mechanic stress and high temperatures determining designers to extend the use of plastic and padding the car cabin [1]. The gradual replacement of the metal elements from the car dashboard has led to a significant decrease of its weight, to the decrease of the production cost, to the possibility of experimenting new shapes, which have raised the ergonomic character and implicitly, the protection in case of a frontal impact [2]. The metal structure was gradually replaced with reinforced fibre glass, with plastic such as ABS and PVC, the outer layer of the dashboard being able to be covered in polyurethane foam with a finishing made of PVC foil or leather in case of the luxury vehicles and PVC in case of the medium level ones. Although the PVC is a material easy to mould and process, with a high variety of textures and colours, it is rigid in case of a physical contact of passengers with the dashboard during a car crash. The technology of covering the dashboard with a layer of polyurethane foam finished with PVC foil has proven to have a low resistance to heat, the constant exposure to temperatures over 100 degrees causing cracks in the fabric (Fig. 1a). The luxury cars dashboards are finished with synthetic or even natural leather, fabrics which resist to high temperatures and significantly ease the frontal impact of passengers due to the elasticity. Taking into account the high implementation costs of this solution, which influences the final cost of the product, most of the car producers, globally, choose the PVC finishing. In this context, the Romanian car producer, Dacia, has presented for the first time in 2020 the third generation of the models Logan and Sandero with textile fabric on the dashboard (Fig. 1b). The unconventional solution will be analysed during a study case, both advantages and disadvantages being presented, functionally and aesthetically.

2. GENERAL INFORMATION

The third generation of the models Logan and Sandero includes a new series of active and passive protection systems for the Romanian car producer Dacia, one of these being the longitudinal insertion of textile fabric on the dashboard (Fig. 1c). Fabrics have been used in the auto industry since its founding, in order to upholster seats and chairs, roofs, door interiors and even the floor. Throughout history, the fabrics used in car interiors have diversified accordingly to discovering new technologies. Thus, the cloth has been replaced since the 1960s with synthetic fibres, cheaper to produce and with a high degree of wear throughout time, but with a low degree of comfort for the passengers, being afterwards replaced with mixed fabrics, from natural and synthetic fibres. Using textiles in a car interior offers passengers the feeling of comfort, of safety. The interaction areas of the passengers with the components from inside the vehicle have gradually been padded in fabric, besides the seats one seeing the armrests, headrests, interior sides of the doors, sun blinds, roof padding. Applying the fabric insertion on the dashboard represents a first in the auto industry, with multiple implications, both functionally, as well as aesthetically.

2.1. The problem

In case of the cars with a medium selling price, category in which Dacia fits, the leather or fabric padding of the passenger interaction areas is limited to the basics. Leather, a luxury material, used by some premium brands for the entire padding of the dashboard, the interior of doors, is used optionally by Dacia only for padding the steering wheel. The dashboard or the door interiors are made of PVC, in order to reduce the production costs. PVC is a mouldable material, which can be processed in a large variety of finishes and colours, so that from an aesthetic point of view the components made of PVC would be similar to those made of leather or even fabrics [3]. Nonetheless, from a tactile perspective, the rough, stiff material does not offer comfort to passengers, the frontal impact and the risk of its splintering in case of an accident can hurt the passengers sitting in the front. The longitudinal strip of fabric (Fig. 2a) placed by Dacia on the dashboard of Logan and Sandero offers a plus of protection in case of an accident, the fabric preventing the interaction of passengers with possible PVC splinters. Also, the layer of sponge which doubles the insertion of fabric contributes to the absorption of the impact and the attenuation of the contact of passengers from the front seats with the dashboard (Fig. 2b) [4].

Fig. 1: *a) Dacia 1310 dashboard made of polyurethane and PVC foil - damage caused by the overheating of the material during summertime; b) Comparison between a conventional ABS and PVC dashboard (Dacia Logan 1) and an ABS and PVC dashboard with a fabric insertion (Dacia Sandero Stepway 3); c) Fabric insertion - detail (Dacia Sandero Stepway 3)*

2.2. The solution

The insertion of fabric, polyester textile, with a width of 100mm, is placed longitudinally on the entire length of the dashboard, in its central area. From an aesthetic point of view, the fabric strip becomes an accent area, which also plays a functional role by visually delimiting the basic dashboard tools (speedometer, revmeter, board computer screen, multimedia touch screen) from the ones used on a sideline (climate control system, car doors security, air recirculation) [5]. The aspect of the fabric, made of a geometric rhythm of white-black, makes the transition between the two functional plans of the dashboard, blending with the aesthetics of the interior design of the entire cabin. The use of the fabric on the dashboard from in front of all car passengers offers them an increased sense of comfort and security, the fabric diminishing, from a perception point of view, the cold nature of plastic [6].

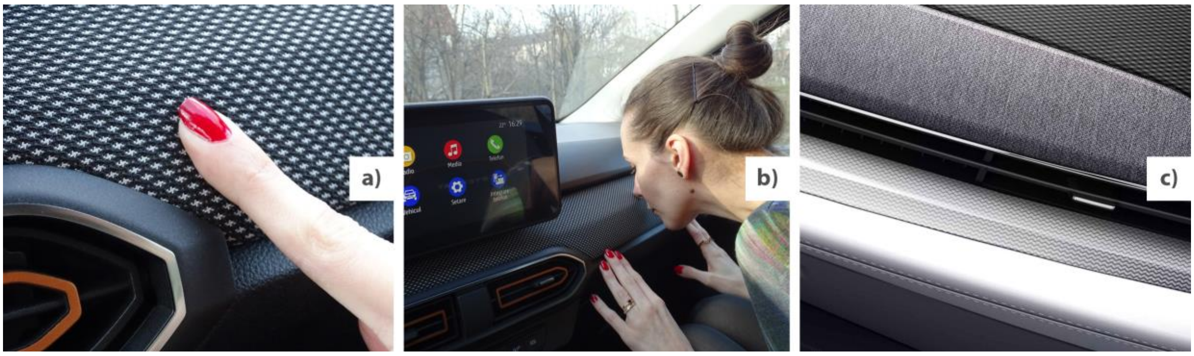

Fig. 2: *a) Padded textile insertion (Dacia Sandero Stepway 3); b) Simulation frontal accident -the padded area ensures frontal protection to passengers; c) Padded textile insertion applied on the dashboard of Ford Mustang Mach – E 2021vehicles*

2.3. Benefits

The polyester textile offers numerous advantages, both functionally and aesthetically, the synthetic material having a high degree of resistance to wear and stretch, being able to take the shape of the dashboard without wrinkling, the synthetic fibres offering a high degree of resistance to high temperatures as well. Nevertheless, using a textile material in a highly used area of the car, which means the interaction of passengers with the controls on the dashboard, leads to its dirtying. Using cleaning technologies based on water and steam may damage the dashboard electronic tools. Also, the fabric is permanently exposed to sunlight, the discoloration and even yellowing process as a constant exposure to high temperatures being irreversible. The specific features of synthetic fibres, such as elasticity and water resistance, ensure a good resistance of the fabric during cold weather and temperature differences, favouring conditions for condensation. Taking into account the normal life duration of an 8-10 years old car, it is estimated that the fabric insertion will physically last, but aesthetically with irredeemable signs of wear, the first 4-5 years of use, if we take into account the evolution of fabrics found in other previous Dacia models [7].

The case study was made on a Dacia Sandero Stepway vehicle, personal propriety, acquired in 2021. Thus, interaction with the dashboard was researched and quantified, including with the fabric padded area, the behaviour of the fabric during summertime, by exposure to constant sunlight and high temperatures and, to an equal extent, during wintertime, to low temperatures and moisture.

3. CONCLUSIONS

The premises of using synthetic textile materials for padding the dashboard of vehicles are positive from the perspective of the relation functionality/ implementation costs. The mechanical proprieties of textile padding offer a good adaptability of the product to operation areas with high temperature differences. Using padding insertions also offers a good protection to passengers in case of impact with the dashboard. The analysed technical solution presents numerous functional and aesthetic advantages unlike the PVC dashboards, conventional for cars with a medium cost of acquisition, answering to the usability and security requirements similar to premium materials used in case of luxury cars. It is estimated that this technical solution will be gradually adopted by many auto producers, aspect supported by new models of Ford companies (Mustang Mach – E 2021) and even the Mercedes-Benz group (Smart Fortwo 2021) (Fig. 2c).

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ELECTROCONDUCTIVE NANOFIBERS FOR TEXTILE-BASED SENSORS AND ACTUATORS

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Abstract: *Smart textiles reach a remarkable potential for use in people's lives by adding new and multiple functions and properties, overcoming the barriers of conventional textiles. They consist of built-in mechanical, thermal, magnetic, chemical, and/or electrical sensing and processing technologies to monitor stimuli, collect and convert data and—sometimes—perform an action, thus being able not only to track and communicate environmental and user data but also to manage and alleviate potential health risks or to give people friendly ways to enjoy life. Many industries are utilizing these smart materials from defencemen to fashion designers, casual shoppers, sportive people, doctors and caregivers, to the occupied business-people.*
With the advancement of nanotechnology, electrospinning has made its presence felt lately due to its reduced complexity and the potential to obtain functionalized continuous fibres with micro and nanometer ordinal dimensions. Electroconductive nanofibers obtained by electrospinning due to their unique structural and electrical properties are very good candidates to obtain sensing and actuation devices. Compared to conventional materials, electroconductive nanofibers possess numerous benefits which can meet the desired requirements for developing such smart applications.
This paper discusses approaches to the manufacture of electroconductive nanofibers by electrospinning technology, their advantages and their use as nanofiber-based sensors and actuators for various applications.

Keywords: *smart textiles, electrospinning, stimuli sensitivity, wearable devices, artificial muscles*

1. INTRODUCTION

Smart textiles are becoming more and more present in our everyday life as they can help us to control and improve the quality of our lives and possess the ability to unlock human potential. The practical applications of these new materials involve different areas, different age groups and different functions, many of these are aimed at uses within the health care industry.

Sensors and actuators are essential elements for active smart textiles that can sense the external stimuli activity and further perform an action. These advanced textile materials can bring significant improvements in textiles performance in terms of functionality and adaptiveness and thus providing a series of services to consumers: knowledge service, communication service, healthcare and safety service and emotional service [1].

Over the last decade, electrospinning, a nanotechnology based on the action of an external electric field to extract from a syringe and a needle various polymeric solutions or melts in the form of nanofibers, has gained increasing attention in the scientific research community, being one of the most emergent routes to the synthesis of electrospun nanofibers with many interesting properties and possibilities to be used in the field of sensors and actuators. Electrically conductive nanofiber mats obtained this way could be highly suitable for sensors and actuators because of many advantages (Fig. 1).

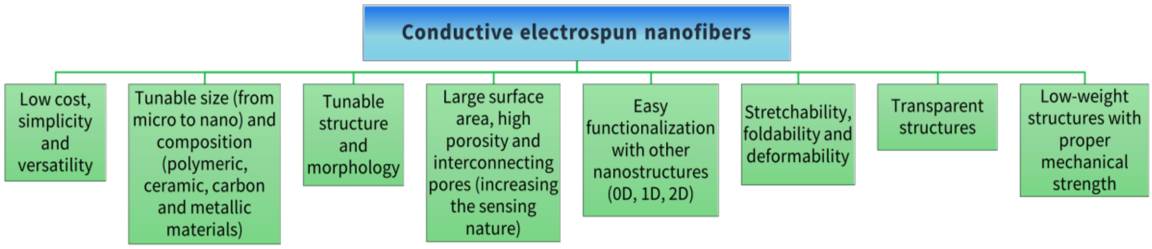

Fig. 1: *Benefits of conductive electrospun nanofibers*

The morphology and the diameter of the electrospun nanofibers play a key role in their final physical and chemical properties. Therefore, to make nanofibers with controlled structures and orientation but also with the desired functions, certain parameters of the technology should be adjusted accordingly (solution parameters, process parameters and ambient parameters). In addition, the different configurations of the equipment, contribute to the change in the composition, orientation, and architecture of the fibres. For example, coaxial electrospinning uses two or more separate syringes with capillaries of different sizes, the smaller capillary being incorporated into the larger one, forming multilayer core-sheath fibres of different materials in just one step. Some technologies exclude the use of capillaries (needles) to obtain nanofibers.

2. ELECTROCONDUCTIVE ELECTROSPUN NANOFIBERS PRODUCTION

Conductive polymers. One usual method for the manufacturing of conductive nanofibers by electrospinning involves the use of conductive polymers such as polyaniline (PANI), polyacetylene, polypyrrole (PPy), polythiophene (PTs), poly(3,4-ethylenedioxythiophene) (PEDOT), polyvinylidene fluoride (PVDF), etc. These polymers are known as electroactive polymers (EAP). They offer thermal, electrochemical, and environmental stability but also high conductivity. However, the processability of these polymers is a challenge [2]. They cannot be processed by melting and are insoluble in most solvents. Therefore, in most cases, they are used to produce coatings on the surface of nanofibers obtained from ordinary non-conductive polymers.

Conductive additives in the spinning solution. The addition of a conductive material, such as carbon black nanoparticles, silver nanoparticles, carbon nanotubes/nanoparticles, graphene nanosheets or an ionic liquid, to the spinning solution is an efficient method of producing electroconductive nanofibers. Recently, the incorporation of ionic liquids into polymeric solutions has gained interest due to their extremely low volatility and their ability to significantly improve conductivity and promote electron transfer [2]. Ionic liquids are organic salts essentially found in the liquid state at room temperature [3]. Some ionic liquids explored as additives for electrospinning solution are 1-butyl-3-methylimidazolium chloride (C_4MIMCl), 1-dodecyl-3-methylimidazolium chloride ($C_{12}MIMCl$), 1-ethyl-3-methylimidazolium bromide (C_2MIMBr), and 1-ethyl-3-methylimidazolium phosphate $(C_2MIM)_3PO_4$ [4].

Graphene is also a suitable nano-additive candidate both for natural polymers and synthetic polymers for electrospinning because it possesses several excellent properties, such as thermal stability, hydrophobicity, conductivity, and mechanical strength. However, a very tough task remains the loading of graphene solution in the electrospinning setup and in general, two methods were addressed: one is based on in situ polymerization technique and the other one is the formation of rGO nanofibers in the presence of high temperature or chemical reduction methods [5].

Heat treatment of the nanofiber mat (carbonization). Electroconductive properties of nanofibers can be obtained by heat treatment of electrospun precursor fibres. The manufacture of carbon nanofibers is a method that involves heat treatment at high temperatures. For example, polyacrylonitrile (PAN) or polyvinylpyrrolidone (PVP) precursor nanofibers are converted to carbon nanofibers due to their easy carbonization process, resulting in one-dimensional structures that possess high mechanical strength, high rigidity, excellent electrical and thermal conductivity, good fatigue resistance corrosion [2].

Surface coatings. The last method involves coating the non-conductive nanofiber structure with a conductive material such as metals (e.g. copper, silver, nickel, gold), electroplating being a widely used technique for depositing metals on the surface of nanofibers [2].

3. ELECTROSPUN SENSORS AND ACTUATORS APPLICATIONS

SENSORS

The signals transmitted by the sensors are mainly in electrical form, so for the realization of a textile sensor, the most used and efficient method is the use of electroconductive materials.

Two essential properties are vital for the high sensitivity and fast response of a sensor: a large specific surface area and a very porous structure, characteristics that are fulfilled by nanofibers obtained by electrospinning. In addition, compared to conventional sensors, electrospun nanostructured sensors show faster adsorption and minimised bulk effects [6].

Conductive electrospun nanofibers can be used to create a variety of sensors like gas sensors, optical sensors (colorimetric and fluorescent), mechanical sensors, electrochemical sensors, and photo-electric sensors. They can be used in areas such as medicine and medical diagnosis, environmental monitoring, food monitoring, industrial processes, biodefence and military, agriculture and plant biology.

Among them, electrochemical sensors stand out, with applicability in the bio-medical field for fast and reliable monitoring of glucose and carbohydrates levels present in the body fluids like saliva, tear, interstitial fluid, sweat, or blood for the treatment and control of metabolic diseases like diabetes [7]. Most importantly, electrospun nanofibers as biosensors are a promising base for the early detection of cancer-related electrochemical biomarkers. For example, imunosensing with electroconductive electrospun nanofibers (immunosensors performing immunoassays on account of antigen and antibody recognition for detection of cancerous molecules in body fluids, especially in serum because of the inherent specificity and accuracy) is an encouraging applicable method for detection of cancer [8].

Gas sensors based on electrically conductive nanofibers have been shown to be suitable for the detection of various diseases (intestinal diseases, lung cancer, asthma, halitosis, diabetes, chronic kidney disease) by analyzing volatile organic compounds in human respiration [9]. Gas-sensing materials formed from nanofibers usually have a porosity of ~70–90%. The presence of large pores along with small pores, that facilitate gas diffusion can also be attributed to the advantages of these materials [10]. Moreover, sensors made of such materials are effectively used to detect a wide range of gaseous substances in the atmosphere, including pollutants, exhaust fumes or industrial gases: methane (mining), hydrocarbons (refineries), ammonia (fertilizers), etc.

Mechanical sensors are another category of sensors that can be developed using nanofibers. They have a high potential to be used in interactive portable/wearable devices, military applications, intelligent soft robots and health monitoring. Pressure and strain sensors are two types of mechanical sensors, the two most studied using electrospun nanofibers. A special advantage is that the electrospun nanofiber mats manifest high tolerance for repetitive external pressing [11].

Obviously, certain critical factors must be considered for the successful development of textile sensors. Abrasion, bending, stretching, confidentiality security, and the gap between laboratory and practical life are the main challenges facing conductive textiles. For the development of sensors made of such materials, it is necessary to ensure that they are durable in the long term, that they have sufficient robustness and dimensional stability, that they withstand frequent washing, dust, sweat or heat cycle over time, especially when intended for use in wearable devices or electronics. In addition, economic aspects are essential for the development of appropriate sensors [12].

ACTUATORS

Conventional actuators are rigid, have robust, heavy and noisy operating systems, features that make them unsuitable for assembly in smart textiles. With the advancement of wearable devices, actuators that overcome these limitations are needed. Thus, polymeric materials are a good solution for making actuators because they are soft, light and can produce flexible movements. However, low-voltage polymer-based actuators can only be used in a solution, while those operating in the atmosphere require high voltages, so it is difficult to extend their scope [13].

Actuators obtained using nanofibers resulting from electrospinning have several advantages, including the ability to be used a wide variety of polymers, good dispersion, increased flexibility, low weight, and the ability to produce different shapes, varying the essential factors. Besides, nanofiber structures have attracted attention for application as actuators due to their ultra-high surface-to-volume ratio, which improves their controllability by the excitation of different stimuli. The driving behaviour of an actuator is influenced by the type of material, physical properties and the thickness of nanofibers.

Thus, depending on the external stimulus used to activate and implement the actuator function, there are photo-sensitive actuators, electrochemical actuators, electrothermal actuators, pneumatic actuators, humidity/water sensitive actuators, magneto-thermal actuators, etc.

To date, several studies have been reported on nanofiber-based actuators using the electrospinning method, and such actuators can be divided into two types: single-nanofiber-based actuators and nanofiber mat-based actuators (table 1). However, only a few works involve the production of individual fibre-based actuators, mainly due to difficult testing procedures depending on the size of the fibres and the infinitesimal forces to be measured (from nN to a few μN) [14]. Also, nanofibers can be incorporated into the actuator component either as electrode layers or as electrolyte layers [15].

Most applications are based on the use of electrospun nanofibers to make artificial muscles because they can form bundles by their parallel arrangement, a configuration that is very similar to the structure of natural muscle fibres made of myofibers with diameters of about 1-2 µm [16]. Artificial muscles studied for a long time since 1950 [17] are very useful today in several applications such as humanoid robots, prosthetic limbs, exoskeletons, for controlling valves and stirring liquids in microfluidic circuits and medical catheters [18].

In this context, conductive polymers (CPs) are suitable candidates for such applications, given their biocompatibility, low actuation potentials and high mechanical properties, but they are mainly used as coatings using in situ chemical polymerization of conductive polymers on the surface of electrospun fibres or electrochemical polymerization [13] in particular to perform bending movements under the action of the electric field and/or oxidation/reduction reactions, so that they may experience changes in shape or volume.

Table 1: *Electrically stimulated actuators manufactured by electrospinning technology*

Actuation mechanism	Materials	Structure	Motion	Application	Ref.
Electro-thermal	PU and $FeCl_3$ powder	Single nanofiber	Bending	Artificial muscle tissue or a filter for a driver	[13]
Electro-chemical	PMMA fibres coated with gold and PANI	Strips of aligned nanofibers	Bending	Artificial muscle	[16]
Electro-chemical	Silk fibroin nanofibers coated with PPy and PEDOT	Bundle (rolling the nanofiber mat)	Elongation and contraction	Tissue engineering	[19]
Electro-chemical	PVDF-graphene nanofiber membrane dipped into an ionic liquid ($EMIMBF_4$) and two deposited PEDOT: PSS layers	Sandwich structure	Bending	Artificial muscles, biomimetic robots, and disposable biomedical devices	[20]
Piezo-electric	PVDF	Single nanofiber	Contraction	NEMS/MEMS	[21]
Electro-mechanical	PE film and PEDOT/PSS film with PVP/ PMMA nanofiber	By-layer structure	Bending	Flexible ambient devices with anisotropic actuation propertie	[22]

4. CONCLUSIONS

Electrospinning technology is a promising solution for the development of advanced materials that will bring a special contribution in improving our comfort, providing us with greater protection and improving our quality of life. Due to recent developments, sensors and actuators based on electrospun conductive nanofibers are gaining interest to be used in many applications such as soft electronics, biomimetic robots, haptic devices, medical diagnostics and treatment, global environmental monitoring, etc. Further improvements should be made to the operational characteristics of these devices. Sensors still need improved detection limits and actuators need enhanced actuation strain to obtain highly efficient devices. Also, some actuation materials need efforts to reduce the driven electric field strength, to improve the response time and to eliminate the surrounding electrolyte medium, so they can be applied in everyday applications. Moreover, it is necessary to reduce the production cost of some nanomaterials and increase the production rate, with repeatability and quality maintained over time to ensure long end-user functionality.

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USING THE GOLDEN RATIO PRINCIPLE TO CREATE A CONTINUOUS PRINT BY MEANS OF THE GRAPHIC PROGRAM ADOBE ILLUTRATOR®

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Abstract*: This paper aims to exemplify the use of the golden ratio principle for the creation of a continuous print. The ratio of 1:1.618 signifies the bases for the creation of the componing elements of the print and corresponds to the rapport. The print is achieved using the graphics program Adobe Illustrator®, starting with the drawing of the rectangle in which the circles, which are the components of the print, will be framed. Adobe Illustrator® is a program that specializes in creating and editing vector graphics. This program has become one of the most popular software in the industry for creating vector graphics that can be scaled and edited without losing resolution or clarity. The program allows you to draw both simple and complex shapes using various tools and palettes, logos, sketches, illustrations. Objects created in Adobe Illustrator can be printed or published exactly as they were made. The subsequent use of the print as well as of the single base element is multiple, this paper describes needed steps for creating a continuous print, but the single initial element can be used for a placed print in a smaller size, such as logo which is the most representative form of product identification. A closer look reveals that the Fibonacci sequence has found its usefulness in a variety of activities, including art, sculpture, architecture, music, and graphics.*

Key words: *golden ratio, Adobe Illustrator ®, continuous print, graphics.*

1. INTRODUCTION

Fibonacci's famous sequence has captivated mathematicians, artists, designers, and scientists for centuries. Among the many mathematical curiosities discovered and studied by many scientists, are those related to a sequence of numbers that have a few features, studied by Fibonacci. A closer look reveals that the Fibonacci sequence has found its use in a variety of activities, including art, sculpture, architecture, music, and graphics [1].

The Fibonacci sequence starts with the numbers 0 and 1, and each next number is equal to the sum of the two numbers that precede it. The sequence therefore has the following appearance: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233 [1].

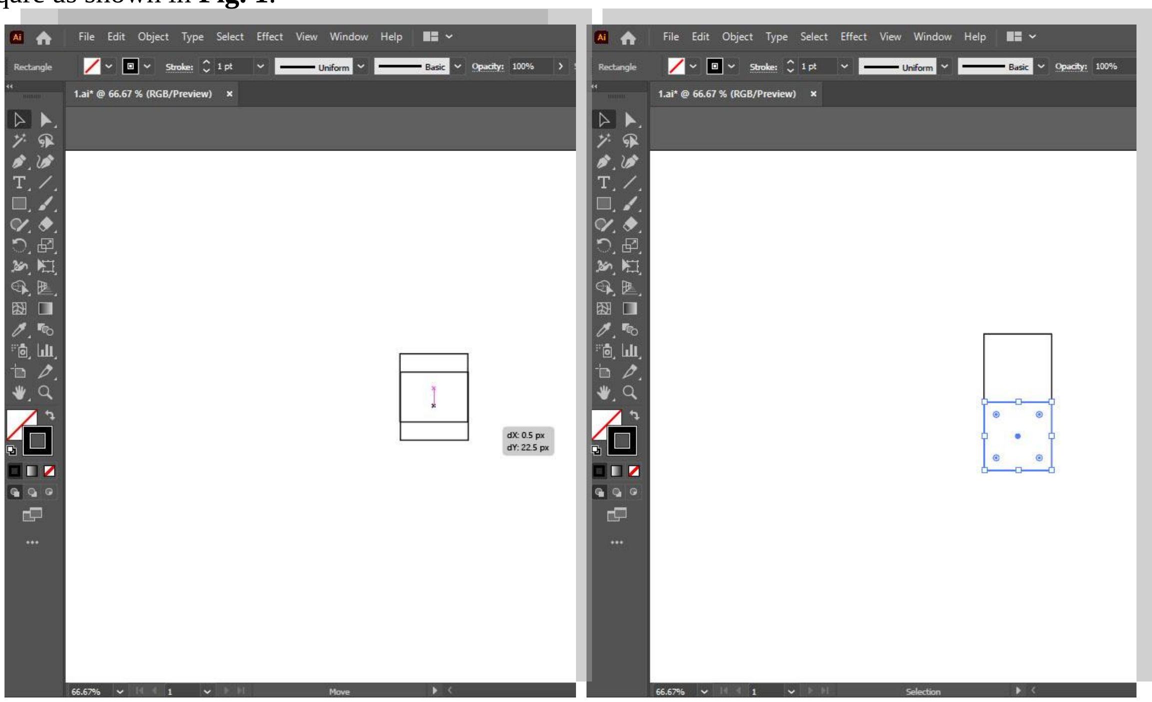
The golden ratio is a two-part division of a line segment, but not into two equal parts, but into two asymmetrical parts. The division must be made in such a way that, from the infinity of points that forms the segment, only one satisfies the ideal ratio in which the two subsegments are located. This is called the golden number and is denoted by Ø or S=1,618033989, found among the features of the sequence of Fibonacci. This way of dividing the segment has had different names in history, among which the most widespread since the antiquity, was: division in average and extreme ratio [1].

M. Ohm gave it the name of the golden section or gold cut, a name that is preserved to this day. Thus this particular ratio can be applied to any geometric shape, including circles. If we insert a circle in the squares drawn according to the ratio, the actual ratio between them is 1: 1,618 then we get what we call golden circles that can be used in designing a logo or even a print, as is the one presented in the current paper, and its realization is done by means of the graphics program Adobe Illustrator® [2, 3].

2. GENERAL INFORMATION

2.1 Achieving the rectangular

The first steps to be taken to make a continuous print are to draw the rectangles in which the circles are to be inserted. To make the rectangle, open a new document in the Adobe Illustrator® graphics program [4, 5, 6, 7] and in the workspace select from the toolbar, the tool for predefined rectangles and by holding down the *Shift key* a square is drawn, afterwards by holding down the *Alt key* copy the initially drawn square. The copied sqare should be postioned unter the initial drawn sqare as shown in **Fig. 1**.



a) b)

***Fig. 1**: Drawing the first sqares with Illustrator®*

After positioning the second square, a new square is made on the side to the overlapping squares, the *Shift key* must be held and starting from the top left point a new square is drawn which must be aligned to the original two squares. After drawing the third square, select the drawing and rotate it 90 °, as shown in **Fig. 2**.

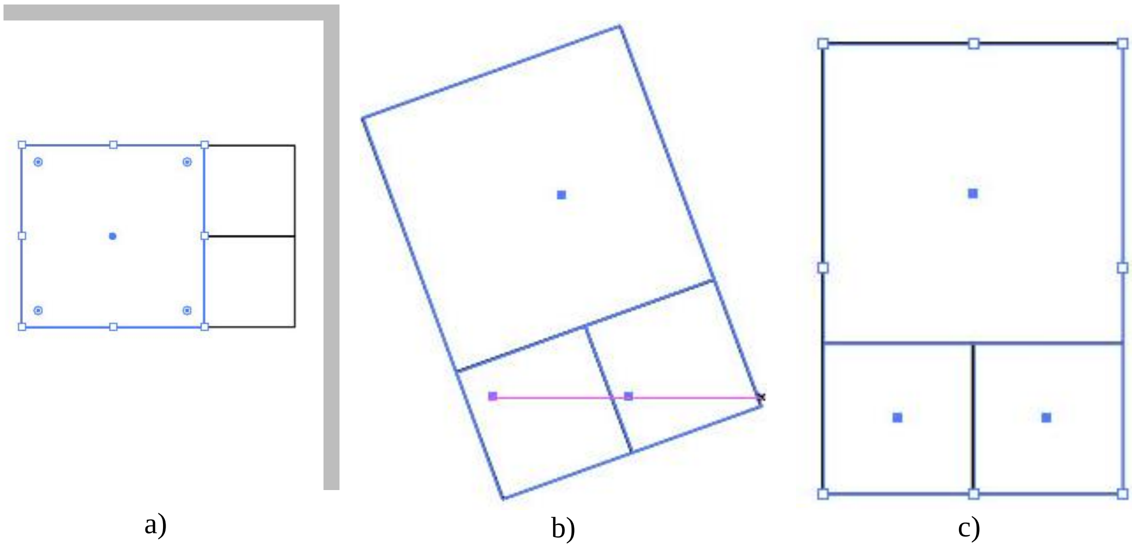


Fig. 2: *Drawing of the following square and its rotation*

The next step involves drawing a new square, starting from the top point - the left side, which must be perfectly aligned to the already drawn squares. After drawing the new square, we move on to rotating the newly obtained drawing, (**Fig. 3 a**, **b**). Repeat the process of drawing a new square until the graphic contains the desired number of elements (squares), (**Fig. 3 c**).

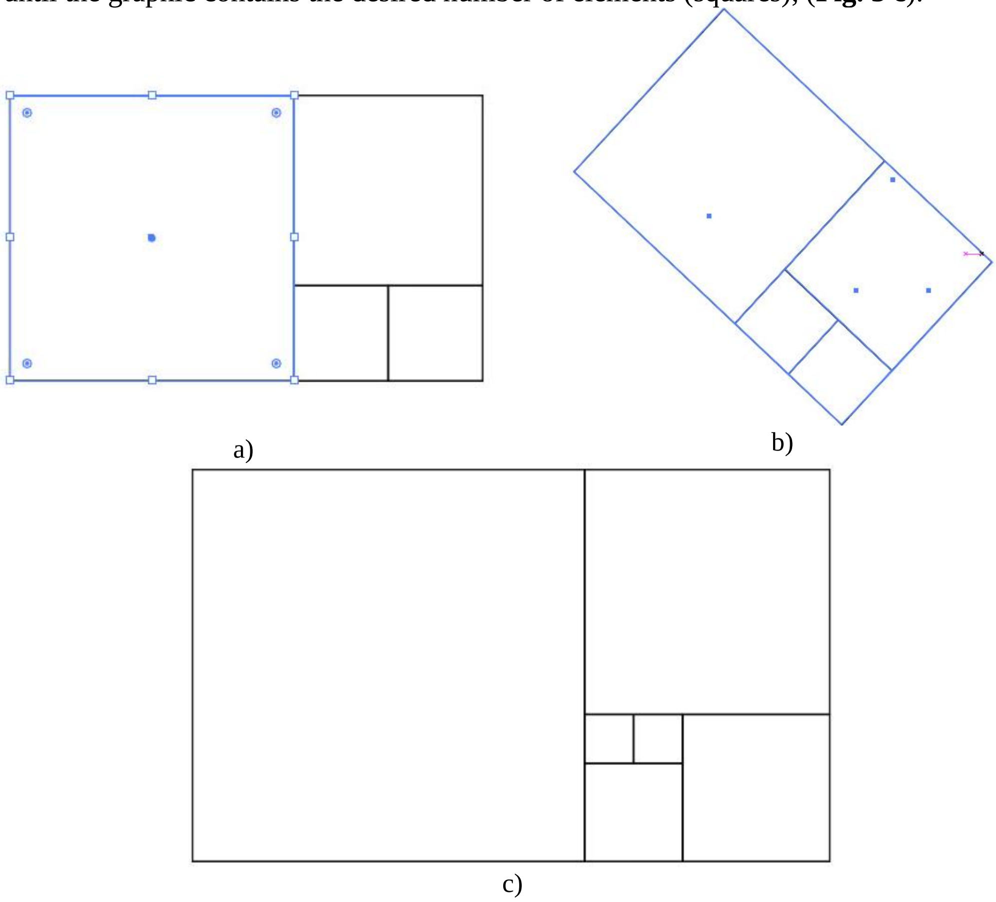


Fig. 3: *Repeat the drawing process until the desired result is achieved*

2.2 Achieving the circles

We select the ellipse tool from the toolbar and starting from the very center of each square by holding down the *Shift* and *Alt keys*, we draw the circles that will fit in the size of the squares perfectly, **Fig. 4**.

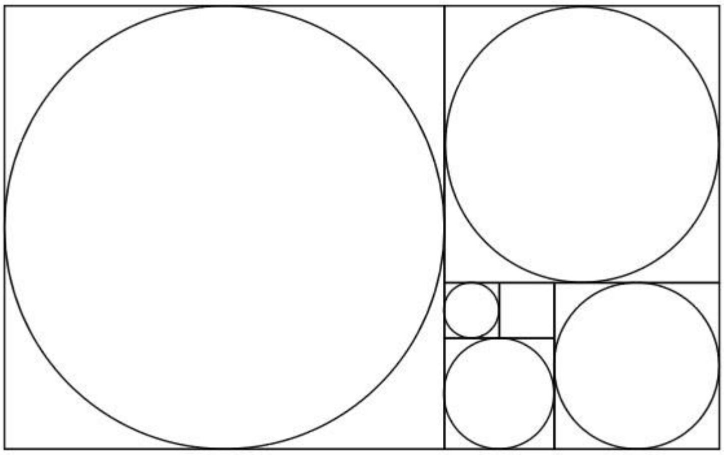
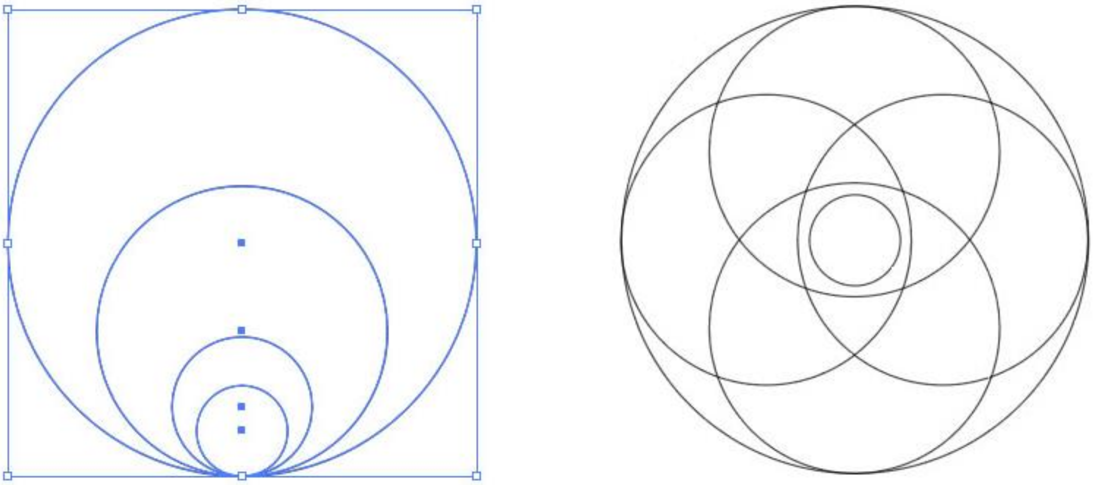


Fig. 4*: Drawing the circles that will form the elements of the print pattern*

3. CREATING THE PRINT

After the circles are drawn and finalised, what follows is the extraction and moving. This is done by activating the selection tool, holding down the *Shift key* and selecting the circles. Their positioning or overlap depends on the desired pattern as shown in **Fig. 5**.



a) b)

Fig. 5*: Positioning the extracted circles in order to achieve the desired pattern*

The finalization of the pattern is done with the key combination Alt and the selection of the *Shape builder tool*, depending on the desired result, the parts of the pattern that are not desired are deleted as shown in **Fig. 6**.

The next step is to select the colors and insert them into the pattern. To the elements the color can be individually assigned as shown **Fig. 7**.

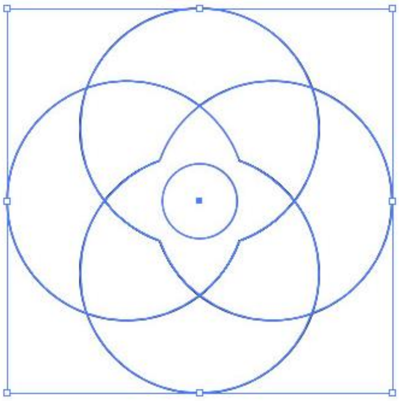


Fig. 6*: Finalising the pattern by deleting the undesired areas*

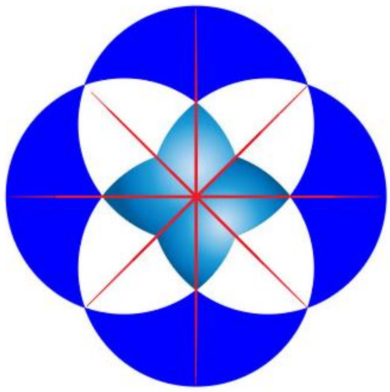


Fig. 7*: Selection and insertion of the desired colors*

The next step is to select the pattern and determine its size. In the example presented in this paper the size is set to 3 x 3cm, so to prepare the print a square with sides of 12cm is created. The background color is chosen according to preferences, and the positioning of the pattern is as follows 4 elements verticaly and 4 elements horizontaly as shown in **Fig. 8**.

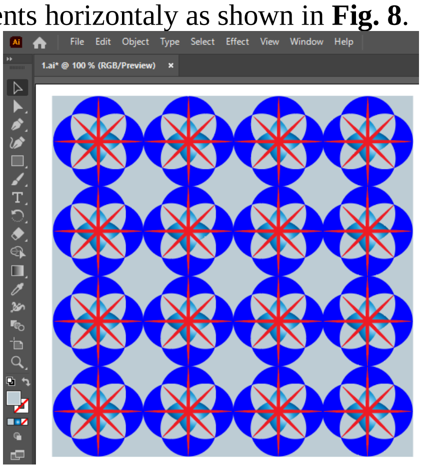


Fig. 8*: Positioning the pattern elements for the final print*

After inserting the patterns horizontally and vertically, select the entire section of the print and add it to the color and swatch panel. Once added to the swatch panel, the size and the shape in which it can be inserted varies, so it can be used both as a continuous print or as a placed print as shown in **Fig. 9**.

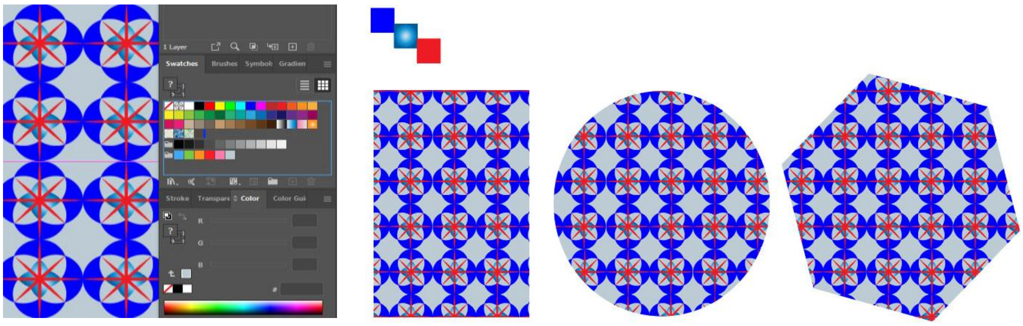


Fig. 9: Inserting the finalised print to the swatch and color panel

5. CONCLUSIONS

The Adobe Illustrator® graphics program with a multitude of features and tools makes it easy to translate creativity into high-fidelity, accurate graphics or complex sketches that can be easily modified and exported to a variety of file types for multiple future use. Therefore, for the design of the graphic element presented in this paper, the Adobe Illustrator® program was a real support, the basis of inspiration being the golden ratio.

The use of the golden ratio is present and used for the proportion set of works of art in general. In graphics, this ratio is the basis for the creation of various and known logos, which is the most representative way of identifying a product.

The beauty of all creations makes us assume that there is a certain need hidden behind any natural form.

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ANNALS OF THE UNIVERSITY OF ORADEA
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MODULAR PERSONAL PROTECTIVE EQUIPMENT SYSTEM FOR FIRST RESPONDERS

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Abstract: *Emergency responders are being asked to react to a growing number of violent events and natural disasters as well as evolving threats, such as mass rioting and targeting of response personnel. The aim of this research was to develop modular PPE systems that protect the emergency responders from injury while acting/ operating effectively in hazardous environments and provide the highest level of protection against a range of possible threats. The modular PPE system, built upon a duty uniform, integrates state-of-the-art protective tehnologies; provides basic protection from most likely threats (for example: fire, extremes weather etc.); enhances daily-wear comfort; provide increased localized protection as needed (for example: knees, forearms); includes next-to-skin layer and outer layer to provide varying levels of protection as needed; the modular layers easily donned and undonned. This modular approach: i) provides several advantages, including preserving comfort and flexibility until the intervention mission requires the use of the next level of protection; ii) it is a guarantee that emergency responders are not in a position of choosing between their safety and the effectiveness of the mission; iii) the use of modular layers could be the most cost-effective option, because only certain layers may become damaged or be in need of decontamination following an incident.*

Key words: *protection, safety and health, duty uniform, mission-specific layers, functional design, modular layers.*

1. INTRODUCTION

Emergency responders, due to the specifics of their work, are exposed to a combination of several different risks and there may be several possible consequences for their safety and health. An assessment of the risks specific to emergency response actions revealed the presence of the following types: physical risks (falling objects, ballistic projectiles / fragments, sharp edges and objects, slippery surfaces, excessive vibrations etc.); environmental risks (high heat, humidity, strong wind, insufficient light, excessive noise etc.); chemical risks (inhalation /absorption on the skin, contact with chemicals in liquid/vapor/powder form, ingestion, injection, chemical explosions etc.); biological hazards (pathogens carried/propagated by blood, tuberculosis or airborne pathogens, biological toxins, biogenic allergens etc.); thermal hazards (radiant and convective heat, flame, hot liquids or gases, hot solids or molten substances etc.); electrical hazards (electric shock, electric arc, static charge generation etc.); radiation risks (ionizing radiation - alpha / beta particles, gamma rays, X-rays, non-ionizing radiation etc.) [1], [2]. The relative risk significantly influences the decisions regarding the compromise that must be made between the level of protection, functionality and comfort provided to the emergency responder.

The aim of the project is to provide emergency responders with a modular PPE system built upon a duty uniform that provides limited protection and physiological benefits (for example, moisture wicking) in combination with a series of modular, mission - specific layers, to provide specialized protection.

This modular approach: i) provides several advantages, including preserving comfort and flexibility until the intervention mission requires the use of the next level of protection; ii) it is a guarantee that emergency responders are not in a position of choosing between their safety and the effectiveness of the mission; iii) the use of modular layers could be the most cost-effective option, because only certain layers may become damaged or be in need of decontamination following an incident.

2. EXPERIMENTAL

2.1 Materials

Considering: i) the specifics of the intervention missions: the confrontation with a multitude of known and unknown threats; ii) the capabilities necessary for the health and safety of the emergency responder: ensuring increased protection against threats without wearing specialized equipment and without compromising comfort and maneuverability; iii) the performance requirements imposed by the specific European standards, a solution for the realization of an PPE system intended for use in emergency intervention actions, is a multilayer structure: a) the inner layer, in contact with the skin/Underwear PPE – which covers the sensorial and thermophysiological comfort functions, ensures thermal protection; b) intermediate layer (base): Duty uniform - with the function of barrier against the risk factors with the highest probability of occurrence in case of an intervention action (thermal risks: convection heat, flame; external risks: splashes with liquids; mechanical hazards: cutting, abrasion etc.); c) outer layer: modular protective layers - Specialized PPE for intervention missions in case of: fires, dangerous materials, weapons of mass destruction, firearms, extreme weather conditions etc.

The methodology used for the design and achievement of the modular PPE system for emergency response actions is based on a multidisciplinary approach to the development and management of "complex systems" [3], [4]. Starting from the needs analysis, the key needs of the PPE system were identified, which were the basis for establishing the key performance parameters and the high performance parameters. The established performance parameters were translated into design requirements, based on which the raw materials, the realization technologies, the conception (design) of the PPE system were identified [5].

Starting from the key needs identified: *User Comfort; Certification of protection properties in accordance with the legislation in the field of PPE; Durability for Daily Wear; Usability/Functionality; Aesthetics;Multi-service Applicability; User acceptability; Reasonable cost* and taking into account the performance requirements imposed on the materials, it was decided to use them for manufacturing: *inner layer* (in contact with the skin) - underwear PPE - for a knitted fabric made of yarn 93/5/2% meta-aramid fibres/ para-aramid fibres/antistatic fibers; *intermediate layer (base*) - Duty uniform - for a woven fabric made of yarn 29/59/10/2% aramid fibres/ FR viscose fibres/polyamide fibres/antistatic fibers; *outer layer* - specialized PPE for firefighters - for a combination of materials: a) fabric 78/20/2% para-aramid fibres/ meta-aramid fibres/antistatic fibers (with fire protection role) + b) 3-D spunlace non-woven made of para-aramidic / meta-aramidic fibers + ePTFE / PU-bicomponent membrane (acting as a thermal-moisture barrier) + c) non-woven made of FR viscose fibres/ aramid fibers + viscose FR / aramid / polyamide fiber fabric (with the role of thermal liner); *outer layer* - specialized PPE for intervention missions in extreme weather conditions - for a multilayer textile support laminated in 3 layers: 100% PES fabric + PTFE film + 100% PES knit

2.2 Prototype design

Based on the protection requirements and the minimum required performance parameters specified, the following experimental program was established for the realization of the prototypes of intervention PPE systems in the modular structure.

Table 1*: Experimental program*

Prototype variant of PPE intervention system	Prototype component of PPE intervention system	Constructive variant
Prototype PPE system for intervention in emergency situations Variant V1	*Modular layer 1:* Underwear PPE - inner layer (in contact with the skin)	Suit consisting of a blouse with long/short sleeves and long /short pants
	Modular Layer 2: Duty Uniform -base layer	Suit consisting of blouse and pants
Prototype PPE system for intervention in emergency situations Variant V2	*Modular layer 1:* Underwear PPE - inner layer (in contact with the skin)	Suit consisting of a blouse with long sleeves and long pants
	Modular Layer 2: Duty Uniform - base layer (intermediate)	Suit consisting of blouse and pants
	Modular layer 3: Specialized PPE for firefighters (outer layer)	Outer suit: Jacket and pants Detachable underwear: Jacket + pants
Prototype PPE system for intervention in emergency situations Variant V3	*Modular layer 1*: Underwear PPE - inner layer (in contact with the skin)	Suit consisting of a blouse with long sleeves and long pants
	Modular Layer 2: Duty Uniform - base layer (intermediate)	Suit consisting of blouse and pants
	Modular layer 3: Specialized PPE for interventions in extreme weather conditions (outer layer)	Jacket with detachable hood and lining

The physical realization of the prototypes of PPE systems for intervention in emergency situations was preceded by the virtual realization of these integrated systems, using solutions for digital design of patterns, modeling and 3D simulation of products on a parameterized mannequin, corresponding to size 50 I, using the OptiTex software suite [6].

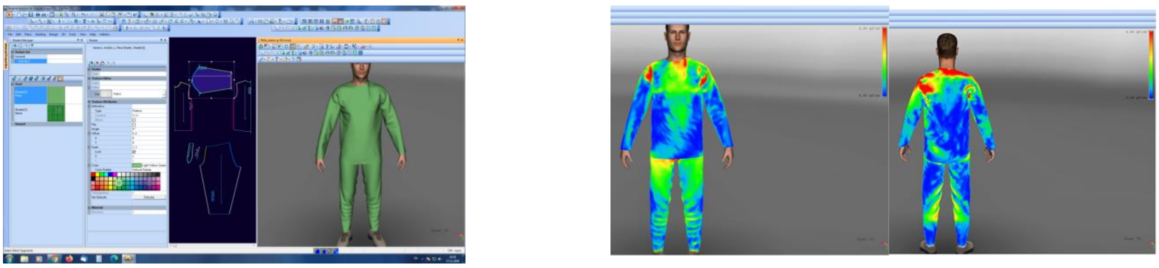


Fig. 1*: Inner layer simulation - underwear PPE: Suit consisting of long-sleeved blouse and long pants*

Fig. 2*: Inner layer simulation – Underwear PPE: Suit consisting of a short-sleeved blouse and shorts*

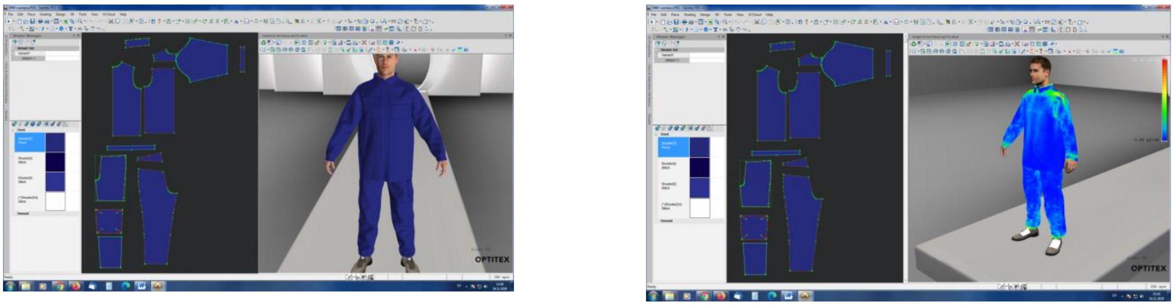


Fig3*: Simulation of the PPE system for intervention in emergency situations that integrates the inner layer (in contact with the skin) - Underwear PPE and the intermediate layer (base) – Duty uniform*

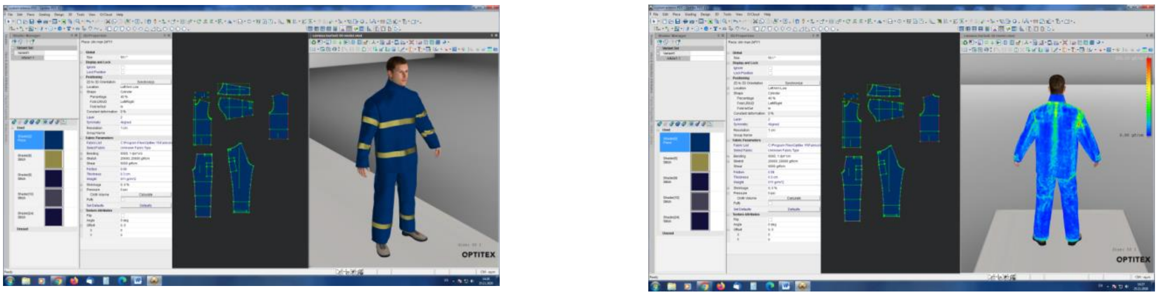


Fig.4*: Simulation of PPE system for intervention in emergency situations that integrates the inner layer (in contact with the skin) - Underwear PPE, intermediate layer (base) – Duty uniform and specialized PPE for firefighters*

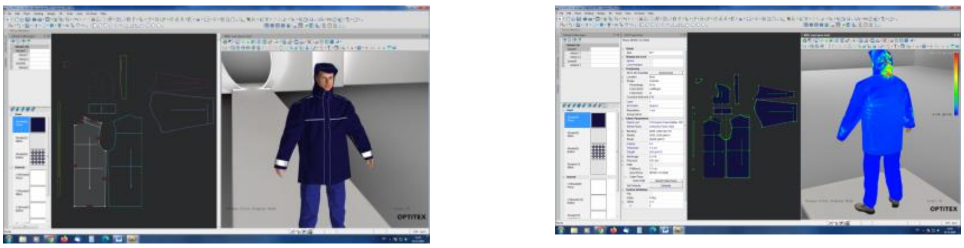


Fig. 5*: Simulation of PPE system for intervention in emergency situations that integrates the inner layer (in contact with the skin) - Underwear PPE, intermediate layer (base) – Duty uniform and specialized PPE for interventions in extreme weather conditions*

Based on the results of the evaluation of the adaptation of the modular layers/integrated systems of modular layers of the intervention PPE on the parameterized virtual manikin (Fig.1, 2, 3, 4, 5), 3 variants of PPE intervention system prototypes were made (Fig. 6, 7, 8), respectively:

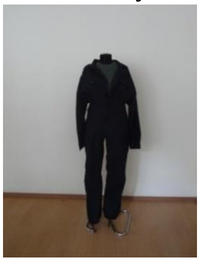
Modular layer 1

Underwear PPE

Modular layer 1

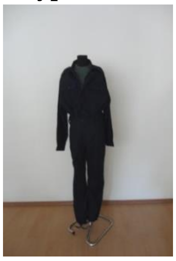
Underwear PPE

Modular layer 2



Duty Uniform

Prototype Variant V1



PPE intervention system prototype

***Fig. 6**: Prototype PPE system for intervention in emergency situations Variant V1*

Modular layer 1

Underwear PPE

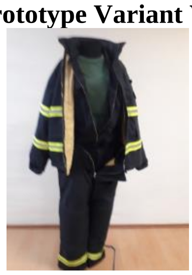
Modular layer 2

Duty Uniform

Modular layer 3

PPE for firefighters

Prototype Variant V2



PPE intervention system prototype

***Fig. 7**: Prototype PPE system for intervention in emergency situations Variant V2*

Modular layer 1

Underwear PPE

Modular layer 2

Duty Uniform

Modular layer 3

PPE for interventions in extreme weather conditions

Prototype Variant V3

PPE intervention system prototype

***Fig. 8:** Prototype PPE system for intervention in emergency situations Variant V3*

3. RESULTS AND DISCUSSIONS

In order to evaluate the performances of the prototypes of PPE intervention systems in the modular structure, the specific laboratory tests performed for the verification of the protection parameters were performed, in accordance with the requirements of the applicable standards, respectively: SR EN ISO 11612:2015- *Protective clothing. Clothing to protect against heat and flame. Minimum performance requirements*; SR EN 469: 2020 - *Protective clothing for firefighters.*

Performance requirements for protective clothing for firefighting activities; SR EN 342: 2018- *Protective clothing. Ensembles and garments for protection against cold*; SR EN 343:2019 - *Protective clothing. Protection against rain*; SR EN ISO 13688: 2013- *Protective clothing - General requirements.*
The performance evaluation highlighted the fact that:

-The PPE intervention system Variant V1 has characteristics according to the specifications of the following standards:

a) SR EN ISO 11612: 2015: point 6.3 (resistance to limited flame spread) - the mean value of afterflame time and afterglow time:0 s, code letter A1 (for knitted fabric of the underwear PPE, respectively for the fabric of the duty uniform); point 6.4 (dimensional change) within the limits imposed, less than ± 3%, in both directions, longitudinally and transversely (for knitted fabric of the underwear PPE) respectively, warp and weft (for the fabric of the duty uniform); point 6.5.1 (tensile strength) above the minimum value imposed, 300 N in warp and weft (for fabric of the duty uniform); point 6.5.2 (tear strength) above the minimum value imposed, 15 N in warp and weft (for fabric of the duty uniform); point 6.5.3 (burst strength) above the minimum required value, 200 kPa (for knitted fabric of the underwear PPE); point 6.9.2 (pH value) within the required limits, greater than 3.5 and less than 9.5 (for knitted fabric of the underwear PPE, respectively for the fabric of the duty uniform);

b) SR EN ISO 13688: 2013: point 4.2 (innocuousness - content of carcinogenic amines) within the imposed limits, undetectable; point 4.3 (design); section 4.4 (comfort).
-The **PPE intervention system Variant V2** has characteristics according to the specifications of the following standards:

a) SR EN ISO 11612: 2015: point 6.3 (resistance to limited flame spread) - the mean value of afterflame time and afterglow time:0 s, code letter A1 (for knitted fabric of the underwear PPE, respectively for the fabric of the duty uniform); point 6.4 (dimensional change) within the limits imposed, less than ± 3%, in both directions, longitudinally and transversely (for knitted fabric of the underwear PPE) respectively, warp and weft (for the fabric of the duty uniform); point 6.5.1 (tensile strength) above the minimum value imposed, 300 N in warp and weft (for fabric, of the duty uniform); point 6.5.2 (tear strength) above the minimum value imposed, 15 N in warp and weft (for fabric of the duty uniform); point 6.5.3 (burst strength) above the minimum required value, 200 kPa (for knitted fabric of the underwear PPE); point 6.9.2 (pH value) within the required limits, greater than 3.5 and less than 9.5 (for knitted fabric of the underwear PPE, respectively for the fabric of the duty uniform);

b) SR EN 469: 2020: point 6.1 (resistance to limited flame spread) - the mean value of afterflame time and afterglow time:0 s, code letter A1 (for specialized PPE for firefighters); point 6.5 (thermal resistance) - dimensional changes after exposure 5 minutes at 180°C, below 5% (for materials made of specialized PPE for firefighters); point 6.6 (tensile strength) above the minimum value imposed for the outer material of the PPE for firefighters, 450 N in warp and weft; point 6.7 (tear strength) above the minimum value imposed for the outer material of the PPE for fighters, 25 N in warp and weft; point 6.8 (surface wetting), above the minimum value imposed for the outer material of the PPE for firefighters, 4 (ISO degree scale); point 6.9 (dimensional change when washing) below the required minimum values, ± 3% (for all materials in the component of the PPE for firefighters); point 6.10 (resistance to penetration of liquid chemicals), rejection rate over 80% for each of the

liquid chemicals mentioned in the standard (for the set of materials in the component of the PPE specialized for firefighters); point 6.11 (resistance to water penetration) over 20 kPa, level 2 performance (for the multilayer assembly with a barrier of moisture of the PPE specialized for firefighters); point 6.12 (water vapor resistance), below 30 m^2Pa/W, performance level 2 (for the set of materials in the component of the PPE specialized for firefighters);
c) SR EN ISO 13688: 2013: point 4.2 (innocuousness - content of carcinogenic amines) within the imposed limits, undetectable; point 4.3 (design); section 4.4 (comfort); point 5 (aging).

-The **PPE intervention system Variant V3** has characteristics according to the specifications of the following standards:

a) SR EN 343:2019: point 4.2 (resistance to water penetration) above the minimum required value, 13000 Pa (for multilayer textile support, material of the specialized PPE - Jacket); point 4.3 (water vapor resistance) below the maximum value imposed, 55 m^2Pa/W (for multilayer textile support, material of the specialized PPE - Jacket); point 4.4 (tensile strength) above the required value, 450 N in warp and weft (for multilayer textile support, material of the specialized PPE- Jacket); point 4.5 (tear strength) above the imposed value, 25 N in warp and weft (for multilayer textile support, material of the specialized PPE - jacket); point 4.6 (dimensional changes) below the required minimum values, ± 3% in both directions of the material of the specialized PPE- Jacket;

b) SR EN 342:2018: point 4.2 (thermal resistance) above the required minimum value, 0.31 m^2K/W (for multilayer textile support, material of specialized PPE-Jacket); point 4.3 (air permeability, AP) within the limit values imposed for performance class 3 (AP <5 mm/s) (for multilayer textile support, material of the specialized PPE- Jacket); point 4.4 (resistance to water penetration) above the minimum value imposed, 13000 Pa (for multilayer textile support, material of the specialized PPE - Jacket); point 4.5 (water vapor resistance) below the maximum value imposed, 55 m^2Pa/W (for multilayer textile support, material of the specialized PPE- Jacket); point. 4.6 (tear strength) above the minimum value imposed, 25 N in warp and weft (for multilayer textile support, material of the specialized PPE - Jacket);

c) SR EN ISO 11612: 2015: point 6.3 (resistance to limited flame spread) - the mean value of afterflame time and afterglow time: 0 s, code letter A1 (for knited fabric of the underwear PPE, respectively for the fabric of the duty uniform); point 6.4 (dimensional change) within the limits imposed, less than ± 3%, in both directions, longitudinally and transversely (for knitted fabric of the underwear PPE) respectively, warp and weft (for the fabric of the duty uniform); point 6.5.1 (tensile strength) above the minimum value imposed, 300 N in warp and weft (for fabric of the duty uniform); point 6.5.2 (tear strength) above the minimum value imposed, 15 N in warp and weft (for fabric of the duty uniform); pt. 6.5.3 (burst strength) above the minimum required value, 200 kPa (for knitted fabric of the underwear PPE); 6.9.2 (pH value) within the required limits, greater than 3.5 and less than 9.5 (for knitted fabric of the underwear PPE, respectively for the fabric, of the duty uniform);
d) SR EN ISO 13688: 2013: point 4.2 (innocuousness - content of carcinogenic amines) within the imposed limits, undetectable; point 4.3 (design); section 4.4 (comfort).

5. CONCLUSIONS

The aim of this research was to develop modular PPE systems that protect the emergency responders from injury while acting/ operating effectively in hazardous environments and provide the highest level of protection against a range of possible threats.

To meet this objective the modular PPE system: integrates state-of-the-art protective tehnologies including flame resistance, water repellency; provides basic protection from most likely threats (for example: fire, extremes weather etc.); enhances daily-wear comfort; provide increased localized protection as needed (for example: knees, forearms); includes next-to-skin layer and outer layer to provide varying levels of protection as needed; the modular layers easily donned and undonned.

The test and evaluation process consisted of objective and subjective testing. The objective laboratory testing quantitavely determined if a fabric could meet the minimum performance requirements. The testing objective consist of material testing and sistem level testing. However, laboratory data cannot accuaratelly assess the operational suitability and effectiveness of a PPE system when used under operational conditions. Critical attributes, such as comfort, appearance, durability, freedom and range of motion, coult not be fully evaluated under laboratory conditions. That is why this research will continue with the Wear Trial of the PPE system under operational conditions. This subjective evaluation will be essential to differentiating the performance of the modular layers integrated into the PPE system prototypes

ACKNOWLEDGEMENTS

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LEATHER AND WOOL BYPRODUCTS PROCESSING FOR BIOACTIVE ADDITIVES

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Abstract: *The leather industry byproducts and coarse wool are valuable bioresources, rich in bioactive proteins, but which are not fully exploited and represent a source of environmental pollution. The biomaterials based on native collagen and keratin are made using sophisticated methods of extraction, synthetic polymers, and organic solvents with toxic potential. The paper presents two methods for collagen gelatin extraction from rabbit skin and bovine pelt, and for keratin solubilization and enzymatic refinery, which were proved to be suitable for the fabrication of new collagen nanofibers and porous keratin powders compatible with wound healing formulations in dressing, creams or gel forms. The neutral and chemical-enzymatic-based technologies for bioactive protein extraction and refinery are presented as alternatives to more expensive and sophisticated methods for native collagen and keratin hydrogels used in making wound healing biomaterials. Bioactive collagen nanofibers and keratin powders for new wound-healing formulations and dressings were successfully obtained. The collagen extracts were found to have good properties for nanofiber fabrication, rabbit collagen showing exceptional characteristics and a high Bloom value. The use of collagen extracts, soluble in ecological solvents with spinnable properties from leather industry byproducts, as well as the preparation of keratin hydrolysate powders from wool waste represents an efficient approach for the capitalization of biomass and the development of new biomaterials with low toxic potential.*

Key words: *collagen, keratin, bioactive proteins, nanofibers, keratin powder, biomaterials.*

1. INTRODUCTION

Protein-based byproducts are rich and not fully exploited resources with high potential to replace synthetic polymers in manufacturing biomaterials for medical applications [1,2].

The paper presents the potential for extraction and refinery of collagen gelatins and keratin hydrolysates from leather industry byproducts or from coarse wool generated in zootechnics.

The neutral and chemical-enzymatic-based technologies for bioactive protein extraction and refinery are presented as alternatives to more expensive and sophisticated methods for native collagen and keratin hydrogels used in making wound healing biomaterials [3]. Bioactive collagen nanofibers and keratin powders for new wound-healing formulations and dressings were successfully obtained. The use of collagen extracts, soluble in ecological solvents with spinnable properties from leather industry byproducts as well as the preparation of keratin hydrolysate powders from wool waste represents an efficient approach for the capitalization of biomass and the development of new biomaterials with low toxic potential.

2. EXPERIMENTAL

2.1 Materials and methods

2.1.1 Materials

The raw materials were purchased from rabbit and sheep breeders. Chemical reagents like sodium carbonate, ammonium solution, sodium hydroxide, and acetic acid were analytical grade and other chemical materials were technical grade: sodium chloride, detergents, sulphuric acid, or formic acid. Valkerase, a keratinase with optimal activity at pH=5.5 and 55°C, was supplied by BioResource International.

2.1.2 Methods

The methods for spinnable collagen and bioactive keratin extraction and refinery are presented in Figures 1 and 2. Rabbit skins or bovine hides were pre-processed by soaking, unhairing and liming, washing deliming, bating, and degreasing. Rabbit skin in pelt or pickled state was processed following the scheme presented in Figure 1 a. Bovine pelt was processed following the same scheme. The scheme for keratin hydrolysate solubilization from sheep wool and refinery for bioactive wound-healing formulations is presented in Figure 1 b.

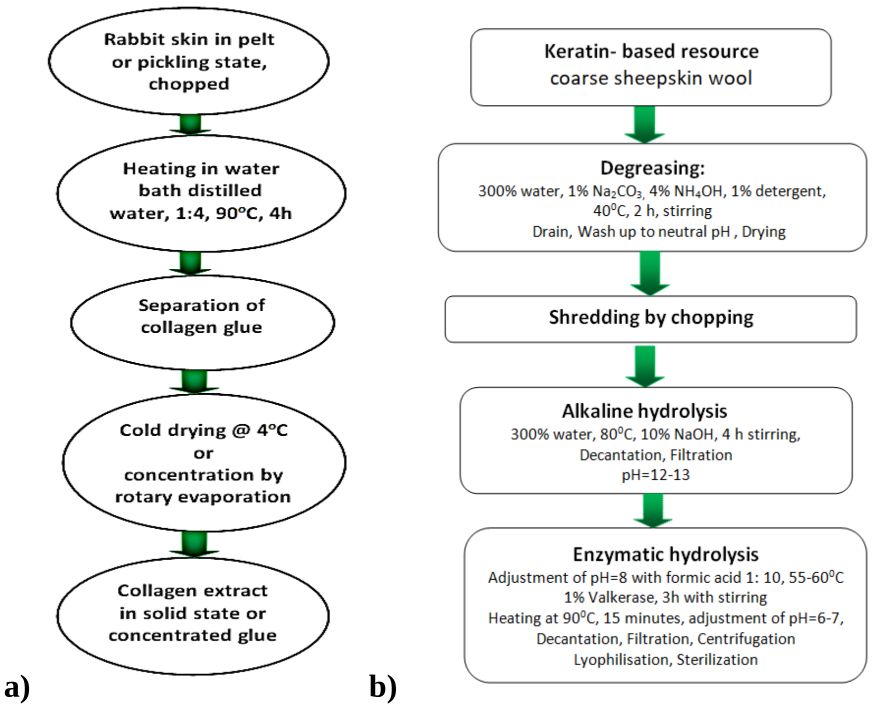

Fig.1: *Technology flowcharts of a) collagen and b) keratin extraction and refinery from leather byproducts or coarse wool*

The main characteristics of the protein extracts prepared from leather and wool byproducts were assessed in view of identifying the main properties of spinnable products and bioactive keratins for new biomaterial formulations. In this sense, the following characteristics were determined: dry substance (SR EN ISO 4684:2007), ash (SR EN ISO 4047:2002), total nitrogen and protein content (SR ISO 5397:1996), pH (STAS 8619/3:1990), viscosity (DV2T™, Brookfield), average particle size, polydispersity, conductivity and Zeta potential of 0.3% filtered solutions through 0.45µm filter (Zetasizer Nano ZS), Bloom test (TEX'AN TOUCH 50N texture analyzer). In order to test new protein extracts for biomaterials formulations, electrospinning mats were fabricated using acetic acid as a solvent for collagen extracts and alginate-polyacrylate gel base for keratin powder integration.

3. RESULTS

The collagen extracts were found to have good properties for nanofiber fabrication, rabbit collagen showing exceptional characteristics due to the known composition of C-terminal region with longer α1 chains due to alanine and arginine amino acids [4] and preservation of subunits like ß (dimer of α-chain), and Υ (trimer of α-chain) in gelatin state [5]. In Table 1 can be seen that the Bloom test is exceptionally high [6] for rabbit collagen as compared to bovine collagen and this made rabbit collagen more suitable for nanofiber spinning as compared to bovine collagen with a lower Bloom test value. The other characteristics like particle size, stability, polydispersity or conductivity showed to be less important as compared to bloom test value for nanofiber preparation by using only nontoxic solvents like acetic acid. Keratin powder with porous morphology was prepared and showed good compatibility for wound dressing formulations in gel forms.

***Table 1:** Physical-chemical characteristics of collagen and keratin extracts for biomedical applications*

Characterization	Rabbit collagen	Bovine collagen	Keratin powder
Dry substance, %	6.21±0.35	7.69±0.35	95.54±0.35
Ash, %	0.81±0.24	7.67±0.24	15.07±0.24
Total nitrogen, %	15.78±0.34	12.87±0.34	11.07±0.34
Protein content, %	98.63±0.34	72.35±0.34	69.99±0.34
pH, pH units	6.1±0.10	6.3±0.10	6.85±0.10
Conductivity, mS/cm	0.128	2.05	0.969
Viscosity, cP	64,080	54,500	-
Particle size, average nm	321.9	284.9	394.9
Zeta potential, mV	-12.40	-9.77	-23.5
Polydispersity	0.851	0.411	0.604
Bloom test, g	657.4	215.3	-

Collagen gelatins processed from rabbit skin or bovine hide byproducts according to the scheme presented in Fig. 1a were tested for nanofibers manufacture by electrospinning (Fig. 2 a,c), confirming that the chosen extraction method was appropriate. Collagen nanofibers were successfully prepared by electrospinning in order to manufacture new wound healing patches as can be seen in Fig.1 d.

Keratin hydrolysate was solubilized from coarse sheep wool preliminary degreased, chopped and alkaline hydrolyzed, followed by the enzymatic refinery, centrifugation lyophilization (Fig.2b) and sterilization, according to the scheme presented in Fig. 1b. Keratin hydrolysate in lyophilized powder was compatible with different components used for designing new wound healing cream and gel formulations (Fig.1 e,f) proving that the extraction and refinery methods were suitable for the research aim.

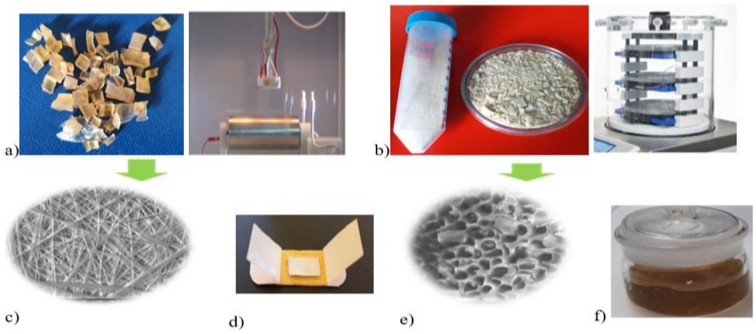

Fig.1 Images of a, c,d) collagen gelatin from rabbit skin processed by electrospinning in view of wound healing patches manufacturing and b,e,f) lyophilized keratin processed as a porous powder in view of new wound-healing creams or gels fabrication.

4. CONCLUSIONS

Collagen gelatins were extracted from rabbit skin and bovine pelts and showed spinnable properties in the acetic acid solvent which represents a safer alternative for organic solvents and more expensive native collagen use. Keratin hydrolysate was solubilized by alkaline hydrolyses and refined by enzymatic molecule tailoring and conditioned by lyophilization in porous powder form which showed good compatibility in wound-healing gel formulations. The research is in progress for in vitro and in vivo testing of new bioactive additives in new wound-healing dressings.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

COLOR AND PHYSICAL PROPERTIES OF LEATHER VIA EXTREME OZONE BLEACHING APPLICATIONS

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Abstract: *Bleaching is a good way for the preparation of fiber based products to remove the colored impurities. However, conventional bleaching processes pollute the water with chemical components and suspended solid particles. Ecological concerns have prompted to search for new solutions to reduce the environmental pollution. This work aims to cleaner bleach the skin surface problems and color with ozonation process and to examine the possible physical and chemical effects on leather products under heavy process applications. In this perpective, decolorization procedure was carried out on the leathers having dyeing spots by different bleaching time of the ozonation process. The effect of ozonation time (45, 60 and 90 min) and water pick-up value (WPV) (0% and 50%) were investigated for decolorization effect on dyed leather products. After decolorizing procedure, color difference and K/S (color strength) values on leathers was spectrophotometrically measured by Konica Minolta CM-3600d testing apparatus. Extreme ozone bleaching under long proess duration was examined in terms of the strength properties of leather. Structural changes were also determined via Cr(VI) analysis after ozonation process. 90 min ozonation application provided the best bleach with 0% WPV and 50% WPV, on the other hand, 90 min as the heaviest ozone bleach condition negatively affected the physical properties of leather.*

Key words: Leather, ozone, bleaching, physical properties.

1. INTRODUCTION

Tanning and dyeing processes in leather production steps; they are processes that are sensitively emphasized in terms of economic, ecological and engineering applications. Tanning agents penetrate into the collagen fibers of the skin, form bonds with the active groups of amino acids, and increase the hydrothermal stability of the proteinic structure. In order for the tanning process to be carried out effectively, the tanning agent must be able to penetrate the three-dimensional fiber structure of the leather at the highest rate and react with collagen. Tanning processes that are not carried out under suitable conditions result in serious surface defects. Considering that approximately 90% of the leathers produced in the world today are tanned with chrome, chromium surface stains which are frequently encountered are an important issue that should be emphasized and resolved. [1-3].

Stained surface appearance in leather products can be also occured because of the defects in dyeing process. Fast fixation, insoluble dyestuffs, inaccurate temperature of the dyeing float and pH adjustment for neutralization can cause the undesirable impurities on leather surface. Thus, homogeneity in color is destroyed. Therefore, bleaching is required for the preparation of fiber based products to remove the colored impurities [4,5].

Various stains that occur in leather production cause companies to have problems in fixing the color on the finished leather and as a result, cause significant economic losses. In the industry, an intensive application is made in the finishing process for such leathers, and discolorations are tried to be covered. However, at the end of this intense finishing application, the leather loses its natural appearance and at the same time its attitude. This causes a decrease in the economic value of leathers. At the same time, these finishing processes applied to cover color errors are reflected as an extra cost to the companies and are not seen as a practical solution [6].

Bleaching is a good way for the preparation of fiber based products to remove the colored impurities. Besides the production of fiber-based products, the bleaching process has great importance to achieve white leather products. However, conventional bleaching processes pollute the water with chemical components and suspended solid particles. Ecological concerns have prompted to search for new solutions to reduce the environmental pollution. For this purpose, much effort has been made to achieve more environmentally friendly production processes [7,8].

Ozone application was successfully implemented in various attempts for leather processes in recent years [8,9]. This work aimed to bleach the skin surface problems and color with heavy ozonation process and to examine the possible physical and chemical effects on leather products.

2. EXPERIMENTAL PART

2.1. Materials

As a leather material, chrome tanned and black dyed domestic sheepskins were used before the finishing process. All used chemicals in this study were of laboratory commercial grade.

2.2. Ozonation process

The equipment used for ozonation has three components; the ozone generator, the applicator, and the ozone destroyer. The system is fully closed because of the harmful effects of ozone on health. The laboratory-scale ozonator (Lundell Aquametrics, Inc.) with 180 mg/h capacity was used in experiments. Oxygen is supplied to the generator from an oxygen tube and the flow rate of ozone was set at 3 L/min. The applicator is a cylindrical glass tube with a diffuser at the bottom. The dimension of the applicator is 12 cm in diameter and 15 cm in height.

The effect of the treatment time during ozonation was researched. Treatment times were set at 45, 60 and 90 min, respectively. During these experiments, firstly, the leather samples were in dry form without any additional soaking process to increase the moisture content (0% WPV). Second, the effect of moisture content in leathers described as WPV% on the decolorization efficiency was investigated. To this end, the samples were soaked in water at pH7; after that, the WPV of the samples was set at 50% with squeezing rollers and drying oven.

2.3. Colorimetric measurements

The color coordinates of control and operated samples with ozonation were measured on a Konica Minolta CM-3600d Spectrophotometer from 360-700 nm under a D65/10^{o} illuminant (D65 illuminant, specular included, 10^{o} observer angle). The percent reflectance values (at λ_{max}=400 nm) were recorded and color strength values (*K/S*) were calculated according to Kubelka-Munk formula (Eq. (1)), which is shown below.

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

where K is the scattering coefficient, S is the absorption coefficient, R is the reflectance.
where, R is the decimal fraction of the reflectance of dyed fiber.
where R=1.0 at 100% reflectance.

Spectrophotometric data for control and operated leather samples were used for color difference calculations. Color difference values were obtained according to the CIELAB (1976) equation [10] as follow (Eq. (2)):

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2} \quad (2)$$

The colors are given in CIEL**a***b**;

Coordinates: L^*corresponding to the brightness (100 = white, 0 = black), a^* to the red-green coordinate (+ = red, - = green) and b^* to the yellow-blue coordinate (+ = yellow, - = blue).

2.4. Strength analyses of final products

Prior to the analyses all finished leathers were conditioned according to the standard of EN ISO 2419 [11] and sampling was done in accordance with the standard of EN ISO 2418 [12]. The final products were subjected to the tests of tensile and tear strength. Shimadzu AG-IS testing device was used for all analyses. Thickness measurement of the samples was performed in accordance with EN ISO 2589 [13], tensile strength with EN ISO 3376 [14] and tear load with EN ISO 3377-2 [15].

2.5. Chromium(VI) analysis

Chromium(VI) analysis in leather samples was performed in triplicate according to IUC 18 (EN ISO 17075 2007) [16] standard before and after ozonation applications. This analytical method is based on the reaction of chromium(VI) with diphenylcarbazide and subsequent colorimetric determination at 540 nm by using a double-beam Shimadzu 1601 UV-Visible region spectrophotometer.

2.6. Statistical analyses

The results were evaluated statistically by using One-Way ANOVA, descriptive statistical and Duncan tests at SPSS 15.0 statistical software package. All data were represented as mean for three independent measurements. Comparison of means was analyzed by Duncan test and differences were considered as significant when $p<0.05$.

3. RESULTS AND DISCUSSION

Utilizing ozone for bleaching processes is used a means of decreasing the environmental impact. Ozone (O_3) has an oxidation potential of 2.07 eV, which is higher than that of the widely used bleaching agent, hydrogen peroxide (1.77 eV). Ozone is available as molecular ozone at acidic pH. It decomposes into secondary oxidants in alkaline pH. Ozone has been successfully used for color removal from textile and leather industry effluents [17,18]. Ozone has also been successfully applied for cotton, jute, linen, wool, angora, denim, soybean, nettle fiber bleaching in recent years [19-24]. However, there is an only literature for decolorization of leather products by ozone application [8].

Ozone can effectively decolorize the dye by breaking the conjugated double (–N = N–) bonds. Ozone cleaves the unsaturated bonds in aromatic molecules found in humic substances, the chromophores of the dyes and other pigmented compounds, thereby reducing the color. The mechanism of the reaction of ozone follows two main pathways, a direct path corresponding to the action of molecular ozone and an indirect path corresponding to the action of free radicals species resulting from the decomposition of ozone in water [18].

Onem et al. (2017) [8] indicated the effectiveness of ozonation process on leathers. 30 min ozonation application provided the best whiteness on the leathers. There was no any structural deformation and strength lose for the ozonated leathers after 30 min duration. This study aimed to examine extreme ozonation conditions for decolorizing effect and physical properties of leather. Table 1 shows the color values of the leather samples before and after ozonation process for 0% WPV application.

Table 1: *Color values of the leather samples before and after ozonation process for 0% WPV*

Ozonation time	**Color values**			
	L	*a**	*b**	*ΔE*
Control sample	24.11±0.39	1.76±0.3	3.31±0.21	-
45 min	32.50±0.41	0.02±0.17	3.71±0.28	8.58
60 min	37.12±0.12	0.67±0.08	6.21±0.19	13.37
90 min	41.16±0.21	1.92±0.18	3.51±0.19	17.05

Table 1 provides the increased *ΔE* values with increased ozonation duration. 17.05 of *ΔE* value was obtained compared to the control leather sample. Higher *L* values also indicate the more whiteness of leathers. Table 2 shows the color values of leather samples before and after ozonation process for 50% WPV application.

Table 2: *Color values of the leather samples before and after ozonation process for 50% WPV*

Ozonation time	**Color values**			
	L	*a**	*b**	*ΔE*
Control sample	24.11±0.39	1.76±0.3	3.31±0.21	-
45 min	36.11±0.36	1.55±0.17	8.21±0.25	12.96
60 min	42.00±0.42	2.0±0.21	11.71±0.21	19.77
90 min	49.81±0.51	4.63±0.37	16.31±0.39	28.94

Table 2 also proved the higher *ΔE* values when ozonation duration was long. 90 min ozonation application gave the highest *L* value and *ΔE* value. Moreover, 90 min ozonation process with 50% WPV gave the better results than 0%WPV according to the whiteness degree of leathers. *L* value came from 24.11 before ozonation to the 49.81 after bleaching process. *ΔE* was 28.94 with 90 min application under 50%WPV.

Fig. 1 demonstrates the color strength (*K/S*) values of ozonated leather samples with 0% and 50% WPVs. Low *K/S* value defines more whiteness properties of leathers. That means better bleashing process by ozonation.

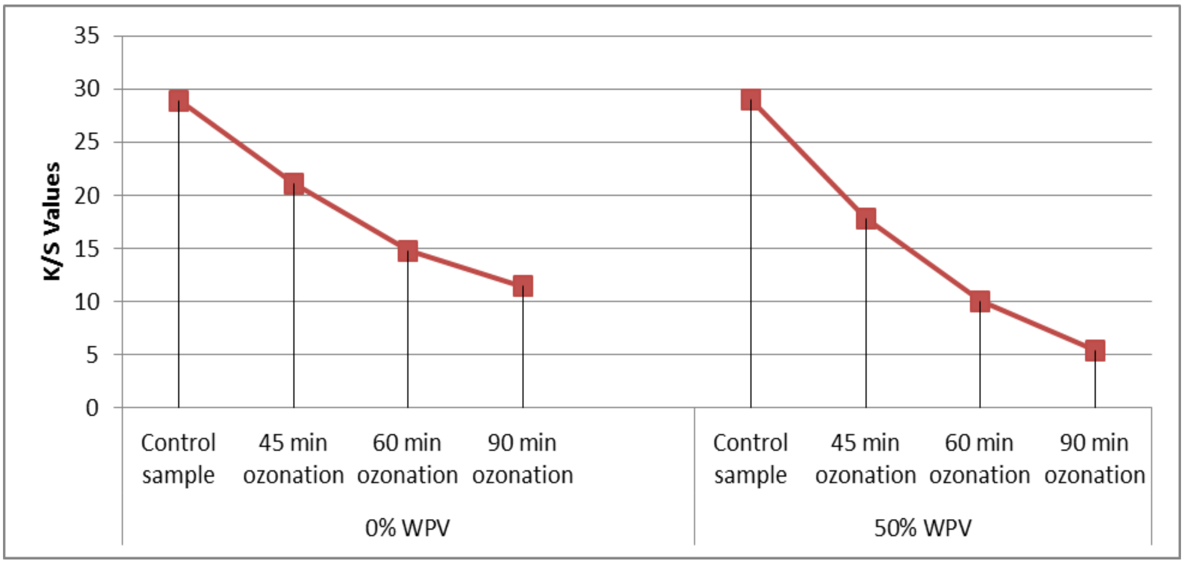

Fig. 1. *Color strength (K/S) values of ozonated leather samples with 0% and 50% WPVs*

90 min ozonation application under 50% WPV showed the closest whiteness value in Fig. 1 as well. Color strength of leather before ozonation was 28.97 with *K/S* indicator. The closest whiteness after bleaching was obtained as 5.42 via the heaviest ozonation application.

Table 3 and Table 4 show the physical strength properties of leathers before and after ozonation under 0% and 50% WPVs.

Table 3: *Strength test results of the untreated and ozonated leather samples under 0% WPV*

Process	Tensile strength	Tear strength
Before bleach	10.16±2.12[a]	35.02±3.23[a]
45 min ozonation	9.95±2.13[a]	32.91±3.16[a]
60 min ozonation	9.57±0.88[a]	32.14±4.09[a]
90 min ozonation	9.12±1.91[b]	30.11±1.77[b]

a, b; values in the same column with different superscript letters are significantly different ($p<0.05$).

Table 4: *Strength test results of the untreated and ozonated leather samples under 50% WPV*

Process	Tensile strength	Tear strength
Before bleach	10.16±2.12[a]	35.02±3.23[a]
45 min ozonation	9.89±2.12[a]	32.90±3.16[a]
60 min ozonation	9.61±0.99[a]	31.99±4.07[a]
90 min ozonation	9.01±1.79[b]	30.12±3.87[b]

a, b; values in the same column with different superscript letters are significantly different ($p<0.05$).

Table 3 and Table 4 proved the decreased strength values with the increased ozonation time. 0% WPV and 50% WPV gave the similar results and correlations. Only 90 min ozonation duration negatively affected the strength properties of leathers statistically. Decreases after 90 min bleaching process were important levels when $p<0.05$ for both dry samples and wet samples. Each ozonation type and duration decreased the physical properties, but they were negligible except of the longest time as the heaviest process.

Essentially 90% of leather products are tanned by chromium salts in the worldwide because of the indispensable features of the given properties of chromium salts for leather products. Conventional bleaching was not applied to leather in this study because conventional oxidative bleaching agents have a big potential to convert Cr(III) in leather to Cr(VI) by oxidation [25-27]. The formation of such materials in leather may cause leather products, such as garment, upholstery and shoe lining, having direct contact with the human body to affect human health seriously. Cr(VI) formation in leathers was also analyzed in our study before and after ozonation applications in case any oxidation formation. The results showed that Cr(VI) contents of the leathers were under 3 ppm. Leathers with this value are in safe because international regulations reported that Cr(VI) content should be under 3 ppm to avoid the ecological risks for the leather goods [25-27]. This result also proved the safe bleaching process and safe product as the environmentally friendly decolorization method.

Moreover, conventional bleaching processes pollute the water with chemical components and suspended solid particles. Ecological concerns have prompted to search new solutions to reduce the environmental pollution in leather industry and sustainable ways are being discovered especially in the recent years. That's why environmentally friendly and safe decolorization processes for leather products are needed. Ozonation of leather products is a great opportunity to remove the chromium and dyeing defects from the surface. In that aspect, the ozonation method is more novel for the leather indutry compared to textile industry, because conventional methods are highly risky on leather products.

Acknowledgements

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4. CONCLUSIONS

Defected leathers having impurities on the surface are poor in terms of the aesthetics and resulted with low prices in sales for the companies. This situation pushes the companies to find the new and innovative solutions. Therefore, such surface defects should be prevented before finishing with the effective ways. These effective ways should also be environmentally friendly in terms of the strict stipulations by the leather industry players and important organizations. Green solutions are being more important day by day. European Green Deal should be taken into consideration for many industrial applications.

Ozonation to decolorize leather products was investigated as a novel bleaching method via this research under respectively heavier conditions compared to the previous literatures carried out for leather products. Leather products were successfully decolorized by ozonation with different durations under increased process time and water pick-up conditions. The water pick-up value of leather samples was found as important parameter in terms of the achieved decolorization effect. The occurred strength loss after prolonged ozonation times was negligible except of the 90 min applications. There was also no problem for the Cr(VI) formation by ozone bleaching process. This study showed the usability, benefits and small disadvantages of ozonation to decolorize the leather products. Studies on an industrial scale should be performed related to the application of ozonation for the leather sector in terms of the cleaner processing ways.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

THE INFLUENCE OF NOVEL TENSIDIC "ARCHETYPES" ON COLLAGEN BYPRODUCT FOR AGRICULTURE APPLICATIONS

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Abstract: *The European Biostimulants Industry Council defines biostimulators as a class of compounds that include substances or microorganisms which have a positive impact on plant growth, yield and chemical composition, as well as on the growth of effects on tolerance to biotic and abiotic stress. Gelatin was proven to enhance plant growth due to better transport of amino acids in plants when is used as a root biostimulant. Tomato plants treated with protein hydrosysates had a higher content of ascorbic acid, lycopene, total polyphenols and higher lipophilic antioxidant activity than the control samples treated with water. Bolaamphiphiles and gemini are new classes of amphiphilic surfactants, with different applications due to their high ability to deliver active substances and capacity to emulsify the mezzo nutrients and microelements in gelatin.*
The aim of the paper is to develop new structured emulsions and study the influence of novel tensidic "archetypes" like layered networks, based surfactants (bolaform, gemini) on collagen gelatin with mezzo and micronutrients, for agriculture applications. In our research we have elaborated a method for including mezzo and microelements in collagen gelatin, obtaining novel stable structured emulsions, with the final purpose of application as a new class of root fertilizers in agriculture. The new multiple structured emulsions are original due to the successful inclusion of surfactants/mezzo and microelements/collagen gelatin, with high potential for biostimulation and nutrition of tomato plants.

Key words: *"archetypes" like layered networks, collagen byproduct, tomato plants biostimulation and nutrition in agriculture*

1. INTRODUCTION

The European Biostimulants Industry Council defines biostimulators as a class of compounds that include substances or microorganisms which have a positive impact on plant growth, yield and chemical composition, as well as on the growth of effects on tolerance to biotic and abiotic stress [1].

Gelatin was proven to enhance plant growth due to better transport of amino acids in plants when is used as a root biostimulant [2]. Tomato plants treated with protein hydrosysates had a higher content of acid acorbic, lycopene, total polyphenols and higher lipophilic antioxidant activity than the control samples treated with water [3,4].

Due to properties of the surfactants such as biodegradability, nontoxicity, and adherence to surfaces, they may be successfully used in the processing of collagen byproducts destined for agriculture, in the improvement of surface properties.

The aim of the paper is to create new structured emulsions and study the influence of novel *tensidic "archetypes" like layered networks,* based on surfactants (bolaform, gemini) on collagen gelatin and mezzo and micronutrients [5-7]. The preparation of new structured emulsions was based on optimization of the main parameters system: composition, emulsifiers, and temperature, in a two-stage process. This research elaborated a new method for including mezzo and microelements in collagen gelatin obtaining novel stable structured emulsions, with application in agriculture for biostimulation and nutrition tomato plants.

2. METHOD FOR OBTAINING STRUCTURED EMULSIONS

The collagen gelatin was obtained from bovine delimed hide by acid hydrolysis at 80°C for four hours. Dried bovine gelatin was mixed with a solution containing mezzo and microelements. Physico-chemical characterizations of bovine gelatin were performed according to the standard in force or literature methods for dry substances, ash, total nitrogen and protein content, aminic nitrogen, pH, contact angle, dynamic light scattering measurements, bloom test, and viscosity.

The samples with gemini and bola were prepared by dropping a 4% solution of surfactants under continuous stirring into a solution containing 2% nonylphenol ethoxylate and 10% bovine gelatine at 60°C. Several experiments were performed with different concentrations of gelatin. The sample containing 10% gelatin proved to be the most stable. Physical-chemical characterization of bovine gelatine is presented in Table 1.

Table 1. *Physical- chemical characterization of bovine gelatine with mezzo and microelements*

Characterization	Bovine gelatine with mezzo and microelements	
Dry substance, %	23.60	
Total ash, %	7.78	
Total nitrogen, %	2.15	
Protein substance, %	12.08	
pH, pH units	6.77	
Bloom, g	248.9	
Viscosity, cPs	3450	

The samples were labeled as follows: **1**-collagen gelatin with mezzo and microelements*;* **4**-collagen gelatin with mezzo and microelements+surfactant Gemini*;* **5**-collagen gelatin with mezzo and microelements +surfactant Bola (fig.1) and **2**-surfactant Gemini; **3**-tenside Bola.

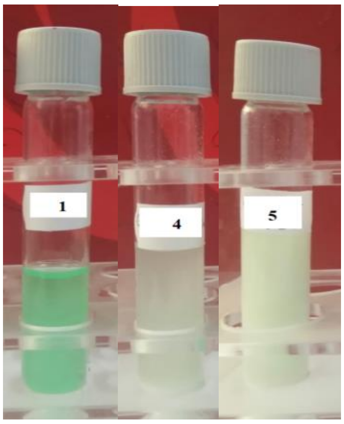

***Fig. 1**: The images of **1**-collagen gelatin with mezzo and microelements; **4**-collagen gelatin with mezzo and microelements +surfactant Gemini; **5**- collagen gelatin with mezzo and microelements +surfactant Bola*

3. RESULTS AND DISSCUTION

Characteristics of nano-structured emulsions were obtained by: optical microscopy analyses, DLS, contact angle and microbiologically tests.

Optical microscopy analyses

The optical microscopy images from Figure 2 (e) show that the emulsion **sample 5- with Bola** *is structured like a layered network* due to the influence of *novel tensidic "archetypes"*.

All emulsions made with Gemini and Bola surfactants are oriented and agglomerated in new archetypes. The results are in agreement with literature data [5-7] related to the formation of chain structures in multiple water-oil-water emulsions.

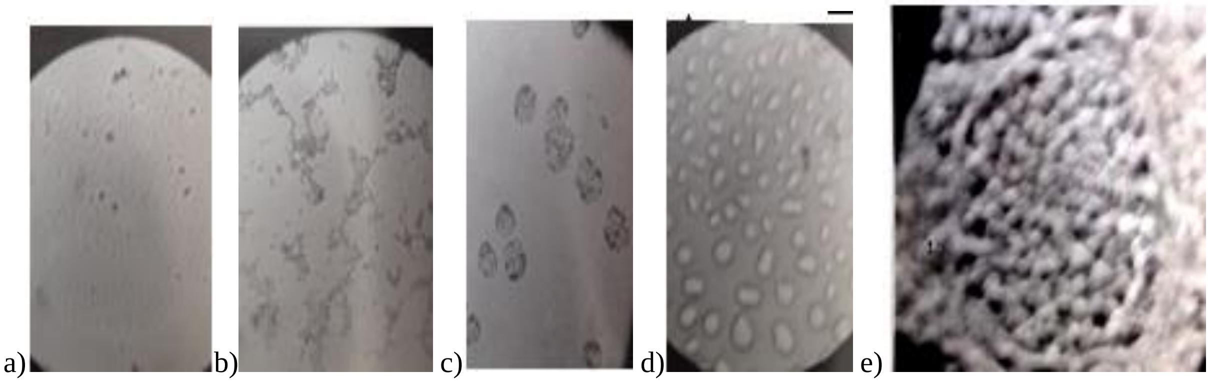

***Fig.2** : Optical microscopy images (1000x) for samples: a)**4**- mezzo and microelements; b)**2**-Gemini surfactant; c)**3**-Bola surfactant; d)**4**-collagen gelatin with mezzo and microelements +surfactant Gemini; e)**5**- collagen gelatin with mezzo and microelements +surfactant Bola*

Dynamic light scattering (DLS)

The average particle sizes of new network emulsions showed increased dimensions as compared to the collagen-mezzo-microelements mixture (697.9-613.9 nm and 304.3 nm, respectively), confirming the formation of the complex aggregates.

The highest average particle size of Gemini emulsion (Fig.3a) showed also the highest Zeta potential absolute value and improved stability as compared to bola emulsion and collagen-mezzo-microelements (Fig.3b).

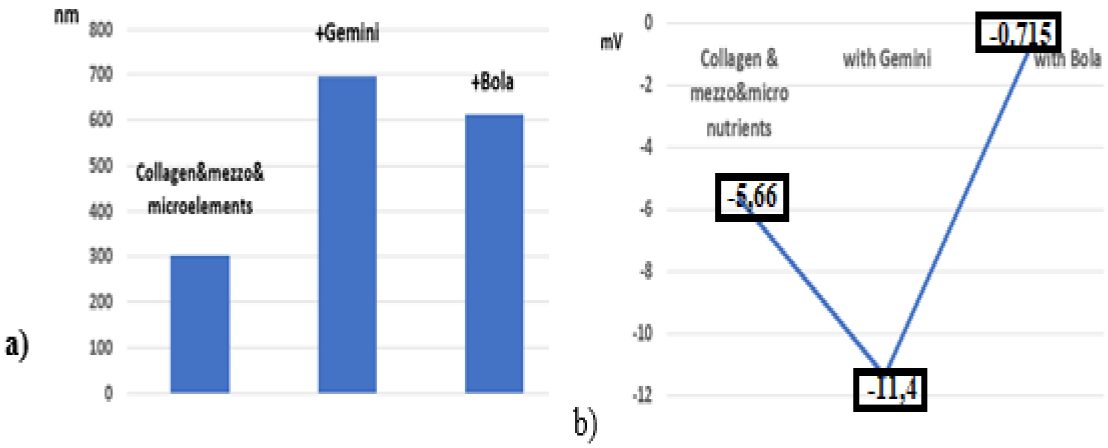

Fig. 3 *a) The average particle size and b) Zeta potential of new emulsions as compared to collagen gelatin with mezzo and micronutrients*

Contact angle

The contact angle measurements were made with a DataPhysics OCA 25 contact angle system. In Figure 4 it can be observed that Bola surfactant is the most hydrophilic and the sample obtained with this surfactant is more hydrophilic than the sample without surfactant and the sample obtained with Gemini surfactant.

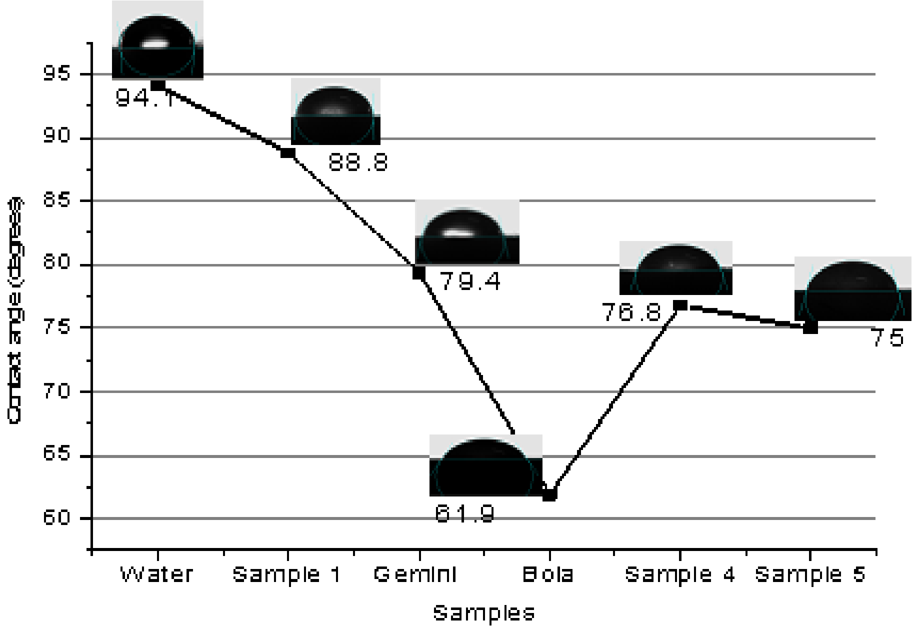

Fig. 4*: The contact angle measurements results for samples* ***1****- collagen gelatin with mezzo and microelements,* ***4****- collagen with mezzo and microelements +surfactant Gemini,* ***5****- collagen with mezzo and microelements +surfactant Bola as compared to water,* ***2****-Gemini and* ***3****-Bola surfactants on a teflon surface*

Microbiologically tests

The stock cultures of microbian inoculums of *Fusarium spp ATCC 36031*, *Penicilium spp*, *Aspergillus niger ATCC 16404*, *Botrytis cinerea* were grown in Czapek-Dox nutritive medium, at 28ºC for 14 days. Two decimal dilutions of paraffin oil (10:2) were made from each culture and the cell concentration in the inoculum used was $9.8x10^3$ CFU / mL (Colony Forming Units) for *Aspergillus niger*, $8.92x10^3$ CFU / mL for *Fusarium spp*., 9.5×10^3 CFU / mL for *Penicilium spp*., and $9.3x10^3$ CFU / mL for *Botrytis cinerea*. The experiments were performed in Eppendorf tubes, previously sterilized at 121ºC for 15 minutes. The microbial inoculum was mixed with the sample, both the microbial inoculum and the sample having constant volumes of 500 µL. All samples were tested in duplicate, and the results were expressed as a mean percentage and logarithmic reduction between the readings on the two Petri dishes corresponding to each sample (Table 2).

From Table 2 can be seen that Gemini and Bola surfactants had excellent antifungal resistance as well as collagen-mezzo-microelements that showed antifungal properties between 99.38% and 99.97%. Gemini surfactant had a positive influence on antifungal resistance of collagen-mezzo-microelements mixture for all tested strains, meanwhile, Bola surfactant showed slightly decreased antimicrobial resistance in collagen-mezzo-microelements-bola emulsions.

Table 2. *Antimicrobial resistance of new emulsions against fungus species*

Sample	Result, UFC/mL	R%	Log_{10} red.	Sample	Result, UFC/mL	R%	Log_{10} red.
Aspergillus niger Inoculum concentration	T_0=9,8x10^3	-	-	***Botrytis cinerea*** Inoculum concentration	T_0=9.3x10^3	-	-
1- Collagen-mezzo-microelements	T_{24}=3.4x10	99.65	2.46	1- Collagen-mezzo-microelements	T_{24}=4.2x10	99.55	2.35
3 - Bola	T_{24}=0	100	4	3 - Bola	T_{24}=2	99.98	3.67
5 - collagen-mezzo-microelements +Bola	T_{24}=2,18x10^2	97.78	1.44	5 - collagen-mezzo-microelements +Bola	T_{24}=1.98x10^2	97.87	1.67
2- Gemini	T_{24}=0	100	4	2- Gemini	T_{24}=1	99.99	3.97
4 - Collagen-mezzo-microelements + Gemini	T_{24}=0	100	**4**	4 - Collagen-mezzo-microelements + Gemini	T_{24}=2	99.90	**3.67**
Fusarium spp Inoculum concentration	T_0=8.92x10^3			***Penicilium spp.*** Inoculum concentration	T_0=9.5 x10^3	-	-
1- Collagen-mezzo-microelements	T_{24}=5.5x10	99.38	2.21	1- Collagen-mezzo-microelements	T_{24}=3	99.97	3.50
3 - Bola	T_{24}=0	100	4	3 - Bola	T_{24}=2	99.98	3.68
5 - Collagen-mezzo-microelements +Bola	T_{24}=3.22x10^2	96.39	1.44	5 - Collagen-mezzo-microelements +Bola	T_{24}=1.32x10^2	98.61	1.86
2- Gemini	T_{24}=0	100	4	2- Gemini	T_{24}=0	100	4
4 - Collagen-mezzo-microelements + Gemini	T_{24}=0	100	**4**	4 - Collagen-mezzo-microelements + Gemini	T_{24}=0	100	**4**

4. CONCLUSIONS

-The aim of this research was fulfilled to develop new structured emulsions and to study the influence of novel tensidic "archetypes" like layered networks, based surfactants (bolaform, gemini) on collagen gelatin with mezzo and micronutrients, for agriculture applications.

-New multiple structured emulsions were successfully made by a two-steps process for mezzo and microelements and collagen gelatin inclusion in a W/O/W system. The archetype structure of new emulsions was demonstrated by optical microscopy.

-The emulsions with particle sizes of 697.9- 613.9 nm as compared to 304.3 nm of collagen gelatin mixture with mezzo and microelements were obtained. The new emulsions showed lower contact angle values which are premises for improved displaying on plant leaves or roots and a higher potential of growth biostimulation and nutrition.

-Gemini surfactants showed an improved influence on antifungal resistance of collagen gelatin-mezzo-microelements mixtures and emulsion stability.

- In our paper it was elaborated a new method for including mezzo and microelements in collagen gelatin, obtaining novel stable structured emulsions, with the final purpose of application *as a new class of root fertilizers in agriculture*.

-The new multiple structured emulsions are original due to the successful inclusion of surfactants/mezzo and microelements/collagen gelatin, with high potential for biostimulation and nutrition of tomato plants.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

FASHION MICRO-ENTREPRENEURS: STRATEGIES FOR ACHIEVING SUSTAINABILITY

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Abstract: *Considering account the accelerated development of globally active fashion micro-enterprises, this study investigates the sustainability strategies integrated into, with the business model of these organizations, as well as the particular stages and processes involved in their adoption. These research objectives are addressed by realizing a literature review on the implementation of sustainable business models in micro-organizations, and collecting and analyzing primary data through semi-structured interviews conducted with 19 French fashion micro-entrepreneurs. The findings indicate that these micro-entrepreneurs are well aware of both the advantages and challenges of sustainable strategies. In addition, it essential to take into account the specificity of these organizations, characterized by small size, low market power, and a low level of resources, but having the competitive advantages of quick decision making, operational and strategic flexibility, and close relationships with their customers, often intermediated by online technologies and social media platforms. The respondents also indicate that implementing sustainable strategies is a gradual process, involving an evolutive business model. Finally, the managers emphasize the problem encountered with balancing the three pillars of sustainable development in the context of their organizations, and the amount of effort and resources required to select, obtain and maintain sustainability certifications.*

Key words: *sustainability, micro-enterprises, advantages, challenges, implementation stages*

1. INTRODUCTION

Sustainability is a concept frequently used today in the public discourse. However, at present, there is no generally accepted definition for sustainability. In general, the word refers to an activity or process than can be continued over time at a certain level of resource consumption. On the other hand, the derived concept of sustainable development has a well-known definition given in the Brundtland Report [1]: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” From this perspective, sustainability must ensure a fair equilibrium between the interest of present and future generations. This process is enacted by reaching an equitable balance in terms of business, social, and environmental goals and activities, representing the three pillars of sustainable development.

Although sustainability is often described, analyzed and discussed in the academic and professional literature pertaining to the fashion industry, most of the extant studies focus on large multinational corporations that own well-known product and/or retail brands. However, the fashion industry is in the midst of a business model transformation, which provides more market and partnership opportunities to small or micro-enterprises. This trend is facilitated by the globalization, digitalization, specialization and automatization of the production process. Despite this trend, little is known about the specific strategies deployed by micro-entrepreneurs to enhance the sustainability of their activities and outputs. This study attempts to address this knowledge gap, answering the following research questions: "What are the main sustainability strategies deployed by micro-entrepreneurs to enhance the sustainability of their organizational activities and outputs?" and "How are these strategies implemented in micro-enterprises?".

To provide valid answers to these questions, we decided to use a qualitative methodology, based on semi-structured interviews conducted with 19 French fashion micro-entrepreneurs, which permits us not only to clearly identify these sustainability strategies, but also to evidence the processes deployed to ensure their implementation.

The findings of this study represent an original contribution to the sustainability literature in the context of the fashion industry, facilitating a better understanding to the strategies and processes used by micro-enterprises for academic, consultants and managers.

2. BACKGROUND

Fashion represents a highly dynamic economic sector, characterized by high growth rates and high levels of competition. As presented in the introduction, globalization, digitalization, specialization and automatization, coupled with the increasing fragmentation and segmentation of markets in highly specific niches, have provided an impetus to creating many fashion micro-enterprises. From an organizational point of view, we apply in this study the definition of micro-enterprises developed by European Commission [2], as enterprises that employ fewer than ten persons and whose annual turnover and/or annual balance sheet total does not exceed two million euros.

In recent years, the growth dynamic of the fashion industry and market have been sustained by large multinationals that own globally known brands and integrated value-added chains. These companies have succeeded to drastically reduce the design, production and commercialization costs while maintaining a high or medium quality of products and services. On the other hand, the market demand for high quality products has increased exponentially, as the growth of consumer resources in many developing counties has given an accelerating impulse to the global demand [3].
Unfortunately, the dark side of the fashion industry is characterized by the exploitation of workforce in some developing counties and short production and consumption cycles, which create significant waste and environmental pollution, as around 85% of the clothing produced each year end up in landfills [3], the fashion industry being responsible for 10% of the global annual carbon dioxide emissions and for the use of 1.5 trillion liters of water annually [4]. In addition, research indicates that micro-plastics from clothing represent a significant polluter of seas and oceans [5].

The business paradigm of the fashion industry is evolving towards organizational models that are design-oriented, producing small batches of clothes that are often sold over the internet or using extant global platforms, such as Amazon. The organizations that are representative for these new trends are usually small or micro-organizations, that thrive through specialization, digitalization and close customer relations often managed through the major social networks, such as Facebook, YouTube or Instagram.

At the same time these creative micro-organizations are confronted with a growing awareness regarding global sustainability issues, being pressured to adopt and ensure the sustainable development of their business model, and respect the growing standards regarding social equity and environmental protection. Addressing the extant knowledge gap regarding the lack of information regarding the implementation of sustainability strategies in micro-organizations, our study explores and analyzes (i) the competitive advantages and the organizational challenges associated with these policies, (ii) the strategies implemented by micro-enterprises to enhance the sustainability of their activity and outputs, and finally, (iii) the specificity of processes used to introduce sustainability issues and principles within their competitive business model.

3.RESEARCH METHODOLOGY

To answer the formulated research questions, we adopted an exploratory approach, based, in the first stage, on a literature review of the investigated topic, followed by a series of semi-structured interviews conducted with 19 French micro-entrepreneurs.

The interviewees have been identified by launching a Google search regarding French micro-enterprises that are active in the fashion industry. After analyzing the returned results, we identified 76 fashion micro-enterprises corresponding to the searched criteria. Then we contacted the managers of these organizations – either by phone or by email, and invited them to participate in this research project. Unfortunately, only 21 answered positively to our invitation. We realized online interviews, which was highly practical considering the numerous restrictions related to the COVID pandemic. Unfortunately, the sample was further reduced to 19 respondents as two managers declared that they lacked the necessary time to discuss with us.

The interviews were organized during November and December 2021, and took between 30 and 45 minutes, being focused on four general discussion themes: (i) the profile, activity and market targeted by each organization; (ii) the level of knowledge and the importance associated with sustainability and sustainable development by the micro-entrepreneur; (iii) the strategies implemented in these organizations to increase the sustainability of their activities and outputs (including the perceived advantages and challenges related with these strategies); and (iv) the stages deployed to implement these sustainability strategies.

The interviews were recorded with respondents' permission, and under the condition of confidentiality regarding real names. These interviews were then transcribed and manually coded in three main stages. First, the interviews were read and integrated in a general way, to understand the context of each investigated organization. Second, the specific information regarding sustainability strategies have been classified under several different categories, such as: types of strategies, perceived advantages, and perceived challenges. Third, the specific decisions, processes and stages applied in the implementation of these sustainability strategies have been separated and analyzed, in relation to the specific organizational and market context of these micro-enterprises. Finally, these categories have been codified, a synthesis of the main findings being presented in the next section.

4. FINDINGS

All interviewed micro-entrepreneurs indicated their knowledge, interest and preoccupation with sustainability and sustainable development. Despite the fact that their commercial output was relatively small, the respondents emphasized the importance of communicating and displaying a sustainable image of their organization and activity to employees, investors, partners, and especially to their consumers.

These fashion micro-entrepreneurs emphasized both the advantages and challenges of adopting an active organizational policy and communication based on sustainability (see Table 1).

Table 1: *Advantages and challenges in implementing an active organizational policy based on sustainability and sustainable development*

Advantages	**Challenges**
Positive organiational reputation	Stigma for (perceived) lower product quality and higher prices
Satisfied stakeholders	Lack of resources
Cost reduction	Lack of knowledge
Competitive advantage in specific niche markets	Lack of support from suppliers, distributors or investors
Possibility to list higher prices	Higher costs
Increased transparency toward customers and investors	Meeting certification costs and requirements
Better positioning for future market evolutions	Balancing the economic, social and environmental components of sustainable development

Despite the recognized importance of sustainability in organizational management and marketing, not all the investigated micro-enterprises are at the same stage of policy implementation or display the same level of commitment. Thus, five of the interviewed 19 micro-entrepreneurs consider that their organization is at the first stage of implementing sustainable organizational policies, which is characterized by a gradual diffusion of sustainability principles, practices and behaviors among employees. The main challenge encountered at this stage is to mitigate between the costs of implementing environmentally friendly manufacturing practices and the need to achieve business rentability and social goals (for example, a fair participation of employees in both the effort and the results of the firm). Therefore, the sustainability policies introduced during this stage are mostly focused on the optimal organization of manufacturing – applying, for example circular processes that reduce waste and reduce energy consumption [6], or specific recycling policies in relation to raw materials or accessories [7].

In the second stage of implementing sustainable strategies, the respondents – eight out of 19, indicated that they attempt to further integrate their organization into global or national sustainable value-added chains, which includes strategies of initiating or developing partnerships with sustainable suppliers, manufacturers and/or distributors. This transformation is not easy, because the majority of suppliers and large retailers adopt a superficial sustainability-friendly policy, primarily based on general declarations of principles and engagements. In this stage, their commitment to sustainable organizational policies is demonstrated into an increasing investment of resources in sustainability-based projects and partnerships.

Finally, in the third stage of sustainable strategies implementation, the organization adopts a holistic view of sustainable development. This vision has a double role: first, it provides a better balance and management of the three pillars of sustainable development, and, second, opens the way towards obtaining formal certifications [8] and implementing a more complex customer relationship policy. The number of micro-entrepreneurs indicating that they reached this stage was six.

5. DISCUSSION

The findings of this study indicate a gradual, evolutionary approach of micro-enterprises to implementing sustainability policies at (i) organizational, (ii) value-added system, and (iii) market levels – i.e., the stages one, two and three presented in the previous section. This gradual approach is due to the small size and market power of the investigated micro-enterprises, which are also associated with a low level of knowledge and resources.

On the other hand, as many other micro-enterprises, their small size increases the decision-making speed and the operational flexibility of these organizations. Generally, the investigated fashion micro-enterprises can be classified into two categories: either local organizations that cater to specific segments of the national market or born-global firms using the Internet to develop, manufacture and commercialize products globally, while also adopting a strong market-niche orientation.

Being highly specialized in a specific area of the value-added chain, these organization rely heavily on alliances and partnership with other similar or complementary firms. An important feature of the micro-enterprises investigated in their study was their creativity, all of them being specialized in fashion design, to which they added different other organizational functions in order to internalize the production and customer-relation processes, often using digital applications and technologies.

An essential problem emphasized by respondents is the vagueness of the sustainable development concept and the multitude of principles, concepts and operations that can, potentially, be included under this conceptual umbrella. Thus, often the three pillars of sustainable development – economic rentability, social equity and environmental protection are difficult to balance and manage simultaneously, especially when the organization lacks knowledge and resources. Finally, another important challenge encountered by the managers of the investigated micro-enterprises is the process of sustainability certifications, some of which deal only with one aspect of sustainable development policies and being differently recognized depending on each geographical market.

6. CONCLUDING REMARKS

This exploratory paper attempts to lay down the foundation of an in-depth investigation of the sustainability strategies implemented by fashion micro-enterprises, and of the implementation process. Despite the low number of interviews conducted with micro-entrepreneurs, we posit that the findings of our study provide interesting and original findings that can increase the understanding of the particular conditions in which micro-enterprises from the fashion sector develop and enact their sustainable business model.

The study has several limitations determined by the selected research methodology: the sample of interviewed micro-entrepreneurs is relatively small, and the resulting findings are limited to the French fashion industry. Future research should further investigate the implementation of sustainability strategies by micro-enterprises from other developed or developing counties, collecting primary data for comparison and synthesis. In addition, it is necessary to analyze the role of customers as a driving, or alternatively, a restrictive force for the implementation of sustainability policies in the fashion industry, as customers’ attitudes and opinions are far from consensus.

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CONTENTS

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