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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

STUDY ON THE REALIZATION OF JEANS IMITATION KNITT STRUCTURES

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Abstract:. *The functionality requirements involved in the choice of materials aim to ensure a state of thermophysiological, psychosensory and dynamic comfort of the wearer as well as the ergonomic requirements and functions that relate to ensuring the mobility of the body. Obtaining jeans products by knitting methods ensures the improvement of their softness and comfort capabilities. From here came the author's idea, to carry out a study on obtaining knitted structures imitation jeans that correspond to all the requirements mentioned. For this we chose 100% cotton yarns, which we knitted in several structures, in order to be able to choose the most suitable variant for making this type of jeans. In this paper there are presented three variants of knitted structure. The results obtained from the study show that the jeans knitted using type 3 method is the one that meets the most requirements related to the realization of a comfortable and aesthetically pleasing pair of jeans even under the conditions of a home office. The knitted structure can also provide a variety of models with general comfort values that are superior to those made of fabric structures. The knitted structure was made on the sir 123 fineness 14 rectilinear knitting machine, produced by Shima Seiki in Japan. These knitting machines use, for product projection, the SDS-One graphics station or the APEX graphics station- the variant of the last generations.*

Key words: *knitt, jeans, knitt proiecting, programming, yarn, knitt structure*

1. INTRODUCTION

Textiles can be considered one of the most requested materials in the world due to their requirements in different application areas. They have versatility, a combination of properties, structures, raw materials and production techniques. With advanced technology and research there is a desire to have a modified form of each product, which fulfills new lifestyles and fashion trends [1]. Jeans are one of the most popular casual fabrics in the world, used for a very wide range of clothing products and accessories. The idea of producing jeans started from the need of workers in the mining industry, who needed protective clothing, with resistance but at the same time made of a comfortable material, nowadays becoming very common.

Satisfying the need to wear comfortable clothing has become paramount in the context of the pandemic, yet mankind also needs the feeling of being dressed beautifully. Knits, which have been greatly popular in recent years, have become among the favorite textiles for making everyday clothing.

2. CREATING THE KNITT STRUCTURES

Traditional jeans are hard to wear because it is a high-density fabric with a large mass per surface unit [2]. Although there are variations that have high elastomer content, it is not suitable for clothing at home, for women and children [3]. Obtaining jeans-type structures by knitting methods ensures the improvement of the softness and comfort capacities of the products made from them.

In order to find a knitted structure of imitation jeans several knitting samples were made. The authors chose, a 100% cotton composition yarn [4], feeding in parallel with a lycra filamentary yarn to ensure the knitting has a capacity to return to the original shape, as a result of the various demands during the exploitation of the products. Bluemarine and white yarns were used to achieve the prewashed blush effect. In this paper there are presented three variants of knitted structure. The knitted structures were made on the SIR 123 rectiliniar knitting machine, fineness 14 [5], produced by Shima Seiki of Japan [6], [7]. These knitting machines use, for the design of products, the SDS-One graphics station or the APEX graphics station- the variant of the last generations.

In the first variant, fig. 5, the front appearance of the knit, an fig.6 the back view, obtained from the realization of a jacard structure, which is presented in fig.1 and fig.2. The designed structure ensures the existence of jeans-specific connecting points, arranged diagonally from the textile material. Fig.3 and fig.4 represent the structure by row section and how is changed the yarn carrier.

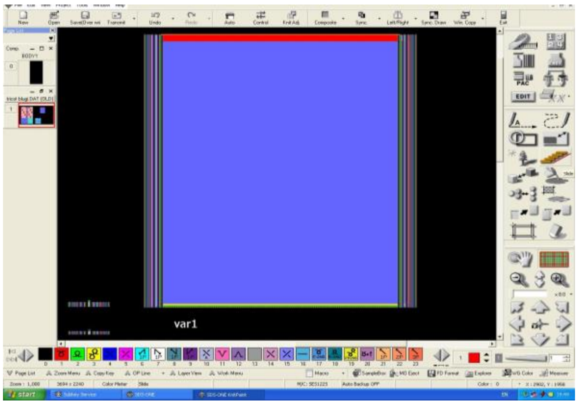

Fig.1.*Program of the knit structure 1*

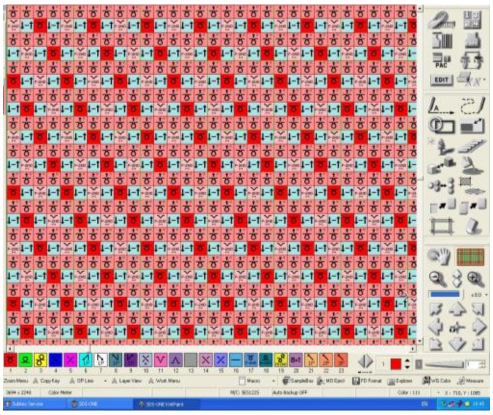

Fig.2. *Basic pattern data 1*

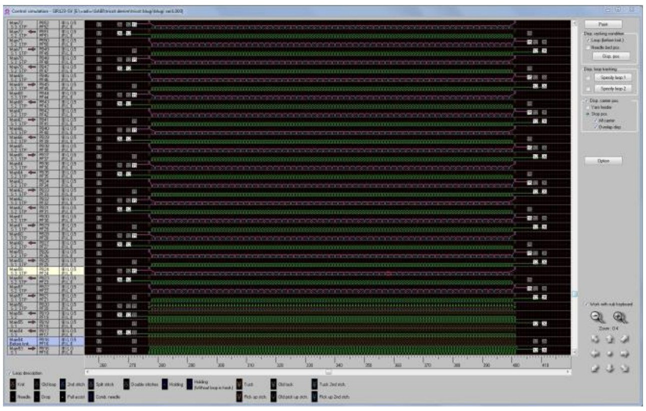

Fig.3. *Representation by row section*

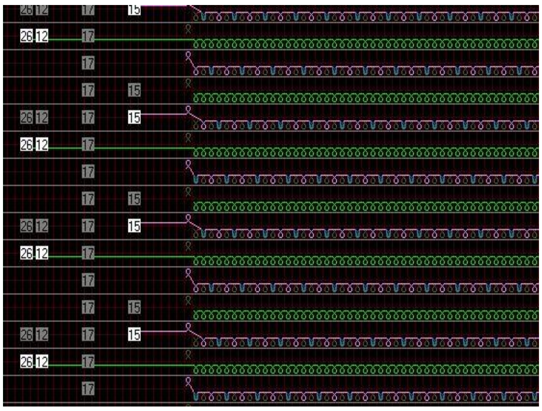

Fig.4. *Representation by row section – yarn carriers*

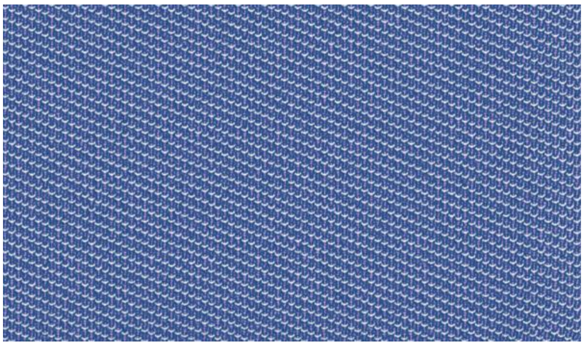

Fig.5. *Knitt structure 1- Front view*

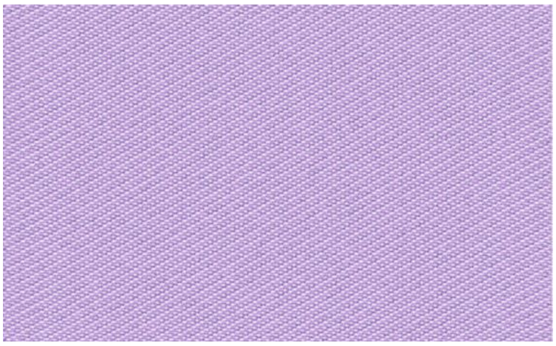

Fig.6. *Knitt structure 1- Back view*

This structure, although it imitates well the appearance of jeans fabrics, has the disadvantage of large loops on the back of the knit. These loops give the knit a thick appearance and can hang quite easily, thus leading to damage of the appearance.

In the case of variant 2, an attempt was made to solve this problem, given by the existence of loops on the back of the knit obtained in variant 1. In fig.11 there is presented the front view of the knit, made according to the structural basic pattern presented in fig.8, using the program from fig.7. This variant presents a look that imitates well the appearance of a jeans fabric and also solves the problem of large loops on the back of the knit, fig.12. Fig.9 and fig.10 represent the structure by row section and how is changed the yarn carrier for realizing it.

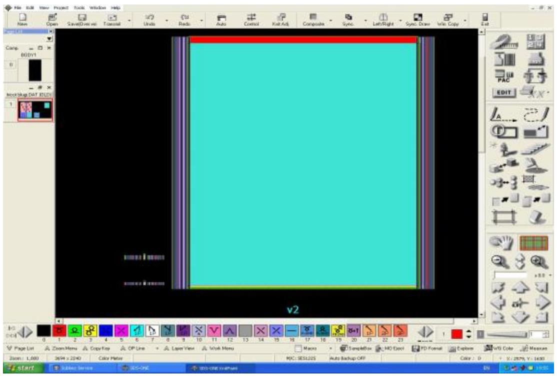

Fig.7. *Program of the knit structure 2*

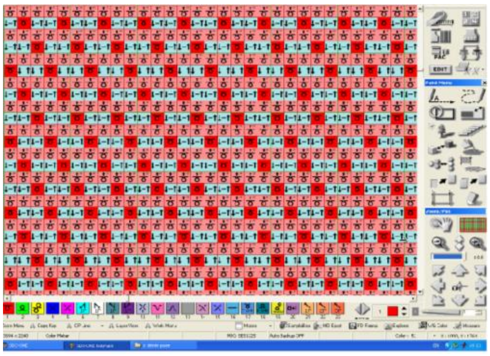

Fig.8. *Basic pattern data 2*

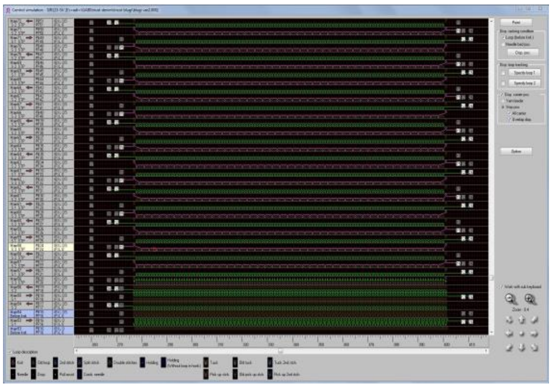

Fig.9. *Representation by row section*

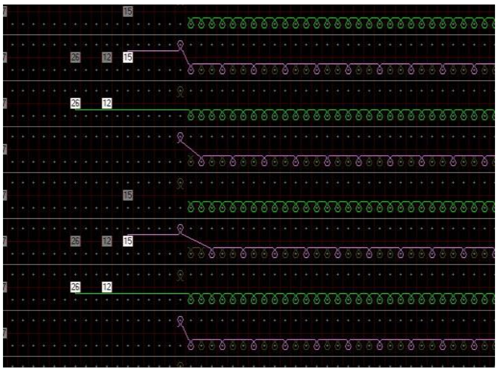

Fig.10. *Representation by row section – yarn carriers*

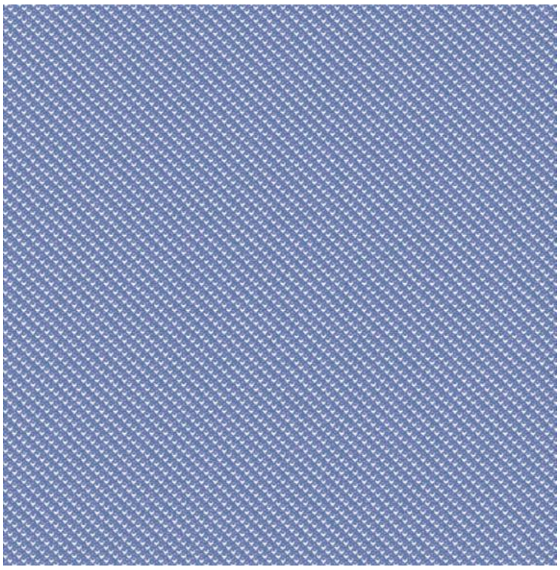

Fig.11. *Knitt structure 2- Front view*

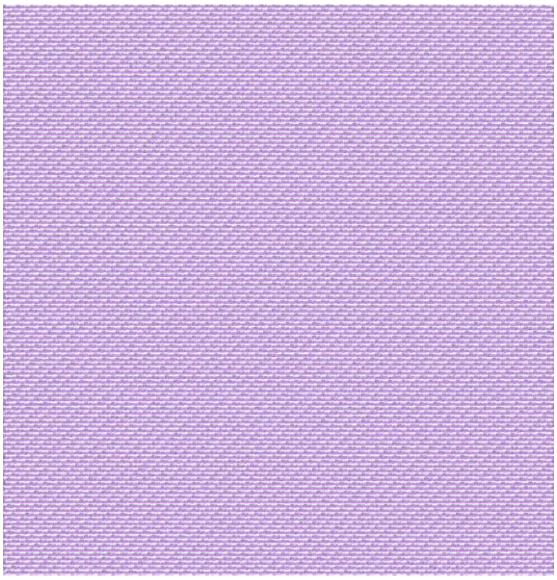

Fig.12. *Knitt structure 2- Back view*

Today's fashion is a crucial factor in how we make our dressing choices. Due to the requirements given by fashion, the design of washed(used) jeans was chosen. In variant 3, a knitted structure was made to meet these requirements, the basic pattern of this is being presented in fig.14 useing program presented in fig.13. The final appearance of the used knit pair of jeans is presented in fig.17, the front view of structure, and the back view fig.18. Fig.15 and fig.16 represent the structure by row section and how is changed the yarn carrier for realizing it.

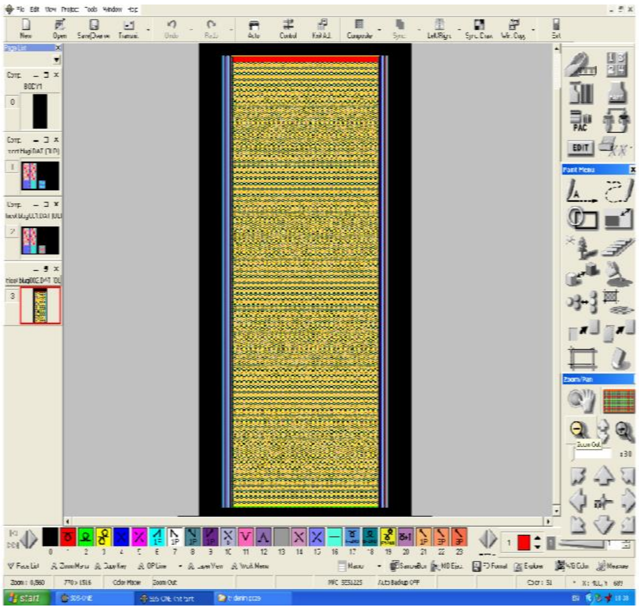

Fig.13. *Program of the knit structure 3*

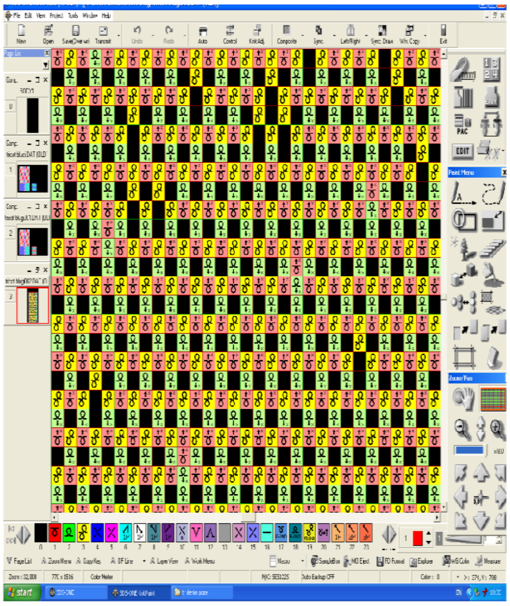

Fig.14. *Basic pattern data 3*

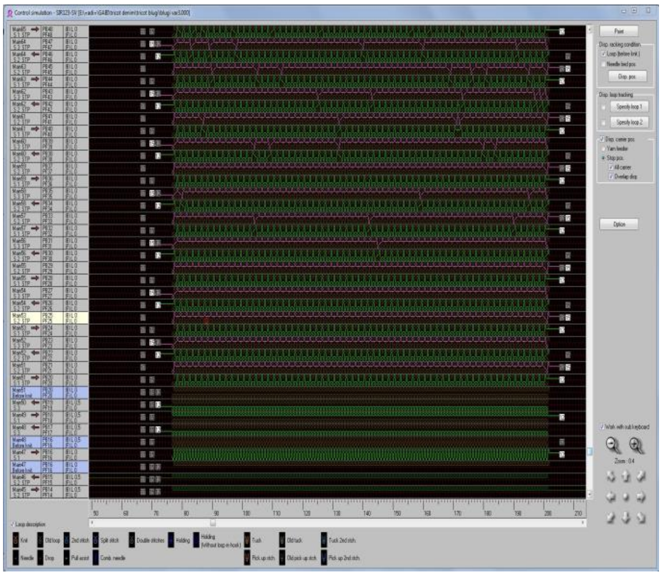

Fig.15. *Representation by row section*

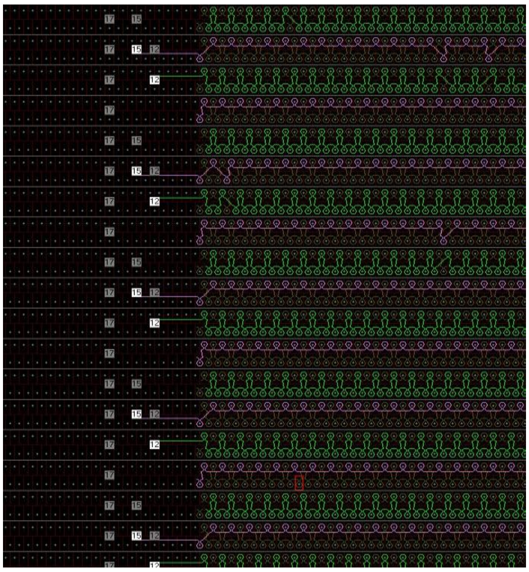

Fig.16. *Representation by row section -yarn carriers*

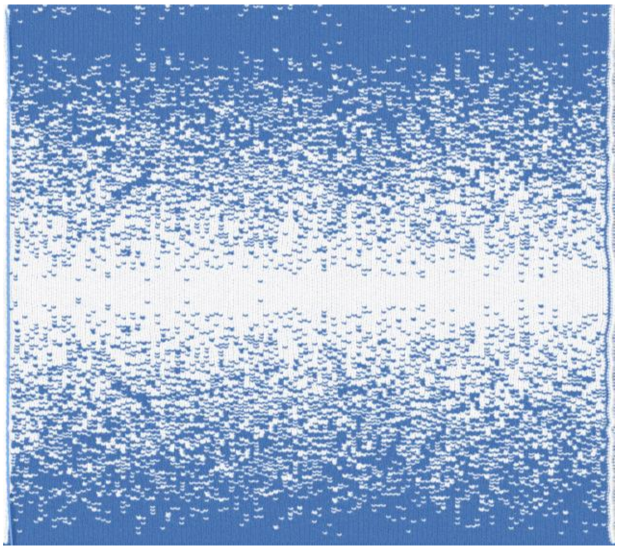

Fig.17. *Knitt structure 3- Front view*

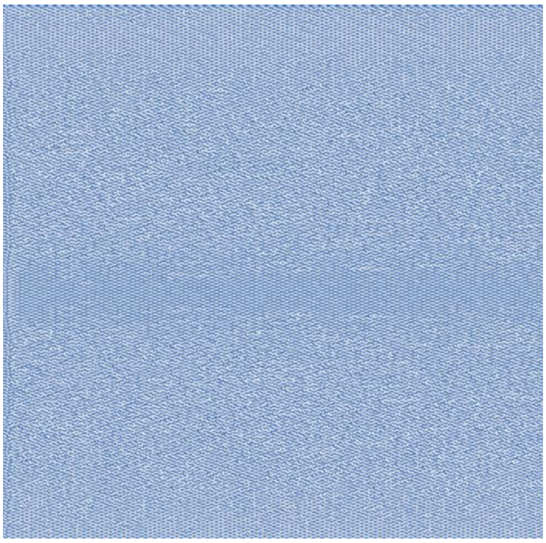

Fig.18. *Knitt structure 3- Back view*

5. CONCLUSIONS

Based on the results it can be concluded that the jeans knit variant 3 is the one that meets the most requirements related to the making of a comfortable pair of jeans, even while having the office at home. The knitted structure can also provide a variety of models with general comfort values superior to those made of fabric structures.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

COLOUR ANALYSIS IN THE CIE LAB SPACE REGARDING THE DYEING WITH WELD AND MADDER DYES

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Abstract: *In recent years, there is a great tendency for ecological dyeing and finishing of natural fabrics with natural dyes. Natural dyes obtained from nature were used for dyeing of textiles from ancient times till the nineteenth century. Weld (Reseda Luteola L.) produces the most stable yellow colour and shades and Madder (Rubia tinctorum L.) produces the most beautiful red colour and shades. These natural dyes were usually combined toghether to produce different shades of orange. Colour represents the bridge between science-art-industry, and can be described by various methods, with the following features: hue, saturation or purity (chroma) and brightness. Any colour can be defined by these three values which describe a unique color. The paper presents the colour analysis, resulting 16 variants of the ecological dyeing on hemp fabric with natural dyes Weld and Madder. In the colour analysis, the following was observed: the influence of the prior application of treatments for improving the absorption capacity of the dye (pre-treatments with enzyme and scouring and bleaching in one step), the influence of using different combinations and concentrations of dye (Weld-Madder combination and Madder-Weld combination), but also the colour resistance after washing on the tested samples. In order to have a general view over the colours obtained after dyeing with natural dyes on hemp samples, colouring measurements in the CIE LAB system with spectrophotometer 968 (X– Rite, USA), with light source D_{65} and observer of 10^0 (Enhanched polarization filter according to ISO/ DIS 13655) have been carried out.*

Key words: *combination of natural dyes, Weld, Madder, hemp, colour measurements*

1. INTRODUCTION

Worldwide, growing consciousness about organic value of ecological products has generated a renewed interest of the use of natural fibre, like hemp, dyed with natural dyes. In this context, an important attention has been focused on research to replace synthetic dyes, in a competitive manner, with natural dyes. Dyeing with natural dyes is a topical issue in the field of textile finishing.

Colour represents the bridge between science, art and industry. Nowadays, the science that studies the colours demonstrates a interdisciplinarity and occupies an important place in theoretical and applied fields, being one of the few disciplines that are linked to branches of knowledge, like art, chemistry, psychology, biology, physics and more [1]. As well is known, colour is one of the most fascinating phenomena which were enticed to chemistry, full comprehension compound needs knowledge of chemistry and spectroscopy. In the scientific field of chromatology, researchers place a special emphasis on the use of colours and chromatic combinations. In textile industry, colour is also particularly importants, the emphasis is mainly on the appearance of the products, because it is supposed to be one of the most important feature.

Natural dyes were used for dyeing of textiles from ancient times till the nineteenth century and as the name suggests, natural dyes are derived from natural sources from nature [2, 3, 4]. At present, application of natural dyes in the dyeing process is gaining popularity all over the world. Weld (Reseda luteola L.) is the flavonoid yellow dye source mentioned in traditional European recipes. The predominant chromophores found in this plant are the flavones luteolin, apigenin and glycosides like luteolin 7-O-glucoside [5]. Weld was usually combined with red dyes to produce different shades of orange [6, 7, 8, 9]. Madder (Rubia tinctorum L.) is a plant anthraquinone red dye, alizarin and purpurin are the main chromophores of this plant. Madder produces pigments in its roots, such as alizarin, pseudopurpurin, purpurin, munjistin, rubiadin, xanthopurpurin and also [2, 5, 6, 10]. The roots of Rubia tinctorum L. are the source of a natural dye and have been used to dye textiles in many parts of the world since ancient times [5, 7, 8, 11]. Madder gives a unique red colour to textiles, and also, combined with different mordants can produce shades that vary from pink to black, purple and red.

The science of colour measurement is an objective method of measuring colour, which takes into account three factors that determine the measured colour: light source, material characteristics and colour response of the observer, which fully characterizes the colour, being extremely precise.

From the research in this field, it is found that the need to approach the research related to colorimetry occurred as a result of implementing practical applications of colour spectrophotometric measurement in the textile industry, especially in the objective control of bleaching and dyeing processes.

2. EXPERIMENTAL

2.1. Materials and methods

In this experimental study the hemp fabric (fineness of warp yarn: Nm=10/2 and fineness of weft yarn: Nm=10/1 with specific weight: 276 g/m2) realised in Romania was used. Natural dyes Weld and Madder (supplied from Couleurs de Plantes, France) were used in the dyeing process. All experiments were performed with demineralized water in the Zeltex VISTA COLOR equipment and the 5 grams textile material was used as sample.

Pre-treatments of fabric*:* The fabric samples were previously treated by applying two treatments, scouring with enzyme (50°C, 1 h, BioPrep 3000L -Novoyzmes and non-ionic surfactant Triton X-100 -Sigma Aldrich) and scouring and bleaching in one step (98°C, 1 h, 5 g/L NaOH 38°BE, 33%; 1 ml/L Tannex CB; 5 ml/L H_2O_2; 2 ml/L Tanaterge Advance -Tanatex Chemicals B.V.).

Mordanting*:* The mordanting procedure was achieved using 0.8 gr of $Al_2(SO_4)_3$ at 98°C, 1 h.

Dyeing*:* The dyeing procedure involved the combination of natural dyes in different combinations (Weld-Madder combination and Madder-Weld combination) and concentrations of dye (5% and 10%), fabric: liquor ratio 1:30 at a temperature of 98°C, 1 h.

Colour fastness tests*:* Wash fastness was achieved in the Linitester equipment, at the temperature of 40°C, for 30 min. and evaluated according to ISO 105-C06 standard procedure.

2.2. Objective colour evaluation using Cie lab space

CIELAB system (1976) was introduced to describe the colour that results from three factors. The colour of the fibre is the result of three combined factors: the spectrum of the light source, the spectral reflectivity of the fibre colour, and the spectral sensitivity of the eye [12]. The system is a three-dimensional space, with coordinate axes L*, a*, b* where the L* axis denotes the lightness of the colour (L* of 0 corresponds to black, L* of 100 corresponds to white), a* represents the green-red axis (a* negative: green, a* positive: red), and b* represents the blue-yellow axis (b* negative: blue, b* positive: yellow). Each sample colour can be represented as a set of values for L*, a*, b*, and consequently as a point in this colour space. The colour representation method in the CIE Lab system uses the trichromatic X, Y, Z coordinates to define three other coordinates, as follows:

Coordinate for luminosity: $L^{*}=116\cdot f(Y/Y_0)$; **(1)**

Coordinate red-green: $a^{*}=500\cdot[\, f(X/X_0)- f(Y/Y_0)]$; **(2)**

Coordonata yellow-blue: $b^{*}=200\cdot[\, f(Y/Y_0)- f(Z/Z_0)]$. **(3)**

In these equations, X_0, Y_0 and Z_0 are the trichromatic coordinates for an object with perfectly white reflection, and are obtained from the following relations:

$$\begin{cases} X_0 = \sum_{\lambda=380}^{770} E(\lambda)\cdot \bar{x}(\lambda) \\ Y_0 = \sum_{\lambda=380}^{770} E(\lambda)\cdot \bar{y}(\lambda) \\ Z_0 = \sum_{\lambda=380}^{770} E(\lambda)\cdot \bar{z}(\lambda) \end{cases} \quad \textbf{(4)}$$

a *, b *=each represents a change in position in the chromatic chart, thus obtaining information regarding the displacement of the chromatic components of the colour of the samples, knowing that the axes correspond:

(+) a*- red colour;
(+) b*- yellow colour;
(-) a*- green colour;
(-) b*- blue colour.

Saturation increases as the distance from the origin increases.

L*=represents the luminosity component and has a positive value (+), if the sample is lighter, respectively (-) negative, if the sample is darker. If all values are positive, the higher it is, the lower the dye intensity.

It is also possible to calculate the colour difference (ΔE*) between two objects represented by the geometric distance between the points corresponding to the colours of the objects located in the colour space:

$$\Delta E^{*} = \left(DL^{*2} + Da^{*2} + Db^{*2}\right)^{1/2} \quad \textbf{(5)}$$

$$\Delta L^{*} = L_1 - L_2 \quad \textbf{(6)}$$

$$\Delta a^{*} = a_1 - a_2 \quad \textbf{(7)}$$

$$\Delta b^{*} = b_1 - b_2 \quad \textbf{(8)}$$

$$C^{*} = \sqrt{a^2 + b^2} \quad \textbf{(9)}$$

ΔL* is the difference in luminosity between the colours of the two objects, Δa* is the difference between the red-green coordinates, Δb* is the difference between the yellow-blue coordinates, Δc* =saturation difference, Δh*=shade difference.

The CIE Lab system allows, in addition to the representation of its rectangular coordinates (L*, a*, b*) the representation of the cylindrical ones L*- luminosity, C*- saturation or purity (chroma), h- shade or hue.

3. RESULTS AND DISCUSSION

Colour measurement in the CIE lab space was performed with the 968 spectrophotometer (X-Rite, USA), with the D_{65} light source and the 10^0 observer (Enhanced polarization filter according to ISO / DIS 13655). Each sample was folded to provide opacity, as three measurements were made for each sample.

The colorimetric values are the coordinates of the green-red axes (a), the yellow-blue axes (b) and the Luminosity (L). The colorimetric values studied were the colour parameters L*, a*, b*, c*, which means L*=luminosity in percent, a*=red-green variation for positive and negative values in Adams Nickerson (AN) units, b*=yellow-blue variation for positive and negative values in units (AN), ΔL=difference in luminosity, Δa=difference between red-green coordinates, Δb=difference between yellow-blue coordinates, ΔE=difference in colour. C*=saturation or purity (chroma).

All these use in order to compare the colour on the samples dyed with 5% and 10% concentration of dye, and also, the samples after washing with detergent for colour testing ECE - Colour Detergent, with Phosphate for Fastness Test acc. ISO 105-C06 (Test Gewebe GmbH, Germany). The final values and and the results were presented in Table 1 and Table 2.

Table 1. *Cie Lab values for the combination of WELD and MADDER dyes*

	WELD-MADDER	5% concentration of dye				10% concentration of dye			
	Pre-treatments	L*	a*	b*	c*	L*	a*	b*	c*
1	scouring with enzyme	52,98	10,95	20,30	23,06	52,11	7,64	29,42	30,40
2	washed	52,56	9,98	25,10	27,01	55,02	4,18	35,98	36,22
3	scouring and bleaching	64,13	9,63	29,40	30,94	64,67	7,58	36,59	37,37
4	washed	65,88	6,54	34,80	35,41	64,41	5,41	44,35	44,68

	WELD-MADDER	ΔL*	ΔL*	ΔL*	ΔE*
	Pre-treatments				
1	scouring with enzyme	0,87	3,31	-9,12	9,74
2	washed	-2,46	5,80	-10,88	12,57
3	scouring and bleaching	-0,54	2,05	-7,19	7,50
4	washed	1,47	1,13	-9,55	9,73

Table 2. *Cie Lab values for the combination of MADDER and WELD dyes*

	MADDER-WELD	5% concentration of dye				10% concentration of dye			
	Pre-treatments	L*	a*	b*	c*	L*	a*	b*	c*
1	scouring with enzyme	55,02	7,51	26,20	27,26	47,63	15,20	22,10	26,82
2	washed	54,12	7,68	30,40	31,36	50,82	12,20	24,89	27,72
3	scouring and bleaching	61,52	14,78	25,10	29,13	58,23	18,20	27,91	33,32
4	washed	68,39	9,99	28,70	30,39	60,26	11,30	33,25	35,12

	MADDER-WELD	ΔL*	ΔL*	ΔL*	ΔE*
	Pre-treatments				
1	scouring with enzyme	7,39	-7,69	4,10	11,43
2	washed	3,30	-4,52	5,51	7,85
3	scouring and bleaching	3,29	-3,42	-2,81	5,52
4	washed	8,13	-1,31	-4,55	9,41

Figure 1 presents the graphical representation of values in the Cie Lab space for the combination of WELD and MADDER dyes.

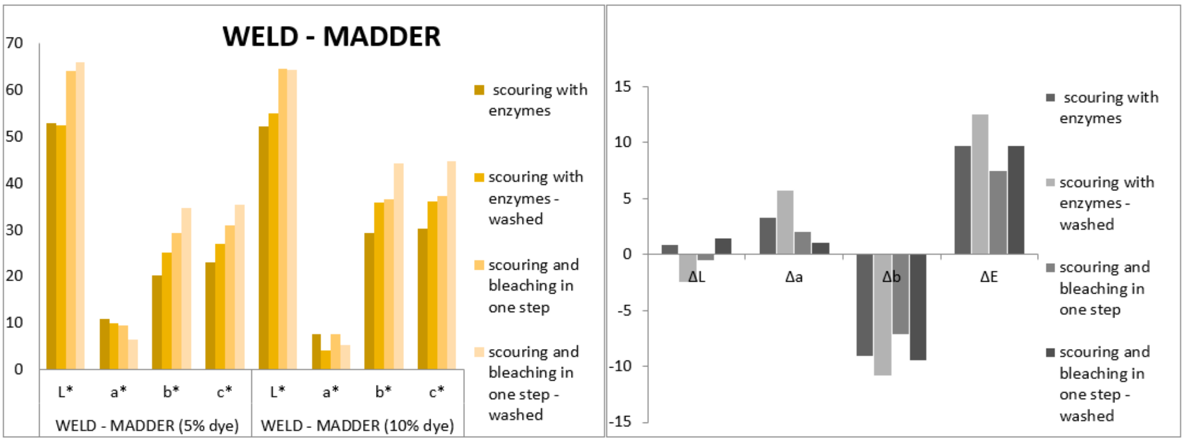

***Fig. 1**: Graphical representation of values in the Cie Lab space for the combination of WELD and MADDER dyes*

Figure 2 presents the graphical representation of values in the Cie Lab space for the combination of MADDER and WELD dyes.

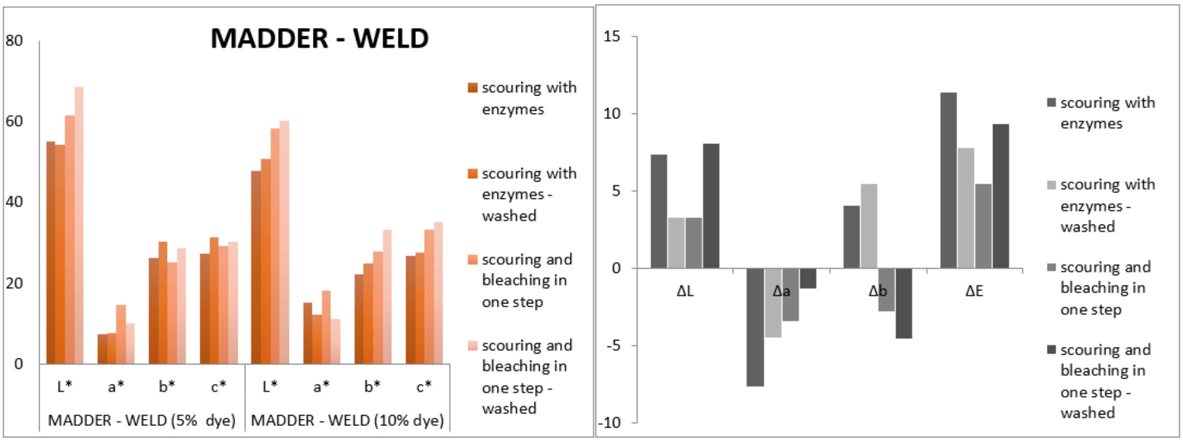

***Fig. 2**: Graphical representation of values in the Cie Lab space for the combination of MADDER and WELD dyes*

4. CONCLUSIONS

In this research, the colour parameters L*, a*, b*, c* were tested, which means L=brightness in percent, a=red-green variation for positive and negative values in Adams Nickerson (AN) units, b=yellow-blue variation for positive and negative values in (AN) units determined on spectrophotometer 968 (X - Rite, USA), with light source D_{65} and 10^0observer (Enhanced polarization filter according to ISO / DIS 13655).

From the data obtained we can observe that there is a marked differentiation between processes 1 and 2 (scouring with enzyme / washed) and processes 3 and 4 (scouring and bleaching in one step / washed) of the hemp support cleaning method. The influence is marked by the chromatic effect of the cleaning with enzymes which in processes 1 and 2 is brown, and in processes 3 and 4 it is white. From the analysis of data and values obtained, presented in Table 1 and Figure 1, the chromatic results show a majority yellow component, respectively with the data and values obtained from Table 2 and Figure 2, chromatic results show a majority red component. In all cases, by washing, a larger amount of dye is fixed on the textile support, as the oxygen dissolved in the washing water to the complexation process by mordanting probably interferes.

From the results of colour measurement in the Cie lab space it can be concluded that combination of natural dyes Weld and Madder are able to provide beautiful colours and shades. By using different pre-treatments and different combination or concentration of the dye we were able to carry out an efficient and eco-friendly process of hemp and developing a chromatic palette.

As a final conclusion, we can emphasize that the dyeing with natural dyes keeps spreading because it brings beauty and innovation in textile and fashion industry, but it also protects the humans health and environment.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

RESEARCHES ON THE FUNCTIONAL CLOTHES USAGE DESTINED FOR PERSONS WITH LIMB AMPUTATIONS

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Abstract: *Recently, the issue of designing special clothing for people with disabilities attracts the attention of specialists in various fields. This topic is very current, important and requires in-depth studies. The need for functional products for people with lower limb amputations is quite high, but they can only be found in specialized workshops. At the moment, local companies do not make clothing for people with special needs, which leads to a shortage of products on the market. The paper presents the results of a study that shows us the need for specialized products for people with lower limb amputations and their use in everyday life. The topicality of the theme is determined by the increase in the number of people with lower limb amputations and the increased interest of specialists in creating clothing for people with disabilities. The paper aims to establish the range of textile products for people with amputations of the lower limbs, necessary during the rehabilitation period and the period of social integration. The general objective of this paper is to analyze the assortment present in the wardrobe of people with amputations of the lower limbs and identify the need in product types. The paper presents the results of a survey of a group of prisoners with lower limb amputations. There is also a tendency to establish the group of clothing products, which would satisfy the wearer, but also those around.*

Key words: *functional clothing, people with lower limb amputations, assortiment*

1. INTRODUCTION

Clothing can play a key role in safety and self-esteem. In the case of people with disabilities, clothing can also be an opportunity to reduce the effort to have a normal life.

People with physical disabilities, including people with amputated lower limbs, face a number of problems that do not allow them to have a normal life. One of the main problems they face is social integration. In order to integrate a person with a disability into social life, it is necessary to provide him with psychological comfort, which is largely not present due to self-distrust. This self-confidence depends a lot on the person's physical and psychological state and of course on the way he looks [1,2].

Currently, with the increase in the number of limb amputations, the problem of rehabilitation and adaptation of patients is quite acute. According to modern statistics, the number of people who have suffered limb amputation is 10% of the total number of patients with musculoskeletal injuries.

In Republic of Moldova, according to the report of the National Center for Health Management, the number of amputations performed (without the Transnistrian region) is increasing. Thus, in 2003, 1090 amputations were performed, and in 2019 the number of amputation surgeries almost tripled, constituting 2728 cases [3].

2. THEORETICAL ASPECTS

Adaptive-functional clothing can be defined as special clothing, designed and developed to ensure the requirements of the wearer and ensure its ergonomic, functional and psychological comfort.

Adapting people with disabilities in society is complicated. Psychological factors cannot be denied here. They make the person feel confident and find their place in society. The role of adaptive-functional clothing is to form a rehabilitation effect, to provide increased comfort and to create a psychological balance.

For the design of adaptive-functional clothing products for people with lower limb amputations, it is necessary to perform a complex study in which the initial information about the wearer will be established, such as: wearer's characteristic for which clothing will be developed, disability characteristic, their way of life, the psycho-physiological and anthropo-morphological characteristics of the wearer, etc.

Of major importance is the movement of people with physical disabilities. The design of the products takes into account the characteristic of the disability and how much it affects the way of travel.

It is also necessary to research the types of clothing and accessories used by people with physical disabilities. They can provide a state of satisfaction and self-confidence, but are hard to find in the local market and are rarely used.

Environmental research is done in order to establish the positive and negative factors that influence the quality of life of people with physical disabilities. Attempts will be made to focus on the positive factors, and the negative factors will allow the formulation of quality requirements for adaptive-functional products.

3. PRACTICAL ASPECTS

Restraining the ability to move leaves a certain imprint on the lifestyle of a person with amputations of the lower limbs. They perform the same characteristic range of motion due to limited functional capacity.

The need for special clothing is of great importance in the lives of people with locomotor disabilities. It must meet aesthetic and ergonomic requirements, adapt to external environmental conditions, increase the quality of life, etc. [4].

People with locomotor disabilities cannot boast a rich assortment. As the results of the survey show, the wardrobe of people with lower limb amputations includes (Figure 1):

- - Men: shirt / t-shirt + pants (80%), shirt / t-shirt + aprons (20%);
- - Women: dress - 20%, blouse / t-shirt + pants (70%), blouse / t-shirt + skirt (10%).

The sets are completed with light exterior products that have a length no longer than the hip line, to provide comfort on the go.

If we analyze the answers offered, we notice that most wearers want to have comfortable clothes that would correspond to the disability they present and to have a beautiful and pleasant appearance. About 86.7% of respondents have positive opinions about the creation of special products, and the others do not consider it necessary to purchase a functional-adaptive product, because they consider that they are unexcused expenses.

The financial part is quite important in the purchase of special clothing, because about 73.3% of respondents do not work, 6.7% study and only 20% are employed. This explains the large number of sports products in the wearer's wardrobe.

Analyzing the way of purchasing special products for people with amputations of the lower limbs in the Republic of Moldova, we notice that the vast majority are forced to purchase products made on an industrial scale, which then modify them as needed. Only a small part can buy clothes online or make custom-made clothing products taking into account individual needs. This is strictly related to the low financial situation of the bearers.

The interviewees explained that they want to wear comfortable products (93.3%), beautiful and modern (60%) and of course quality (53.3%). Among the respondents' observations were also detected a series of non-compliant factors that can be observed in the clothing products they wear: high price (93.3%), inadequacy of the products to the type of disability (86.7%) and discomfort in behavior (66,7%).

Thus, taking into account the results obtained from the survey, it was proposed the range of necessary products used by people with amputations of the lower limbs during the period of adaptation and the period of social integration (Table 1).

Table 1. *Assortment of textile products for people with lower limb amputations*

Periods	Textile products	Product type
rehabilitation	clothing products	- underwear; - special clothing for patients with lower limb amputations (robe, gown, trouser, long-sleeve t-shirt, set for men and women (top and trouser)).
	auxiliary products	Bandages, compression stockings, liner.
integration	clothing products	- underwear; - outerwear (coats, jackets, trench coat – medium length); - intermediate (blouse, shirts, vests, sundresses, dress, pants, skirts, shorts, breeches – with special elements that will allow access to the amputated limb); - corsetry articles; - headgear and accessories.
	auxiliary products	Liner for prosthetic leg, stockings, tights.

3. CONCLUSIONS

Following the research, we can say that people with amputations of the lower limbs do not have a rich assortment of clothing products. They have to purchase industrially made products, which can then be modified as needed or adapted to them. It is observed that most of the products belong to a group that seems to be intended for the elderly without taking into account the fashion trends and the age of the wearer. It is also observed that a large part of the products are unisex, ie designed for both women and men.

All this does not allow the wearer to present an attractive image that would ensure increased self-confidence and allow a faster inclusion in society. That is why it is necessary to develop a rational wardrobe both for the period of social integration and for the period of rehabilitation, which:

1. to provide a special design with functional elements that will allow the “erasure” of the difference between people with special needs and ordinary people and to ensure psychological comfort;
2. to be ergonomic, to meet the requirements of the “human-clothing-environment” system and to allow the fulfillment of all the processes present in life such as independent dressing / undressing, matching clothing in static, dynamic and other positions characteristic of disability;
3. to present a series of optimal solutions through the presence of various functional-constructive elements, which would allow access to some less accessible areas, modification of functional elements, placement / removal of product details, etc .;
4. to raise the quality of life by offering the opportunity to participate in various social events.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

ANTIMICROBIAL FINISHING OF TEXTILES USING EMULSIONS BASED ON NATURAL PRODUCTS

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Abstract: *Bioactive dressings are obtained using substances which release bioactive compounds. A way of immobilization active ingredients on various textile materials is through emulsions based on natural polymers. Active ingredients, like essential oils and propolis play an important role in the inhibition and prevention of bacterial growth. Chitosan and xanthan gum are suitable for essential oil entrapment due to their biodegradability, low product costs and environmentally friendly production processes. The aim of this paper is to highlight the antimicrobial activity and biocompatibility of textile materials treated with cinnamon essential oil and propolis based emulsions. In this respect, experimental samples of oil-in-water emulsions type, based on chitosan-propolis-cinnamon essential oil and xanthan-propolis-cinnamon essential oil were prepared and then were immobilized on woven fabrics with different fiber compositions. The functionalized textile materials were characterized in terms of their physical-mechanical and physical-chemical characteristics, antibacterial activity and biocompatibility point of view. From the corroboration of the obtained data it was found that the obtained samples are more hydrophobic than the untreated material and the bioactive polymeric systems have shown antibacterial activity for both gram positive bacteria (S. aureus) and gram negative bacteria (E. coli) test strains. The in vitro biocompatibility evaluation on human skin cells confirmed the absence of cytotoxicity after the short-term exposure. Also, the treated samples displayed a good biocompatibility without skin irritations.*

Keywords: *bioactive textiles, propolis, chitosan, xanthan, antibacterial activity, biocompatibility*

1. INTRODUCTION

Skin provides the barrier between the body and the environment and the first line of defence against different noxious agents. Atopic dermatitis is a chronic relapsing inflammatory skin disease which usually starts during the first years of life. There are many factors known to worsen the disease, including food and inhalant allergens, climatic factors, skin infections due to *Staphylococcus aureus*, stress, chemical and physical irritants. In the management of AD, the correct approach requires a combination of multiple treatments to identify and eliminate trigger factors, and to improve the alteration of the skin barrier. Dressings can be an effective barrier against persistent scratching, allowing more rapid improvement of the lesions, and may reduce the external source of skin irritants and bacterial infection. Traditional dressings, such as material gauze and bandages, are the most common products to treat wounds, different skin problems, providing a protective barrier against microorganisms.

Herbal remedies are used for the control of bacterial infections [1]. The essential oils are complex mixture of chemical compounds sensitive to oxygen, light and high temperature. They are hydrophobic and therefore insoluble in water, which reduces their bioavailability and absorption in to the body. The encapsulation of essential oils in different matrices is necessary in order to prevent this inconvenience [2].

Cinnamomum verum (cinnamon) essential oil is known to have antioxidant, anti-inflammatory, and antimicrobial properties [1]. Propolis is a resinous substance of bees *Apis mellifera var. carnica*. Based on pharmacology, flavonoids are the most important. They are attributed many therapeutic effects such as antioxidant, antibacterial, antiviral, anti-inflammatory and antitumor [3].

A natural polymer used successfully in the biomedical field is chitosan, derived from chitin. It has the property to form films, is easy to chemically modify and has a high mechanical strength [4]. Chitosan exhibits excellent biocompatibility, biodegradability, nontoxicity and anti-microbial activity. Also, chitosan has an adhesive nature, antifungal, bactericidal feature, and oxygen permeability. Because of these immense activities, chitosan and its composites show good positive impacts on wound healing [5]. Xanthan gum is a microbial polysaccharide that has been widely used in medicine, food technology, chemical industry, textile and other fields, due to its desirable thickening, suspension, thermal resistance, acid and alkali resistance, electrolyte resistance and other properties [6].

The main goal of this study was to develop biofuntional textile materials designed for the treatment of inflammatory skin conditions and to enable the overall finishing processes influence on the physical-mechanical and physical-chemical characteristics, antibacterial and biological properties**.**

2. EXPERIMENTAL PART

2.1. Materials

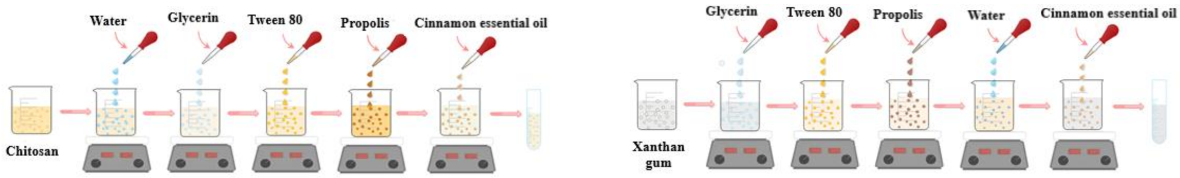
For the experiments, the following materials were used: chitosan with low molecular weight (Fluka Chemie GmbH, Switzerland) and xanthan gum (Mayam, Romania) as agents for incorporating the active principles, Tween 80 (Sigma Aldrich, Germania) as emulsifying surfactant, vegetable glycerin (SC Herbavit SRL Romania) as wetting solubilizer, cinnamon leaf essential oil (Adams Supplements, Romania) and propolis tincture of 70% ethanolic solution (Larix SA, Romania) as active ingredients, acetic acid (96%) (Consors, Romania), distilled water. Two scoured and bleached plain weave fabrics made from 100% cotton fixed at warp direction were used for the functionalization processes. The main characteristics of the fabrics are given in **Table 1**.

2.2. Preparation of polymeric bioactive systems

Oil-in-water emulsions were prepared by mechanical emulsification, the preparation methodology and their characterization being presented in previously our studies [7,8]. The succession of the preparation stages of polymeric bioactive systems is presented in **Fig. 1**.

2.3. Immobilization of bioactive polymeric systems on the textile materials

In this sense, the 2 polymeric systems were immobilized on the textile supports by the padding method in the following conditions: 3 passes, squeezing degree 85%, squeezing pressure 2.7 bars. The treated textile substrates were subsequently subjected to the drying operation at 50°C for 3 minutes. The codification of the experimental variants is presented in the **Table 1**.



a) b)

Fig. 1: *The succession of the preparation stages of the bioactive systems:*
a. chitosan-propolis-cinnamon essential oil; b. xanthan-propolis-cinnamon essential oil

Table 1: Coding of textile materials treated with bioactive systems

Code	**Fibrous composition**		**Mass [g/m²]**	**Carrier system**	**Experimental variants**
	Warp	**Weft**			
V1	100% cotton, Nm50/2	100% acetate, 130dtex	136	chitosan-propolis-cinnamon essential oil	**V1C**
V2	100% cotton, Nm50/2	100% lenpur, Nm 34/1	172	chitosan-propolis-cinnamon essential oil	**V2C**
V1	100% cotton, Nm50/2	100% acetate, 130dtex	136	xanthan-propolis-cinnamon essential oil	**V1X**
V2	100% cotton, Nm50/2	100% lenpur, Nm 34/1	172	xanthan-propolis-cinnamon essential oil	**V2X**

2.4. Methods

2.4.1. Testing the physical-mechanical and physical-chemical properties

The treated fabrics were characterized in terms of the main physical-chemical and physical-mechanical characteristics, respectively: mass per unit area (SR EN 12127-2003), hydrophilicity (drop test method according with SR 12751/1989 standard), water vapour permeability (STAS 9005: 1979), permeability to air (SR EN ISO 9237: 1999).

2.4.2. Evaluation of antibacterial activity

For testing the antimicrobial activity, the diffusion agar method was used in according to the standard SR EN ISO 20645:2005, with cultures in 24-hour liquid medium of ATCC 11229 *Escherichia coli* (Gram-negative) and ATCC 6538 *Staphylococcus aureus* (Gram-positive) test strains.

2.4.3. Biocompatibility

To evaluate biocompatibility, the MTT test (based on the reduction of a yellow tetrazolium salt- 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide or MTT, to purple formazan crystals by metabolically active cells) was performed to determine cell viability and the level of nitric oxide (NO) released in the culture medium was determined. Preliminary steps were required to perform these tests that consists in cultivation of HaCaT keratinocytes and exposure them to textile materials in 24-well plates and in cell culture inserts. All results were calculated with mean values of at least three independent experiments (n = 3). The data were representative of the non-impregnated control.

3. RESULTS AND DISCUSSION

3.1. Physical-mechanical and physical-chemical properties

The comparative analysis of the measured characteristics for the textile materials treated with both carrier systems, presented in **Table 2,** highlighted that the functionalization treatments generates an increase of the mass characteristics due to the amount of polymeric substances immobilized on the surface of the textile fabrics that remain fixed to the textile support at the end of the process, the growing being differentiated depending on the fibrous composition and to type the polymeric system used for the conferring of healing properties. Air permeability of functionalized samples registers much lower ratio compared to untreated ones, indicating a decrease in comfort properties for all experimental variants. The performed functionalization treatments lead to the decrease of the water vapour permeability, there being a small insignificant variation between the two variants of textile structures. The functionalization treatments, applied on both textile structures, performed with the polymeric system based on chitosan leads to a more accentuated decrease of the hydrophilicity compared to the treatment performed with the polymeric system based on xanthan.

Table 2: Physical-mechanical and physical-chemical characteristics of the treated samples

Code	**Fibrous composition**		**Mass**	**Air permeability**	**Water vapour**	**Hydrophilicity**
	Warp	**Weft**	**(g/m²)**	**(l/m²/sec)**	**permeability (%)**	**(s)**
V1	100% cotton, Nm 50/2	100% acetate, 130 dtex	136	260.4	42.4	instantaneous
V1C			169	116.4	25.8	6.95
V1X			171	85.02	29.9	1.81
V2	100% cotton, Nm 50/2	100% juniper, Nm 34/1	172	386	45.5	instantaneous
V2C			201	349.2	27.5	5
V2X			199	261	30.7	0.98

3.2. Evaluation of antibacterial activity

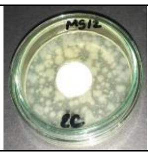
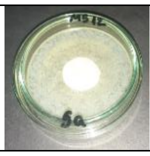
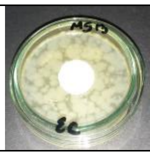
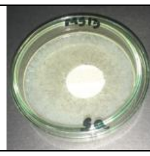
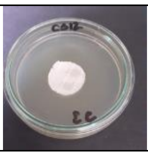
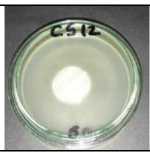
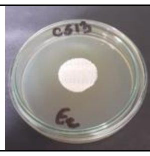
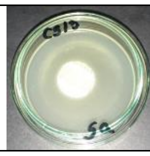
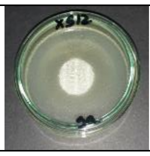
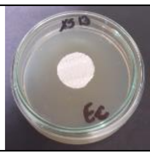
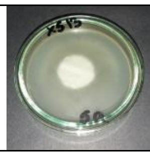
The evaluation of antibacterial activity is presented in **Table 3** and the images of the Petri dishes registered after 24 hours of incubation are shown in **Table 4**.

Table 3: Evaluation of antibacterial activity

Code	**Inhibition zone (mm)**		**Evaluation**	
	E. coli	*S. aureus*	*E. coli*	*S. aureus*
V1	0	0	Insufficient effect	Insufficient effect
V1C	16	11	Satisfactory effect	Satisfactory effect
V1X	5	15	Satisfactory effect	Satisfactory effect
V2	0	0	Insufficient effect	Insufficient effect
V2C	16	10	Satisfactory effect	Satisfactory effect
V2X	16	13.5	Satisfactory effect	Satisfactory effect

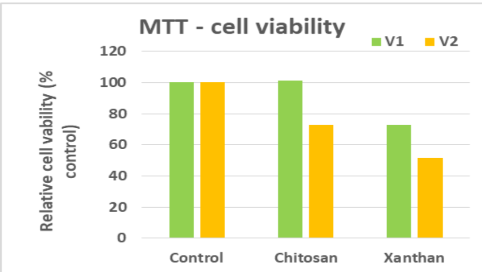
Regardless of the textile structure used to obtain biomaterials designed for the treatment of inflammatory diseases, textile structures treated with bioactive polimeric systems have an antibacterial effect against both test strains, with inhibition zones between 5 mm (V1X in the presence of *E. coli*) and 16 mm (V2X, V1C, V2C in the presence of *E. coli*). In the case of untreated textile structures, considered control, the test strains had a significant development, the inhibition zone around the textile samples being absent.

Table 4: Images of Petri dishes after the exposure to the *E. coli* and *S. aureus* strains of the V1, V2 woven fabrics before and after the functionalization

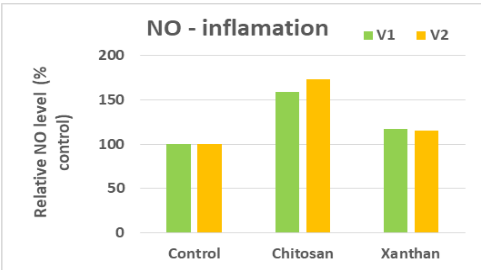
E coli	***S aureus***	***E coli***	***S aureus***
V1		**V2**	
			
V1C		**V2C**	
			
V1X		**V2X**	
			

3.3. Biocompatibility

Based on the biocompatibility tests (**Fig. 2.a**), it was revealed that in the presence of functionalized textile materials, the fibroblasts cultured on inserts maintained their viability. In the case of keratinocytes cultured in the presence of textiles materials treated with chitosan-propolis-cinnamon essential oil polymeric system, cell viability was better compared to the results obtained in the case of keratinocytes cultured in the presence of textiles impregnated with the polymeric system based on xanthan-propolis-cinnamon essential oil. Also, a moderate increase in nitric oxide (**Fig. 2.b.**) can be observed in the case of textiles impregnated with the polymeric system based on chitosan.



a)



b)

Fig. 2: *Graphical represenatations of: a - Cell viability test - MTT after 5 hours of incubation; b - Relative level of NO released in culture medium in two-dimensional system*

5. CONCLUSIONS

Two types of blended textile materials with different fiber composition impregnated with emulsions based on chitosan-propolis-cinamon essential oil and xanthan-propolis-cinamon essential oil were assessed in order to explore their physical-mechanical, physical-chemical, antimicrobial and biological properties and to find out the possible applications in developing bioactive dressings destined for the treatment of inflamatory skin injuries. The functionalization treatments have increased the mass characteristics per unit area due to the polymeric products immobilized on the surface of the textile supports. Air and water vapour permeability of functionalized samples registers much lower scales compared to untreated ones, indicating a decrease in comfort for all selected experimental variants

Textile materials treated with both bioactive polymeric systems have shown antibacterial activity for both gram positive bacteria (*S. aureus*) and gram negative bacteria (*E. coli*) test strains. The *in vitro* biocompatibility evaluation on human skin cells confirmed the absence of cytotoxicity after the short-term exposure. As our findings showed their good biocompatibility, these newly biofunctional textiles obtained by treatment with chitosan/xanthan-propolis-cinnamon essential oil polymeric systems can become a suitable candidate for the curative treatment of skin injuries, providing no skin irritations.

ACKNOWLEDGEMENT

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

SEAM PROPERTIES OF STRETCH FABRICS

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Abstract: *The paper investigates the longitudinal seam stretching properties on ISO 301 lockstitch seams on garments made of stretch fabric. The influence of factors such as manual manipulation during sewing, stitch density, ply number in the seam and sewing thread extension, was investigated on stretch fabric. The result of planed experiment shows that the ply number thread extension and stitch density are significant factors to seam stretching in seam direction. It was found that the most significant factor on seam stretching in longitudinal direction is ply number. By application of sewing thread of higher extension, the stretching of the lockstitch seams in longitudinal direction of over 100% can be obtained.*

Key words: *longitudinal seam stretching, stretch fabrics, ply number, thread extension, stitch density*

1. INTRODUCTION

Seam is a basic requirement in clothing production. The seam must have good visual appearance, appropriate functional properties and durability. The seams are considered one of the essential requirements in apparel construction and their properties must correlate to the quality of main fabric. Seam performance relies on several parameters such as: seam strength, elasticity, durability, puckering, appearance and yarn severance [1-4]. Also, seam quality depends on its type, stitch density, sewing thread tension and seam efficiency [5].

During the usage and wear, the seams may be loaded at any angle to the direction of sewing. The response of the seam to application of a load, and to its subsequent release, is the issue underlying many investigations. A response of the seam varies with the direction of loading and size of the load.

Appearance and performance of the seam are dependent upon the quality of sewing threads and their dynamic behavior. One essential requirement of any sewing thread is that it must be compatible with the needle size, various sewing machine settings (sewing speed, thread tension) and the fabric on which it is being used [6]. Although the effect of the sewing thread on seam performance is generally much less noticeable than the fabric one, many situations occur where the use of better sewing thread represents a practical solution to a seam performance problem [7].

Due to the tendency for stretch fabrics in the textile industry, garment manufacturers need to work more precisely on the sewing of elastic fabrics. Most stretch knit garments are seamed with overedge and/or cover stitch seam constructions because these stitches offer the best seam elasticity and coverage of the raw edge of the fabric. A quality problem that is common with stretch knits is excessive "broken stitches" or "stitch cracking" when the seam stretches excessively. It was found that the linear density of the weft in-laying threads and the preliminary tension of the ground yarn at pillar stitch affect stretch properties of elastic warp knitted fabric and deformation [8]. The detail analyses of the constructions of the medical preventive goods were carried out, and Melnyk and Kyzymchuk [9] considerate that an elastic warp knitted structure with pillar stitch is usually used for such purposes. The influence of inlaying variants of weft yarn on structure parameters of such stretch warp knitted fabric was found to have greater effect on fabric stretching [10]. Pillar stitch is not widely used interloping and the tensile strength of pillar stitch fabric is smallest among three common types of warp knit stitches (tricot, cord, and pillar) [11]. In recent years, stretch fabrics have been extensively used in garment production as face fabric and in combination of other face materials [12, 13]. Beside improvements in deformation and compression properties, there are still problems regarding seam extensions in longitudinal direction in stretch fabric garments, especially in application of lockstitch type stitch. The aim of the paper is to investigate the factors affecting longitudinal seam stretching and possibilities of improving longitudinal seam stretching in production of shirts made of stretch material.

2. EXPERIMENTAL

The investigation is undertaken to deal with real production problem in shirt manufacturing. The shirt was produced from stretchable knit fabric of fibre composition 76% polyamide and 24% elastane. Apart from other seams of the garment, the bottom hemming seam of the shirt was required to be produced on single needle lockstitch sewing machine employing stitch type 301. It was noticed that the extension of bottom hemming seam in longitudinal direction was not sufficient for the extension of the fabric. This was exhibited by thread breaking in the seam or seam cracking when stretching the seam in longitudinal direction. To investigate the possibility to increase seam extension, the manual stretching of the material while sewing was applied. The material was stretched as evenly as possible while sewing. Furthermore, the influence of various factors such as: stitch density, material ply number in the seam and sewing thread extension, on seam stretching properties was evaluated using planned experiment. Two types of sewing threads of various breaking strength and extension at break were used for production.

The following methods were employed for testing the fabric and seams:

- BS EN ISO 13934-2:1999Textiles. Tensile properties of fabrics. Determination of maximum force using the grab method
- DIN EN ISO 2026:1995-05Textiles – Yarns from packages – Determination of single-end breaking force and elongation at break using constant rate of extension (CRE)
- AATCC TS-015: 2004Seam stretchability of knitted garments. The width of the sample is 100mm and the distance between the clamps is 75mm.

3. RESULTS AND DISUSSION

The features of the fabric and sewing thread are depicted in Table 1 and 2.

Table 1: *The properties of the stretch fabric*

Fibre composition	Fabric weight,g/m^2	Breaking strength, N		Extension at break, %	
		Lengthways	Widthways	Lengthways	Widthways
76% PA 24% Elastane	154.7	225.3	226.9	287.9	364.8

Table 2: *The properties of the sewing threads*

Thread designation	Fibre composition	Thread count, Tex	Breaking strength, N	Extension till break, %
S1	100% PES	27	9.62	13.72
A1	100% PES	27	11.39	17.69

The fabric for shirt production has similar breaking strength in both testing direction. The extension of the fabric till break is over 100% and it is 70% higher widthways. Regarding applied sewing threads, the thread A1 has higher breaking strength and has 4% higher extension at break than thread S1.

When testing the seam in longitudinal direction, there is characteristic load extension curve consisting of several peaks (fig 1). When seam is being extended, the sewing thread breaks first. This can repeat several times, till the seam is still capable of carrying the stress. After that, the fabric carries the stress and test continues till fabric breaks. The moments when sewing thread breaks is displayed on graph by several peaks starting at the beginning of load extension curve.

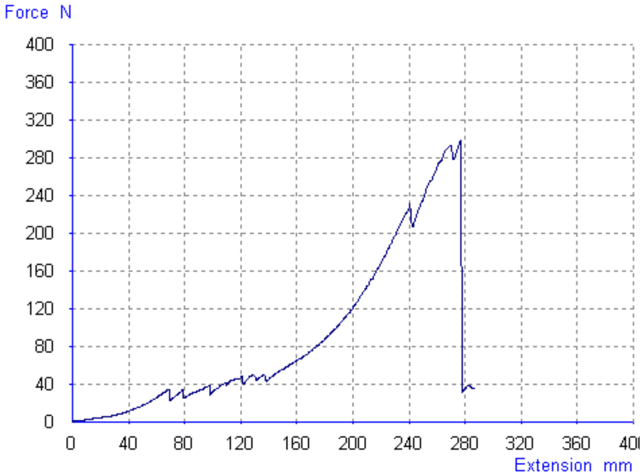

***Fig. 1**: Stress extension curve for the seams in longitudinal direction*

The results of longitudinal seam strength and extension for 2 ply superimposed seams is shown in table 3. The strength and extension of the seams are recorded for the first 4 peaks of the load extension curve. In all cases the breaking strength and extension increase from the first to the following peaks. However, already at first peak, the tread in the seam breaks and the seam is regarded unacceptable. The seam made of thread S1 (which have higher strength and extension than A1) shows higher seam strength and stretching. There is not clear difference in seam breaking strength and extension between the stretched sewing seam and the regular one, at the first peak. At this peak, which is most important for the seam quality, there is no difference for stretched sewing and regular sewing seams of thread S1. The stretched seam from thread A1 shows just 2% higher percentage of extension than regular one. At following peaks, the difference in strength and extension of stretched and regular sewn seams is greater and generally stretched sewing seams show higher extension and breaking strength.

***Table 3:** The seam strength and extension in longitudinal direction*

Designation	I peak		II Peak		III peak		IV Peak	
	Breaking strength (N)	Extension (%)	Breaking strength, (N)	Extension (%)	Breaking strength (N)	Extension (%)	Breaking strength (N)	Extension (%)
S1-stretched sewing	25.7	44.2	26.6	63.7	37.7	109.4	41.8	123.4
S1-regular sewing	26.2	44.5	24.7	53	35	105.6	34.5	114.3
A1-stretched sewing	18.6	33.1	18.9	43.3	24.4	73.5	29.8	97.1
A1-regular sewing	18.7	31.3	21.1	41	24.4	82.4	26	92

Planned 2^3 experiment was conducted to analyze the influence of three factors: A-seam stitch density, B-seam ply number and C-thread extension on seam extension properties in longitudinal direction. The seam extension was registered from the load extension curve just for the first peak of the thread breaking. For testing three ply seams, knife pleat 2.0 cm wide was made in the middle of the sample and pleat was seamed in the middle by single needle lockstitch machine. The factor levels are shown in table 4 and the results of the planned experiment in table 5.

Table 4: *High and low levels of the factors for planned experiment*

Factors / Levels	A	B	C
	Stitch density	Ply number	Thread extension
-1	4.5 cm^{-1}	1	13.9%
1	5.5 cm^{-1}	3	17.7%

Table 5: *The factors combination matrix and result of 2^3planned experiment*

Run	Replication	A-Stitch density	B-Ply number	C-Thread extension	Seam extension, %
1	1	1	-1	1	36.33
2	1	-1	1	1	89.2
3	1	-1	-1	-1	31.77
4	1	1	1	-1	74.13
5	2	1	-1	1	43.16
6	2	-1	1	1	92.4
7	2	-1	-1	-1	28.12
8	2	1	1	-1	72.26
9	3	1	-1	1	35.41
10	3	-1	1	1	93.73
11	3	-1	-1	-1	28.58
12	3	1	1	-1	74.13

The ANOVA results show that the all three factors have significant influence on seam extension in longitudinal direction (Fcalc.>Fcrit. for 95% confidence limit and $p<0.05$). The Pareto chart shows the effect of the three factors on seam extension in longitudinal direction (fig. 2). The ply number has greatest effect on seam extension, followed by sewing thread extension and stitch density.

Table 6: *ANOVA table of the influence of three factors on seam extension in longitudinal direction*

	SS	df	MS	F	p
(C) Stitch density	67.119	1	67.119	9.432	0.015322
(B) Ply number	7128.713	1	7128.713	1001.742	0.000000
(A) Thread extension	549.995	1	549.995	77.286	0.000022
Error	56.931	8	7.116		
Total SS	7802.757	11			

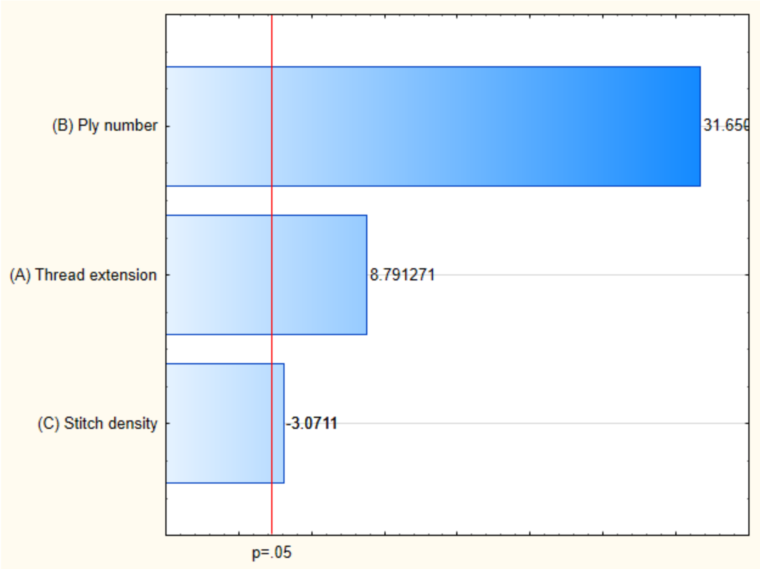

Fig. 2*: Pareto chart of standardized effects of the three factors on two levels on seam extension*

Although the factor ply number has greatest effect on seam extension, the ply number cannot be changed during manufacturing since it is specified in technical pack. The same apply for stitch density. So, the only solution that can do in manufacturing is the application of the sewing thread of higher extension. The regression equation of seam extension in longitudinal direction is given in equation 1.

Table 7: *Regression summary for dependent variable seam extension*

	b*	Std. Err. - of b*	b	Std. Err. - of b	t(8)	p-value
Intercept			-23.1262	10.16253	-2.27564	0.052427
Stitch density	-0.092747	0.030200	-4.7300	1.54016	-3.07110	0.015322
Ply number	0.955832	0.030200	24.3733	0.77008	31.65031	0.000000
Thread ext.	0.265494	0.030200	3.5632	0.40531	8.79127	0.000022

$$E_{seam/L} = -23.1 + 24.4 \times n + 3.6 \times E_{thread} - 4.7 \times s_d \quad \textbf{(1)}$$

Where:
$E_{seam/L}$ - seam extension in longitudinal direction
n- ply numbers in the seam
E_{thread} - thread extension
s_d- stitch density

There are several sewing thread manufacturersoffering sewing threads for stretchable fabrics of high extensibility up to 22% [14]. For the threads S1 and A1 the equation gives values of 77.6% and 91.7% seam extension respectively. For the thread extension of 22%, ply number of 3 and stitch density of 4.5 cm^{-1}, the equation returns the value of seam extension in longitudinal direction of 107%. So the application of the special sewing thread of high extension can considerably improve longitudinal stretching properties of the lockstitch seam.

4. CONCLUSION

The sewing thread extension, stitch density longitudinal seam stretching and ply number in the seam affects seam stretching in longitudinal direction.

The manual stretching of the ply while sewing does not show clear effect on longitudinal seam stretching.

The result of the planed experiment and analysis of variance shows that most significant factor on seam stretching is ply number in the seam, followed by sewing thread extension and seam stitch density.

The regression model of seam stretching suggests that the application of special sewing thread of high extension can increase the longitudinal seam stretching or lockstitch type seam to over 100%.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

DYEING OF COTTON MATERIALS AFTER BIOSCOURING AND ENZYMATIC BLEACHING TREATMENTS

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Abstract: *The research aim was to determine the pretreatment (scouring and bleaching) method's influence on 100 % cotton materials dyeing. Before bleaching treatments, the fabrics' non-cellulosic attendants were removed during a pectinolytic treatment and classic alkaline treatment. The general idea of the investigation was maintained in all stages approached, so in addition to the alkaline treatment, an enzymatic treatment was performed (bioscouring) where the classical chelating agent, EDTA, was replaced with sodium citrate. Further, the fabrics were bleached using hydrogen peroxide or a green one, enzymatic, with laccase. A commercial reactive dye was used to colour the cotton samples. The efficiency of the treatment was determined by following the dye fixation degree through soaping.*
The weight loss, hydrophilicity, tensile strength, elongation at break and colorimetric measurements were used to analyse the treated samples. The higher weight loss values of ~ 5% were found for the alkaline scoured sample and alkaline scoured sample followed by hydrogen peroxide bleaching which also showed the lowest value for tensile strength (259.90 N). Hydrophilicity was less than 3 seconds for all treatments. The 100% dye fixation degree was obtained for the bioscoured sample and bleached with H_2O_2.
Even if the eco-friendly treatments proposed as an alternative for classical scouring and bleaching lead to similar or lower results, some of their advantages should be considered: environmentally friendly, lower costs, a lower fibre damage degree, etc. All these procedures use a lower temperature, respectively, fewer quantities of reagents and are not significantly aggressive with the environment.

Key words: *eco-friendly treatments, laccase, dyed cotton fabrics, colorimetric measurements, dye fixation*

1. INTRODUCTION

The textile industry proved to be feasible for the new world tendency in reducing environmental damaging factors. Many studies underline the possibility of using eco-friendly treatments for different purposes as desizing [1], bioscouring [2], or bleaching [3]. The technological steps could be considered separately [1-3] or integrated [4], regarding the enzymatic procedure.

Regardless of the phase, the use of the biotechnologies represents an ecological alternative to the classical approaches. The characteristic parameters of the treated fabrics (wettability, whiteness degree, tensile strength and elongation at break, etc.) are comparable or improved compared with standard methods [5].

Our present investigation had as a primary objective of the comparative evaluation of cotton fabric dyeing behaviour after enzymatic and classical, scouring and bleaching treatments. To ensure the higher ecological approach the samples were bioscoured. The reaction bath formula was modified, also in respect to the complexing agent. In this regard, EDTA was replaced with a citrate salt, considered a greener chelator [6] for Ca^{2+} ions released during the pectic hydrolysis. The cotton fabrics were subjected to bleaching after removing the non-cellulosic attendants (waxes, pectins, organic acids, etc.) during the scouring/bioscouring treatment. The natural yellow-brown colour of the fibre being known is a preparatory step before dyeing. It also improves the hydrophilicity of the material simultaneously with increasing whiteness degree [5]. Currently are used different methods to conduct this procedure. The most used treatment is based on hydrogen peroxide due to its satisfactory results obtained. Over time, different bleaching formulas based on synthetic or enzymatic reagents have been proposed. Although, some non-enzymatic formulas are considered economically efficient [7] they retain their degree of toxicity to the environment. To obtain a whitening effect, the used treatments must be based on oxidative reactions. Under these conditions' oxidases can be successfully used. Good results have been obtained in the case of laccase biocomposites [8]. Looking at efficiency, economic and environmental perspective, promising results at the pilot scale have been obtained using a mixt classic- green system, hydrogen peroxide-laccase in ultrasound media [9].

Another possibility to decrease the harmful potential of classical cotton bleaching treatment consists of the use of different activators. In the case of N-[4-(triethylammoniomethyl) benzoyl]butyrolactam chloride, the reaction temperature needed was almost half (50 °C) compared with the one normally used (90°) [10]. This approach contributes to energy saving.

2. EXPERIMENTAL PART

2.1 Materials

The samples consisted of cotton fabric with 150 ± 3 cm width, 200 ± 10 g/m^2 weight, 100% cotton yarn with Ne 25/2 warp and 100% cotton yarn with Ne 25/1 weft.

The mixture of pectinases, Beisol PRO, the surfactant Denimcol Wash RGN, commercial reactive dye Bezaktiv Rot S-3B and Denimcol LAC-LRE were provided by CHT Bezema. Sulfolen 148 (S-148, alkyl polyglicol ether) and the anionic washing agent Cotoblanc HTD-N were provided by Rotta Company. Sodium citrate, sodium hydroxide, sodium carbonate, sodium bisulfite, sodium silicate, hydrogen peroxide, sodium chloride were purchased from Sigma-Aldrich.

2.2 Methods

2.3.1 Samples pretreatment

To remove the dust and physically linked attendants the samples were first washed at 100 °C in an AATCC standardized Lander-Ömeter, model M228-AA from SDL Atlas Company-USA. The procedure was followed by drying, conditioning and mass determination as described in the international standards.

2.3.2 The bioscouring/scouring treatment

The pectin hydrolysis was developed in an ultrasound (45 KHz) assisted media at 1:20 liquor to fabric ratio. 2 % (concentration over fibre) of Beisol PRO biocatalyst was used for 35 minutes at 55 °C to remove the pectin from the cotton fibre. In the bath reaction were added also a surfactant Denimcol Wash RGN 0.5 % and sodium citrate 2 g/L as a chelating agent. The scouring treatment was performed for 1h at 100 °C using 1 g/L sodium bisulfite, 2 g/L sodium silicate, 5 g/L sodium carbonate, 10 g/L sodium hydroxide and 2 g/L of wetting agent Sulfolen 148 (S-148, alkyl polyglicol ether). All the samples were then washed with hot (70 °C) and cold water and dried at room temperature.

2.3.3 The bleaching treatments

The cotton samples were bleached using a c*lassical procedure* and an *enzymatic* one. In the first case, the reagents mixture consisted of 3 mL/L hydrogen peroxide (30 %), 1 g/L NaOH and 4.5 mL/L sodium silicate. The fabrics were kept 40 min at 95°C. In the enzymatic procedure 3 % o.w.f. (over fibre) commercial laccase (Denimcol LAC-LRE) was used. It is a suitable enzyme for the bleaching of cellulosic materials. The conditions indicated in the technical data sheet from the manufacturer were used: temperature 60 ^{0}C for 40 min. In both cases, the fabric to liquid ratio was 1:10.

2.3.4 The dyeing treatment

Dyeing of the cotton samples was made with a commercial reactive dye Bezaktiv Rot S-3B-2 % (o.w.f.), 1.5 mL/L NaOH 32.5 %, 15 g/L Na_2CO_3 and 80 g/L NaCl. The treatment was carried out by all-in procedure in a JULABO water bath at 60 ^{o}C for 90 minutes at a bath ratio of 1:40. The dyeing treatment was followed by three successive washing steps with distilled water and a washing step in a soap solution of 2 mL/L Cotoblanc HTD-N, anionic washing agent and 1 g/L Na_2CO_3 at 90°C for 15 min. The samples were further rinsed again with distilled water and air-dried at ambient temperature [11].

2.3.5 The weight loss, hydrophilicity and tensile strength

The samples were kept in a standard atmosphere (65 ± 2% humidity at 21 ± 1°C) to achieve the humidity equilibrium before the weight loss, hydrophilicity and mechanical properties determinations. The mass loss of the cotton samples was gravimetric determined. The tests were dried at 105°C in an oven (Caloris Group, Romania). The parameter was determined using the equation (1):

$$\% \text{ weight loss} = (W1-W2) \times 100/W1 \quad \textbf{(1)}$$

where: W1-W2 are the weights of dried samples fabric before and after the treatments.

The standardized AATTCC Test Method 79-2007 was used for hydrophilicity determination. The mechanical properties were investigated based on the method described previously [12] using a 5KT testing machine (Tinius Olsen-United States) with a Horizon software interface running on a connected PC.

2.3.6 The colorimetric measurements

The dyeing efficiency was measured using a Datacolor 500 spectrophotometer. The colour strength [K/S] was determined after the samples' colouring and after the soaping procedure. The %R reflectance was measured at the maximum wavelength (500 nm). The K/S was calculated at the batch wavelength of maximum absorbance according to the equations (2) and (3):

$$K/S = [\{(1-R)_2 / 2R\}] \quad \textbf{(2)}$$

$$\text{Colour Strength} = [(K/S)_{Batch} / (K/S)_{Standard}] \times 100 \quad \textbf{(3)}$$

where: R-reflectance measured at 500 nm;
K/S_{Batch}-colour strength of the dyed treated sample;
$K/S_{Standard}$-colour strength of the standard.

3. RESULTS AND DISCUSSIONS

The characteristic parameters of the cotton samples after all the applied pretreatments (classical scouring, enzymatic scouring, classical bleaching and enzymatic bleaching) are presented in Table 1.

Table 1: *Characteristic parameters of the 100% cotton samples after all the applied pretreatments*

Samples	Weight loss (%)	Hydrophilicity (s)	Whiteness degree R (%)	Tensile strength (N)	Elongation at break (%)
B	1.3	3	55.88	295.71	21.60
BL	0.34	1.8	57.20	294.40	21.70
BHP	1.54	1.1	70.65	283.40.	21.40
AS	5.0	1	72.90	270.05	24.30
AL	1.89	<1	73.14	269.80	25.20
AHP	4.66	<1	83.30	259.90	19.70

B-bioscoured sample; BL-bioscoured laccase bleached sample; BHP-bioscoured hydrogen peroxide bleached sample; AS-alkaline scoured sample; AL-alkaline scoured-laccase bleached sample; AHP-alkaline scoured hydrogen peroxide bleached sample.

The data presented in Table 1 show a higher weight loss in the case of the samples classical bleached. Comparing the mass decrease degree between the laccase treated samples and the hydrogen peroxide one, the difference registered is only 0.7 %. These results open the possibility to use the enzymatic treatment due to its higher biodegradability. The sample's wettability values are comparable in the case of the whitened specimens independent of the conditions considered. Levels lower than 3 seconds are appreciated as being good. The tensile strength and elongation at break of the treated cotton samples differ depending on the treatment conditions. In the case of the enzymatically treated samples, the mechanical characteristics have higher values after both bioscouring and bleaching treatments. The alkaline scoured samples have lower tensile strength, the minimum value recorded being for the sample alkaline treated and bleached with hydrogen peroxide. The situation may be determined by the fact that this was the most aggressive treatment [13].

The dyed sampled colorimetric characteristics are presented in Figures 1 and 2.

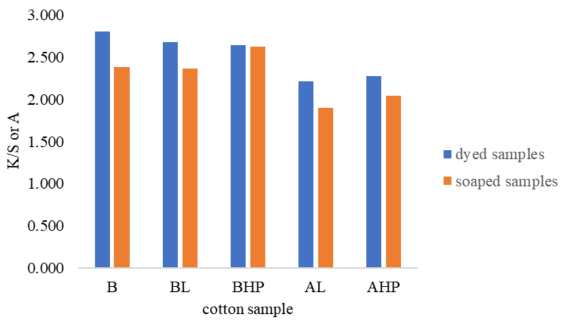

Fig. 1*: Cotton samples colour strength at the wavelength of maximum absorbance*

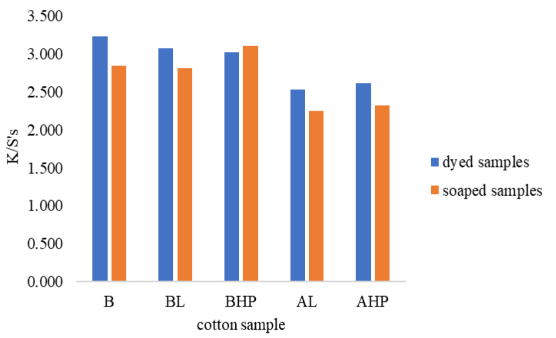

Fig. 2*: Cotton samples colour strength at the dominant wavelength*

The measured reflectance values for the dyed cotton samples were used to calculate colour strength [K/S]. The values varied between 13.413 (B) and 17.825 (AL). The differences between the enzymatic bleached (BL) sample and the classical (AL) one is not significative being of approximative 14%. As expected, the %R increased values were obtained for the alkaline scoured samples, cases in which also the whiteness degree was higher.

As shown in Figures 1 and 2, the calculated colour strength registers a slight decrease in the case of the alkaline scoured samples, the difference being almost 22% compared with the bioscoured one. This indicates the formation of several reactive groups during the pectinolytic treatment, which further influences the cotton-dye covalent link formation. The trend remains the same also after the soaping procedure.

The dye fixation degree after the soaping procedure is presented in Table 2.

Table 2: *Dye fixation degree parameters of the 100% cotton samples after dyeing and soaping*

Samples	Fixation degree calculated with K/S or A at Wl. of Max. Abs. [%]	Fixation degree calculated with Batch K/S's [%]
B	84.827	87.810
BL	88.294	91.491
BHP	99.098	100.001
AL	85.861	88.767
AHP	89.789	88.958

The dye fixation values were calculated using data from Datacolour software (K/S or A at Wl. of Max. Abs. and Batch K/S's). As presented in Table 2, the maximum value was obtained for the cotton sample bioscoured and classical bleached. The differences between the various samples are relatively low, varying with approximative 5%, independent of the bleaching or scouring treatment. The results can be explained by the formation of approximately the same number of cellulose hydroxylic ionic groups which covalently bind the dye [1]. In this situation the enzymatic treatments successfully could be recommended, their impact on the environment being lower compared with the classical ones.

4. CONCLUSIONS

A comparative evaluation of 100% cotton fabric’s dyeing behaviour after enzymatic and alkaline scouring followed by enzymatic and classical bleaching treatments was performed. The samples analysis after scouring, bleaching and dyeing were performed based on evaluation of different characteristics: physic, mechanic and colorimetric parameters. All three mentioned treatments were made using enzymatic and classical conditions. The higher weight loss values were obtained in the case of alkaline scoured sample and alkaline scoured sample followed by hydrogen peroxide bleaching. This weight loss also led to lower values for the tensile strength of the fabric. Better results were observed in the case of all enzymatic treatments with lower weight loss values, better tensile strength and comparable values for hydrophilicity. The measured reflectance values for the dyed cotton samples varied between 13.413 (B) and 17.825 (AL), the differences between the enzymatic bleached sample (BL) and the classical (AL) one being of approximative 14%. Fixation degree values of the dyed samples after the soaping procedure were between 87.810% and 100%, the higher value being for BHP sample. The results obtained recommend the enzymatic conditions for scouring followed by hydrogen peroxide bleaching, the procedure being less aggressive, the environmental and economic impact being lower in these cases.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

DEVELOPMENT AND CHARACTERISATION OF POLYPROPYLENE-PLGA ELECTROSPUN HERNIA MESHES

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Abstract: *The use of polymer hernia meshes lead to significant reduction in the rate of relapse, pain minimisation, overall improving the post-operative outcomes of abdominal hernia. Regardless of the fact that a wide range of surgical meshes have been tailored and employed in hernia healing procedures, no mesh has yet enabled a sufficiently strong structure to simultaneously promote the remodeling of the host tissue. Within this line of thought, Electrospinning is a versatile technique, being the most reliable way of manufacturing continuous fibers scaling from nano to micrometer. Electrospun fibers have high porosities and a highsurface-volume ratio perfectly mimicking the native extracellular matrix. We have used electrospinning of poly (lactic-co-glycolic acid) (PLGA) on polypropylene hernia meshes which we characterized by scanning electron microscopy. The biocompatibility of the fibers was confirmed by cell viability assay and cell morphology analysis. We show here that the meshes modified with PLGA- nanofibers harbored an excellent biocompatibility.*

Key words: *hernia mesh, electrospinning, PLGA, polypropylene meshes, biocompatibility*

1. INTRODUCTION

Electrospinning is a versatile technique, being the most reliable way of manufacturing continuous fibers scaling from nano to micrometer. Electrospun fibers have high porosities and a highsurface-volume ratio [1] and can perfectly mimic the native extracellular matrix (ECM). Many scientific papers have demonstrated the ability of micro/ nano-fibres to support cellular attachment and enhancecell proliferation. There is a wide range of materials that can be used in this technique, such as natural or synthetic polymers, ceramic, as well as composites. Typically, natural polymers used for electrospinning include gelatin, collagen, chitosan and silk fibroin, while synthetic polymers include polylactide (PLA), poly (lactic-co-glycolic acid) (PLGA) and poly (-caprolactone) (PCL) [2-3].

Within this study, we have performed electrospinning of PLGA on a polypropylene hernia mesh. Moreover, we show that surface modification has significantly improved biocompatibility of the surgical mesh.

2. MATERIALS AND METHODS

2.1. Preparation of electrospun PLGA nanofibers. PLGA was firstly dissolved in choloroform/DMF (v/v = 3:1) at a concentration of 16%. The electrospun nanofibers were prepared with an in house engineered electrospinning equipment where a stainless steel needle with an inner diameter of .19 mm mm was used. The electrospinning conditions were set at an applied voltage of 15 kV, a tip-to-collector distance of 15 cm, and a flow rate of 0.5 mL/h controlled by a syringe pump (working temperature 24°C and relative humidity of 35%)

2.2. Morphology characterisation. Morphologies of the PLGA nanofibers was analysed by a scanning electron microscopy (SEM) (type Quanta 200 (FEI, Eindhoven, Netherlands) with an operating voltage of 15 kV. Before microscopic observation, meshes were sputter coated with gold films (10 nm thickness). Fiber diameters were quantified using the Image J 1.40G software.

2.3. Biocompatibility

Biocompatibility was evaluated using the MTT and LDH tests a spreviously described [7]. MTT assay is a quantitative test used for evaluation of both cell viability and proliferation. Briefly, NCTC fibroblasts were incubated with 1 mg/ml [3-(4.5- dimethylthiazol-2yl)]-2.5-diphenyltetrazolium bromide (MTT) solution for 4 hours. Formazan crystals were solubilized with HCl-SDS, resulting in purple solution, quantified by spectrophotometry at 570 nm, using FlexStation3 (Molecular Devices, USA).

The cytotoxicity LDH test (Roche) was performed according to manufacturer's instructions. Cells that no longer have membrane integrity release lactate dehydrogenase (LDH) into the culture medium. The culture medium was collected and mixed with the kit's components in order to be evaluated 2 days of culture by spectrophotometric readings at 490 nm. Cell morphology in the presence of the electrospun meshes was evaluated by phase contrast microscopy.

3. RESULTS AND DISCUSSION

The morphology of the formed PLGA nanofibers was analysed by SEM (Figure 1). The PLGA nanofibers were shown to have a smooth and uniform morphology with a mean diameter of 112 ± 21 nm.

MTT assay results, after 48 hours of culture in standard conditions, showed an overall good viability of L929 fibroblasts cultured in contact with a simple polypropylene mesh and the polypropylene-PLGA mesh. The PLGA modified mesh exhibited a significantly increased viability (Figure 2A) compared to the simple polypropylene mesh. Since viability and proliferation were better on the PLGA-polypropelene material than on the polypropylene mesh control, this might suggest that the electrospun fibers did not affect the fibroblasts cell viability, probably due to material's high surface area to volume ratio.

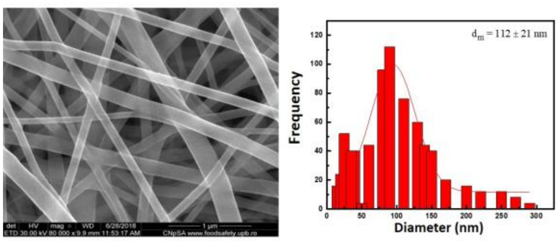

***Fig. 1**: PLGA nanofibers -SEM analysis*

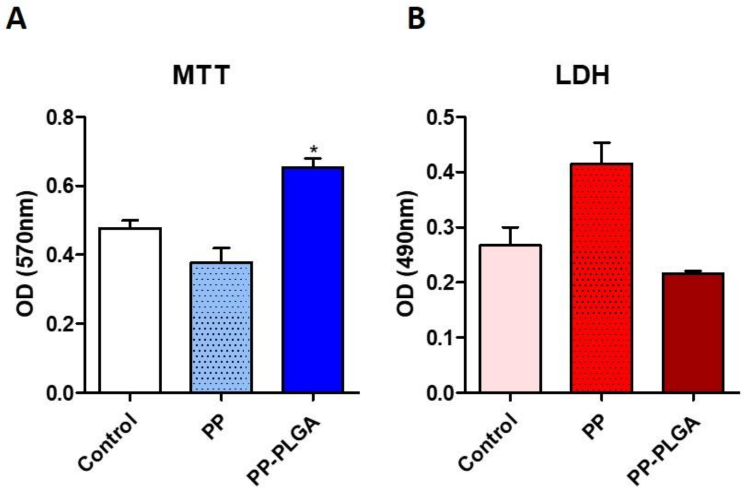

Fig. 2. *Biocompatibility analysis. A. MTT test; B. LDH cytotoxicity test*

After two days of culture in standard conditions, LDH assay indicated a similar cytotoxic effect (Figure 2B) for the PLGA-polypropylene mesh compared to the cell control, since a low number of dead cells were found after they were kept in contact with the materials. The results suggest that electrospun surgical meshes did not exert a significant cytotoxic effect on the cellular component. The results of these biochemical tests were also correlated with the microscopic analysis of the cells cultivated in the presence of the material (Figure 3). L929 cells cultured in the presence of PLGA-polypropylene meshes were shown to have a typical fibroblast shape whereas the cells cultured in the presence of simple polypropylene meshes had round morphology, typical of a stress response. Altogether, these data highlight the fact that hernia meshes surface modified by PLGA electrospinning exhibit an improved biocompatibility.

PLGA has been extensively investigated for medical uses, including suture materials, implants, prosthetic devices, bone fixation, surgical sealant films as well as drug delivery systems [4]. Recently electrospun PLGA nano- and microfibers have also been studied for tissue engineering, bone regeneration and wound dressings [5].

Our data is in agreement with other published papers. For instance, Zhang et al showed that PLGA electrospun meshes accelerated the excretion of extracellular matrix providing a promising technique to control the migration of cells [6].

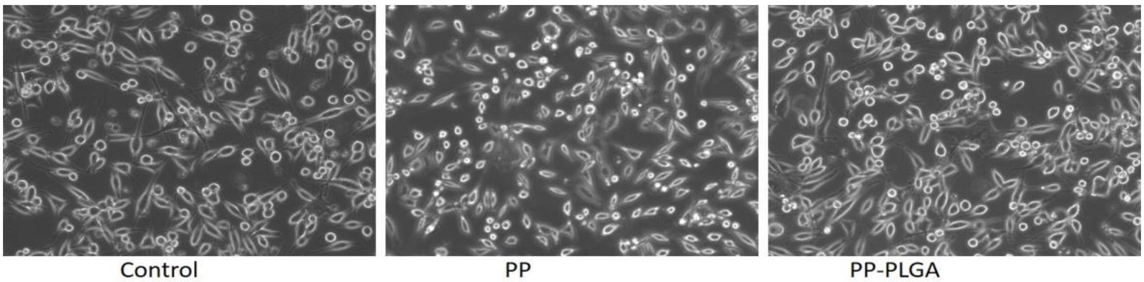

Fig. 3. *Cell morphology in the presence of PLGA electrospun meshes – phase contrast microscopy (20x magnification)*

Böhm et al showed using an *in vivo* diaphragmatic hernia model that PLGA modification of polypropylene meshes lead to increased biocompatibility compared to a standard polypropylene-based mesh [7-8].

4. CONCLUSIONS

Abdominal hernia is routinely rpaired by surgical meshes fabricated various biomaterials but , so far, no ideal hernia mesh exists. Nowadyas, surgical meshes with different fiber diameters and porosity are being developed by various manufacturing methods and implantation procedures. Surface modification can be used to retain material strength while enhancing biocompatibility of available meshes. Meshes manufactured using textile technologies reinforced with electrospun nanofibers were shown to yield scaffolds with exceptional mechanical properties and cytocompatibility.

We describe here the development of new polypropylene meshes coated with PLGA nanofibers designed for improved hernia repair. We show that these meshes harbores good cytocompatibility *in vitro* but, nevertheless future *in vivo* approaches are needed.

ACKNOWLEDGEMENTS

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

CREATING A GRAPHICAL USER INTERFACE FOR THE DESIGN OF NATURAL FORMS WITH COLOR DECOMPOSITION

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Abstract: *Graphical user interfaces for the design of shapes, combined with a different number of colors, facilitate the work of the designer, but on the other hand generate a limited number of figures. In the present paper a software tool for realization of methods and procedures for generating geometric elements has been developed. Pantone® colors have been used for a decade (2010-2020). The created graphical user interface offers opportunities to add new shapes, colors and controls. It is implemented through open source software tools. This significantly expands its possibilities for use by users who can add, change, customize, improve software tools. This minimizes the technical realization of the graphic elements and allows the designer to focus his efforts on the creative part in creating the final product. The technical tools proposed in the present work can be used in the creation of elements for friezes and patterns for textile design. Also, the results of this work can be used in the training of future specialists in the subject area.*

Keywords: *Data analysis, GUI, Textile design, Pattern making, Open source*

1. INTRODUCTION

The shapes and forms are the basis for creating elements in the design of fabrics. They represent logos, illustrations, friezes, patterns and they help the designer to give style to the fabric and to organize the elements in different patterns.

Colors play a significant role in design, followed by shape, symbols, descriptions. They not only influence emotions, but they also hold meaning. The perception of color is based on the cultural understandings of consumers. The choice of colors and their combination with shapes is extremely important for the overall success of fabric design and how it will be perceived by consumers. The shape and color of the elements that make up the decoration of the fabric are interrelated [1];

In the art of fabric design, in addition to purely artistic features, there is a number of technical requirements that confront the artist with certain limits, such as the size of the repetition, the limited number of colors [2].

Therefore, the peculiarity in the composition of decorative fabrics is in the organic relationship between the properties of the material, the purpose of the product, its decoration and shape. The composition of decorative fabrics can be with a clear center, with figures arranged in a circle, square, with borders, with ornaments along the entire width and length. The types of decorative compositions that are used in the creation of designs for patterns are: frieze, closed, open compositions. In all cases the composition must bring together all the decorative elements [3].

In recent years, there has been an increased interest in the use of computer-generated forms in the design of fabrics, clothing, logos [4].

Creating shapes and combining them with colors, using computer-based tools, requires knowledge of programming, working with CAD systems and design [5].

Designers cannot be expected to be programmers and mathematicians to create their own shapes, to combine them with different colors, using the capabilities of computer technology.

Software tools are designed that facilitate the process of creating computer-generated shapes and combining them with different colors. A significant part of the publications in this field is represented by mathematical descriptions of various geometric shapes from nature [6]. Graphical user interfaces (GUIs) are available for shape design [7], combined with a different number of colors. These software tools facilitate the designer's work in designing their elements, but on the other hand offer the generation of a limited number of figures.

In this form, technical and mathematical tools, to some extent, limit the ability of designers to create shapes for patterns of fabrics, using the capabilities of computer technology.

In the Matlab software system (The Math Works Inc.) as well as its free analogue Octave (GNU Octave), there are several ways to compile a user interface: Text, GUIde, Figure.

Regardless of how the graphical interface is created, this activity involves two main stages [8]:

- ✓ Use the controls and coordinate axes on the graphics window;
- ✓ Programming events that occur when a user influences an object, such as pressing a button.

The main elements in computer-generated figure creation systems are graphical user interfaces [9]. While creating them, it is necessary to follow a number of steps to make them easy to use, effective, intuitive [10].

The purpose of this article is to propose an algorithm for creating combinations of computer-generated shapes and colors to be implemented through a graphical user interface.

2. MATERIAL AND METHODS

The colors used are presented. The way of color decomposition is demonstrated. The used figures and the software used for their creation are indicated.

Table 1 shows the RGB and Lab values of the colors of the Pantone® for one decade (2010-2020). This decade is even, which means that the colors are lighter than the previous one (2000-2010) [11, 12]. During this decade, Pantone® chosed two colors of the year in 2016. This is related to a current trend in 2016 for gender equality [13].

Table 1. *Colors of Pantone® for a decade (2010-2020)*

Year	Pantone color	R	G	B	L	a	b
2010	PANTONE 15-5519 Turquoise	66	181	166	67,25	-35,69	-1,89
2011	PANTONE 18-2120 Honeysuckle	214	79	119	53,19	56,21	6,05
2012	PANTONE 17-1463 Tangerine Tango	221	65	36	51,01	58,09	50,75
2013	PANTONE 17-5641 Emerald	3	155	117	56,83	-43,89	10,35
2014	PANTONE 18-3224 Radiant Orchid	180	99	159	77,91	-13,62	17,90
2015	PANTONE 18-1438 Marsala	152	80	81	42,77	30,04	12,99
2016	PANTONE 13-1520 Rose Quartz	247	202	202	85,14	15,89	6,00
2016	PANTONE 15-3919 Serenity	147	169	209	68,88	1,59	-22,82
2017	PANTONE 15-0343 GREENERY	108	165	58	62,00	-36,83	48,03
2018	PANTONE 18-3838 ULTRA VIOLET	100	84	149	39,95	21,96	-33,49
2019	PANTONE 16-1546 Living Coral	255	112	98	64,75	53,52	34,86
2020	PANTONE 19-4052 Classic Blue	15	76	129	31,48	2,36	-35,04

The decomposition of the color is done in three colors. This approach has the advantage over using only two colors because it adds depth to the generated figure. Figure 1 shows a pseudocode for determining the transition between two colors. These calculations are made between the individual RGB components of the two colors. The decomposition between the first and second color has to be calculated, and then between the second and third.

```
%Input variables
Start_color;
Stop_color;
Num_elements;
Index;
%Output
out = Start_color + (Index-1) * (Stop_color - Start_color) ./ (Num_elements-1)
```

Fig. 1. *Pseudocode for calculating the transition between colors*

The method of creation of used figures is presented in detail in [14]. The next figures are used:

- ✓ Maurer's Rose;
- ✓ Rose;
- ✓ Spiral.

The figures are complemented by a circle element, which have an increasing radius and are colored with the decomposed colors.

Figure UI tools in the Matlab software environment (The Math Works Inc.) were used to create a graphical user interface.

A fully completed and working software application with a graphical interface has been developed. They are created and connected with the control graphic elements, their respective callback functions.

3. RESULTS AND DISCUSSION

The developed graphical user interface is presented and it is shown the sequence for working with it. The possibilities for its realization in an open source software environment are described. A textile design with GUI-generated elements is proposed. A comparative analysis is made with other publications in the subject area.

Figure 2 shows a general view of the developed graphical user interface. It is a form implemented through Figure UI.

The graphical user interface of a software system for obtaining figures contains a total of 12 controls.

The colors of Panton® for the period 2010-2020 are visualized in the right part of the form. The year and RGB values for each color are presented. The purpose of this visualization is to make it easier for the user to choose colors.

Through the "Popup menu" control, three colors are selected, marked with the year to which they refer.

The same control selects the type of figure to be drawn. Below the drop-down menu for selecting the figure are sliders, through which the parameters of the figures are adjusted. The selected values of these settings are displayed to the right of the sliders. This is realized through control type "Edit. For example, the Maurer Rose setting parameters are the variables n and d. In the case of "Spiral" the settings are for radius "r" and an angle "θ" [14].

Finally, in the left part of this form, the selected figure is drawn with the transitions of the colors specified by the user.

Saving the resulting decorative figure as a file can be done through the "Edit" menu of the "Figure" element (Edit-Copy Figure). It is stored in the Windows Clipboard and can be placed, for example, in an image processing program or other suitable program that the user uses.

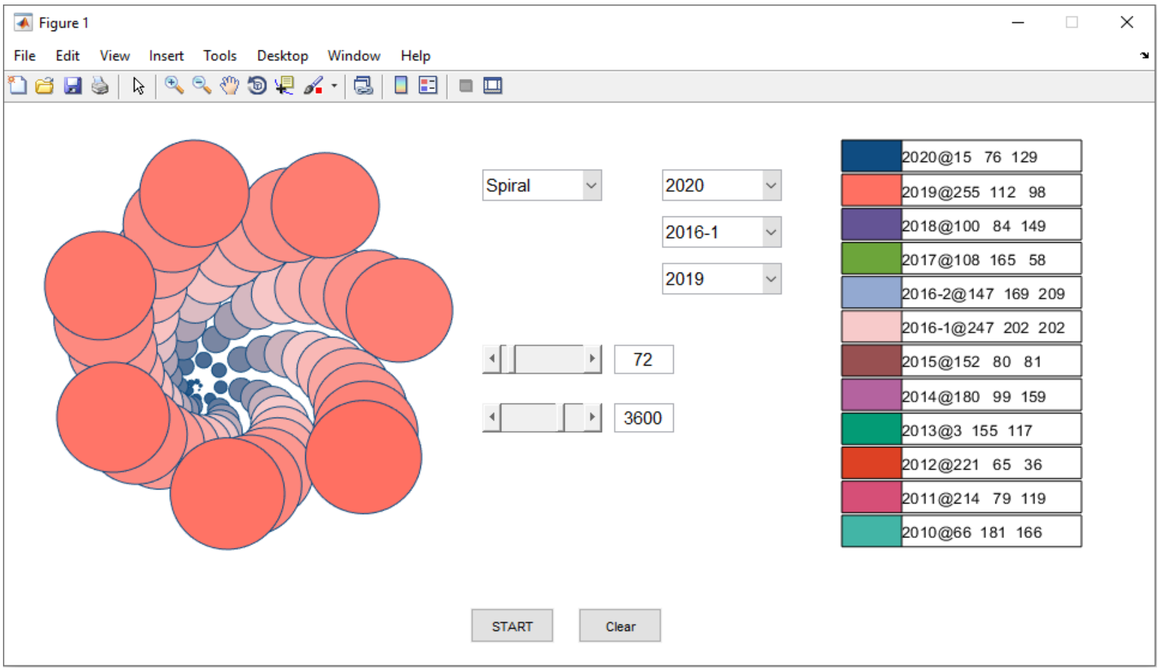


Fig. 2. *Graphical user interface - general view*

Figure 3 shows a block diagram of the sequence of operation with the graphical user interface (GPI). After starting the application, adjust the figure. The type of the figure, its colors and the parameters for its construction are selected. Then the figure is generated and it can be saved as a file.

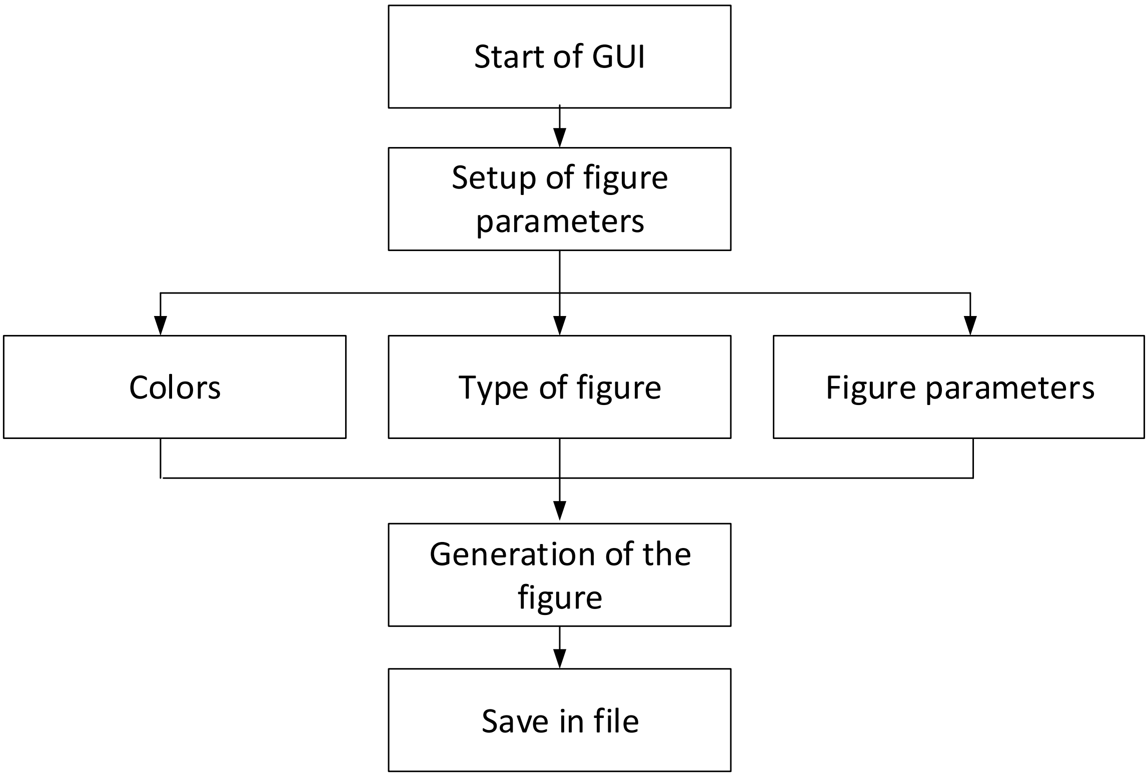


Fig. 3. *Sequence of work with GUI*

The presented figures can be realized in GNU Octave (https://octave-online.net/), which is a free analogue of Matlab. After registration, the user can use the full functionality of the online programming system. Also Octave can be downloaded completely free as a desktop application.

Figure 4 shows a screen from the online software system Octave, through which the figure "Spiral" is realized, through colors and circles used in the graphical user interface. The figure can be exported in the *.PNG and *.SVG file formats.

The proposed graphical user interface is developed in the Matlab programming environment. After a partial modification, it can also be implemented in GNU Octave.

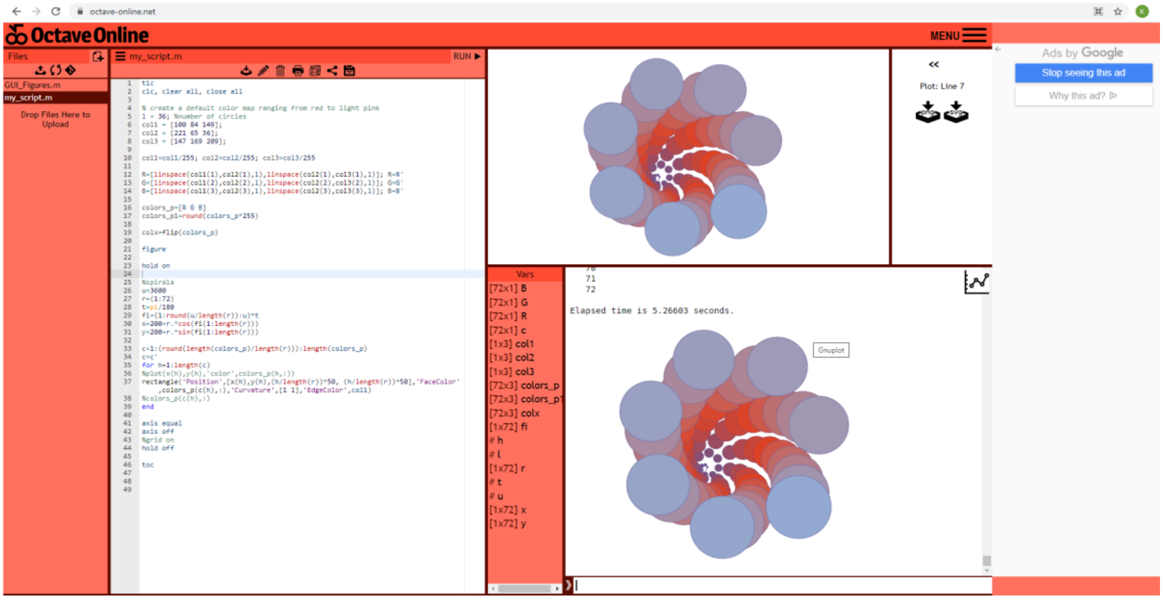


***Fig. 4.** Realization of a figure in Octave*

Figure 5 shows some decorative elements generated by the developed GPI. In addition to the basic settings, the drawing of the figures can be modified in the computer program so as to use elements other than a circle, for example an ellipse, a square, a rhombus, an asteroid.

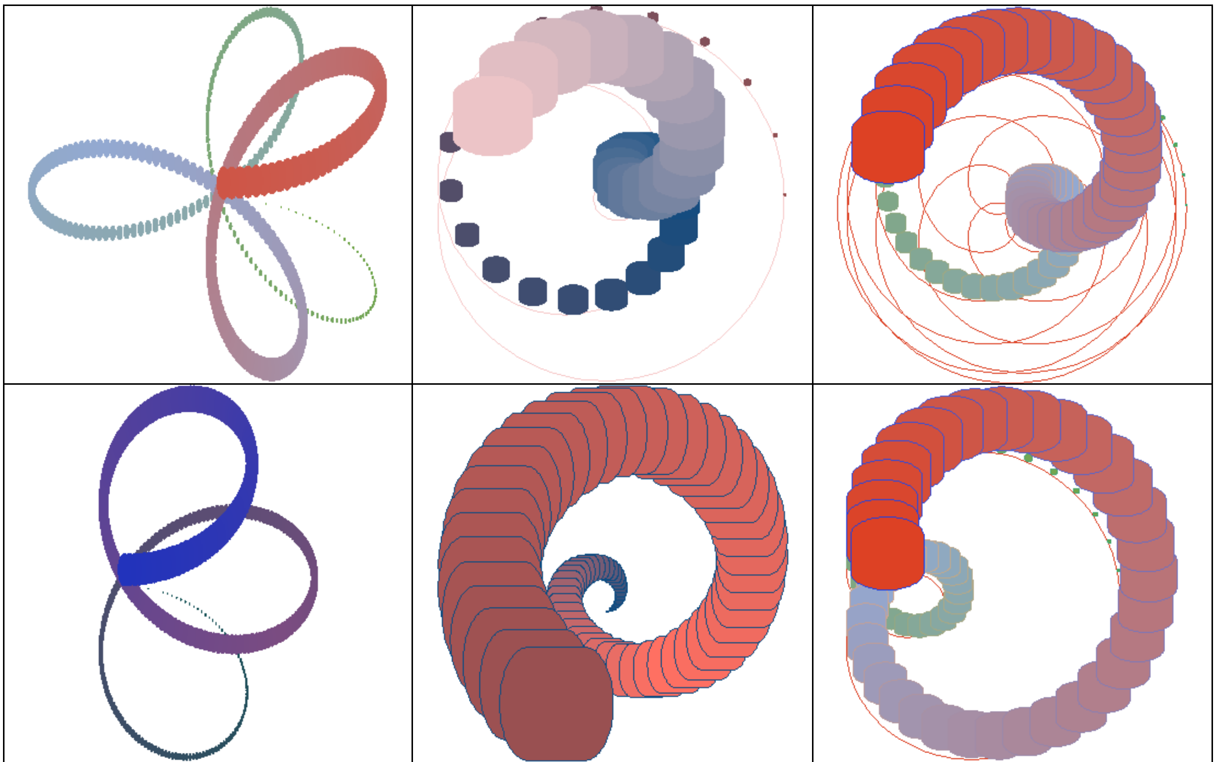


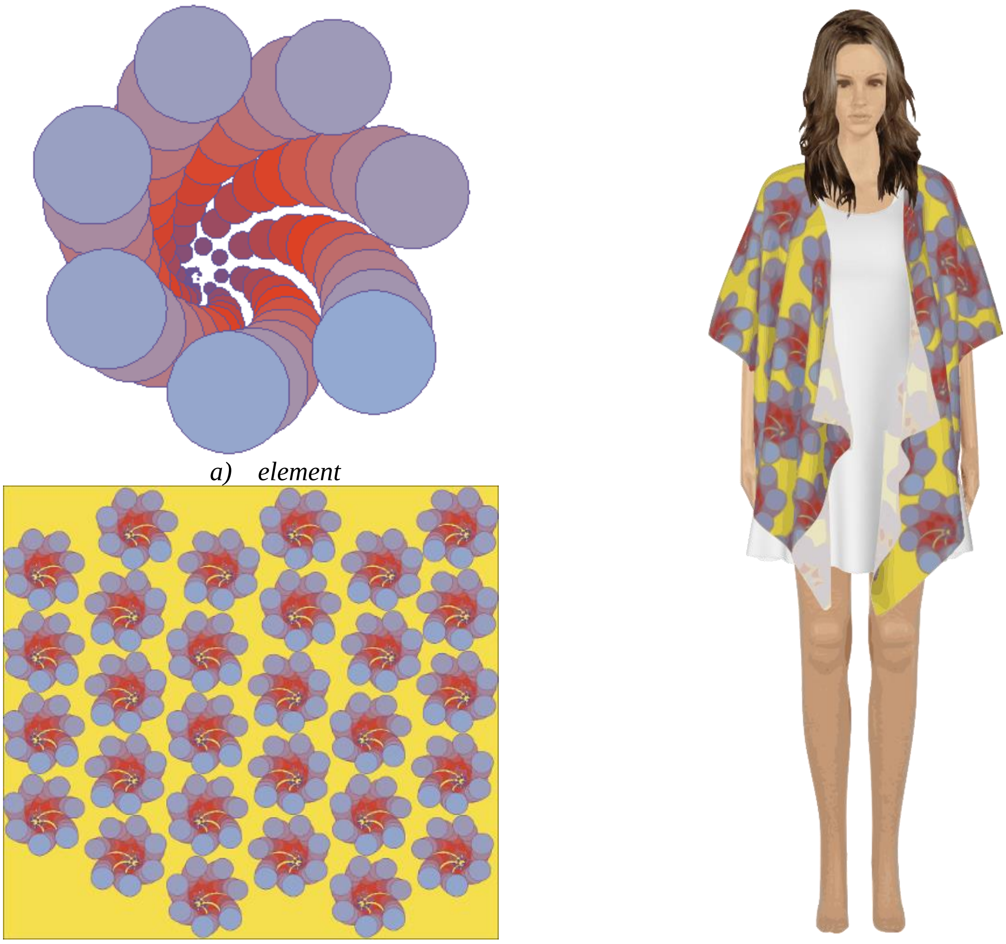
***Fig. 5.** Elements generated by GUI*

The generated elements can be used to create patterns to be used for the design of fabrics and clothing, respectively.

Figure 6 shows an example of the use of a pattern in clothing design.

An online tool Design Lab (https://artofwhere.com) was used to visualize the model. The model was created in the Inkscape software environment (https://inkscape.org). It consists of a mannequin, a wig and clothing.

The element is a spiral, generated by the procedure described above. The pattern is created by Half-drop repeat with a mirror arrangement of the elements. The clothing model is a draped kimono. It is an everyday outfit that can be worn by the ladies around the pool, on the beach, at home. The kimono can be easily combined with summer dresses, tank top, pants, skirts, shorts.



a) element

b) pattern *c) fashion model*

Fig. 6. *Example of a fashion model, from elements created by GUI*

The results obtained in the present work confirm and on the other hand supplement those of the available literature.

The GUI proposed here expands the possibilities of that proposed by Li et al.[7] by adding the ability to select more than one figure, keeping the choice of transitions between three colors.

Another advantage is the use of open source (APPENDIX A). In this way, the user can supplement the main program with colors, new shapes and controls, depending on their needs.

By adding program code to the GUI, the user can use known figures whose mathematical dependencies have been published [15]. This also solves the problem of the need for programming knowledge to use figures that are represented by their mathematical equations [6].

4. CONCLUSION

A software tool has been developed for the implementation of the proposed methods and procedures for generating geometric figures.

The created graphical user interface complements those developed so far, with the ability to add new figures, colors and controls. It is also possible to implement add-ons through open source software tools. This significantly expands its possibilities for use by users who can add, change, customize, improve the software tools implemented in the GUI.

The advantage of the software tools proposed in the present work is that when creating shapes and combining them with colors, through the use of computer-based tools, no knowledge of programming is required. This minimizes the technical realization of the graphic elements and allows the designer to focus his efforts on the creative part in creating the final product.

The technical tools, proposed in the present work can be used in the creation of elements for friezes and patterns for textile design. Also, the results of this work can be used in the training of future specialists in the subject area.

ACKNOWLEDGEMENTS

This work is partially supported by project №02.OUP/2020 “Construction of infrastructure for processing and analysis of data from contactless sensors with the application of machine training”.

APPENDIX A. Free access to the developed GUI

The developed software tools are freely available as a ZIP archive on the following Internet link: https://drive.google.com/file/d/1Iwe17BsuVeSkof0tAfjb3TOOp6sO70-i/view?usp=sharing

When using the software tools, this article needs to be cited.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

SUBASSEMBLIES OF THE PARACHUTE CONTAINER WITH IMPROVED GEOMETRY BASED ON DIGITAL SOLUTIONS

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Abstract: *The recovery system used in the aeronautic field have, as a main element, the whole set of parachutes, that represents a very complex system for which a thorough knowledge of the performance characteristics of the component materials is required, as well as the technologies, taking into account that they represent decisional elements in design and manufacture. The harness / container assembly represents the parachutist's safety system because controls the unfolding and opening of the parachutes and includes all the subassemblies necessary to make a parachute suitable for safe usage. Any constructive form of the canopy can be connected to the container in the specific compartments, which control the opening, the harness ensuring the parachutist's connection with them. The basic harness / container assembly is what remains when all detachable subassemblies are to be removed.*
The paper presents the digitized design solutions used for the improvement of the textile parts used in the construction of the harness-container assembly used for the sports parachutes. The requirements underlying the design were related to: compliance with the dimensions of the container compartments for both the main and the reserve parachute, in order to avoid premature openings caused by unstable opening pins; the use of raw materials and materials with physical-mechanical characteristics similar to those used to make the prototype, following the same price / quality ratio; eliminating the wavy areas both at the strip and at the base layer, on the portions that have different rounded shapes and are difficult to align.

Key words: *sports parachuting, safety system, harness/container assembly, CAD/CAM, einfas, parts.*

1. INTRODUCTION

The parachute is an complex equipment, with a role in increasing the drag resistance of a body moving in a fluid environment. [1, 2]. Because this fluid is air, a parachute can be considered a particular case of "air brake". In most applications, the force that propels the body is its own weight, so the weight of the device that provides resistance must be very small. From this point of view, the parachute can ensure a high drag resistance, with a very low weight gain (8–12%) [3, 4]. The parachute is an assembly which consists of elements that, working together, ensure conditions of controlled descent, braking and stabilization as well as: automatic opening, deployment, load support and drag resistance for a given mass.

The first reports of parachute applications appeared in the 14th and 15th centuries in Siam and China, when animals were parachuted during fairs and carnivals. The development of parachutes in Europe and the USA did not appear until the 18th century, and they were also meant for entertainment. The first application of parachutes appeared during the First World War, when aviators were rescued from aircrafts with the help of parachutes. [2,4] Subsequent developments have led to the conclusion that parachute recovery systems can also be used for:

- Aerial launch of military personnel, equipment and military technique in the final phase of transport to the theater of operations (**Fig. 1**). Under these conditions, the personnel must be unharmed and ready for action, and the equipment must be intact and ready for use. [1,3]

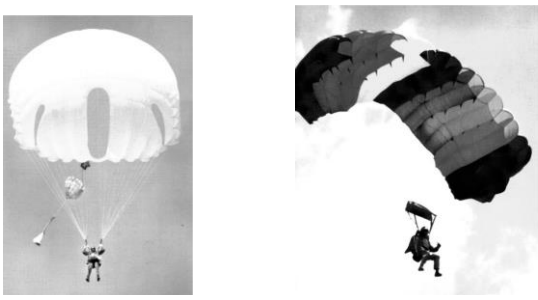


Fig. 1*: Military parachutes for aerial launch*
Courtesy SC CONDOR SA Bucharest – Manufacturer of parachutes and flight equiment

- Stabilization and braking of the aircraft during military operations (**Fig. 2**). 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 reduced shock load at opening. [3]

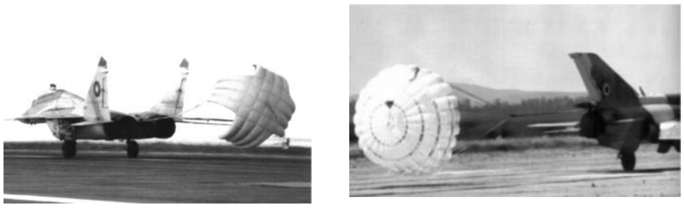


Fig. 2*: Parachutes for landing and deceleration of the supersonic aircraft*
Courtesy SC CONDOR SA Bucharest – Manufacturer of parachutes and flight equiment

-Armament delay to enable the aircraft to adjust its firing, to stabilize the artillery ammunition before entering the water, to obtain the desired angle of impact and an orderly distribution of shrapnel.

The modern parachutes can be used for supersonic applications, others for gliding (paragliding). [4] However, superior aerodynamic performance cannot be guaranteed with just one type of parachute. The most important parachutes known today are differentiated in terms of stability, drag resistance, opening behavior, speed or design.

2. HARNESS/CONTAINER ASSEMBLY FOR SPORTS PARACHUTE

2.1 Requirements for the design and execution of a harness-container assembly

The main subassemblies of the container are specific to the type of parachutes connected to the container [5,6]. The containers for sports parachutes have two compartments, one for each parachute (**Fig. 3**)

The harness-container assembly represents the parachutist's safety system and contains all the parts necessary to make a parachute suitable for flight. The assembly allows the control and opening of the parachutes. The role of the container is to keep the canopy of the folded parachutes (main and reserve pilot chutes), together with the suspensions, the opening device (if used), and the opening parachute. The container is closes by locking with pins or ripcord cables through one or more cones or curls and stitches.

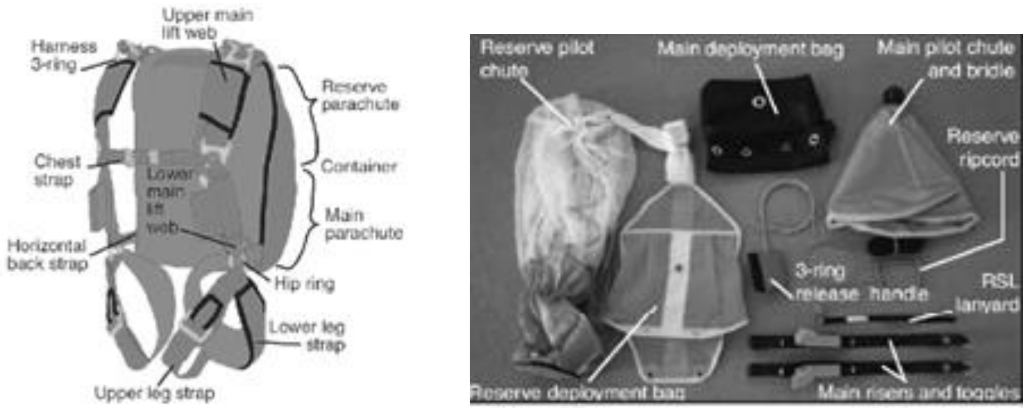


***Fig. 3**: Harness/container equipment for parachutes [5,6]*

The purpose of the parachute harness is to transmit the opening forces to the parachutist so that there is no possibility of injuring them during the jump. It is made of metal straps and buckles.

The main requirements imposed for design and accomplishment of the ham-container ensemble are respectively:

- for container

  - to ensure the correct opening in extreme conditions, when: the flexible metal cable, the cord attached to the aircraft and the extractor parachute that initiates the deployment of the main parachute at the aircraft jump (AAD) are activated and to enable the uninterrupted deployment of the canopy.

  - reducing the stiffening ribs to reduce the weight, the wear points and increase the wearing comfort.

- for harness (suspension system)

  - to ensure simple, visible and minimal adjustments made by the parachutist both from sitting and standing positions;

  - to be designed with a safety factor of at least 1.5;

  - to be safe and to avoid the contact of the mechanical devices with the parachutist body, mainly with the head and back zones;

  - to ensure the compliance with the requirements imposed by the standards of the aviation industry related to the position and color of the control handle that must be in contrast with that of the harness;

  - to limit the force required for the fast and safe operation of the trigger device to max. 10daN.

- for stitches - to comply with the requirements of the SR ISO 4915: 2001

- for assembly - to comply with the requirements of the SR ISO 4916: 1999 in designing of the component parts.

2.2. Solutions for accomplishing the container subassemblies

Requirements:

i) compliance with the calculated dimensions of the compartments of the container for:

- main parachute with a volume of 5733 cm^3 and 6880 cm^3 corresponding to areas of the main parachute of about 12.3 sqm and 16.6 sqm;
- reserve parachute with a volume of 4914 cm^3 and 6224 cm^3 corresponding to areas of the reserve parachute of about 11.9 sqm and 15.6 sqm.

ii) the use of the container for parachutes of different volumes, respectively:
- adjusting the volume of the reserve parachute compartment depending on the volume of the parachute, in the folded state, by adjusting the length of the closing loop;
- adjusting the volume of the main parachute compartment depending on the volume, in the folded state, of the parachute by building an additional compartment, which can be loaded with a ballast for parachutes with a smaller volume.

iii) narrow fabric used to make the container to have physical-mechanical characteristics similar or superior to those used to make the prototype (with emphasis on abrasion resistance).

Table 1: *Technical characteristics for narrow fabrics*

Nr. crt.	Characteristics	Tape Campina Kaki according with BA 65T/2017
1	Raw material	100% PA6
2	Pattern	R2/2
3	Thickness, mm	0.61
4	Tensile strength, daN	380
5	Elongation at break, %	6.0

iv) lack of intervention on the technical characteristics of the fabrics [5,6] used to make the container, respectively:

Table 2*: Technical characteristics for woven fabrics used for ham/container assembly (prototype)*

Nr crt	Characteristic	Cordura 1000 Cf. BA 65T/2017	Cordura 500 Cf.BA143T/2016 si BA 65/2016
1	Raw material	100% PA6.6	100% PA6.6
2	Pattern	1/1	1/1
3	Mass, g/sqm	322	239
4	Tensile strength, daN, warp/weft	305/230	224/209
5	Tear strength, daN, warp/weft	39/41	10/10
6	Resistance to hydrostatic pressure, min., mm col. H_2O	412	395
7	Abrasion resistance (Martindale), no. cycles	100 000 without wear	100 000 without wear

v) elimination of the wavy areas at the narrow fabric and at the base layer, on the zones that have a different shape than the linear one.

The analog data resulting from the design, realization and experimentation of the harness / container assembly prototype made by INCDTP specialists were processed with the help of software that allows, through the included modules, the realization of the sketch, and of the 3D visualizations.

The constructive solutions proposed for two subassemblies of the container (panel no.1 and no.2) are presented in table 3.

Table 3: *Proposed solutions – pattern measurements, shapes and einface subassemblies*

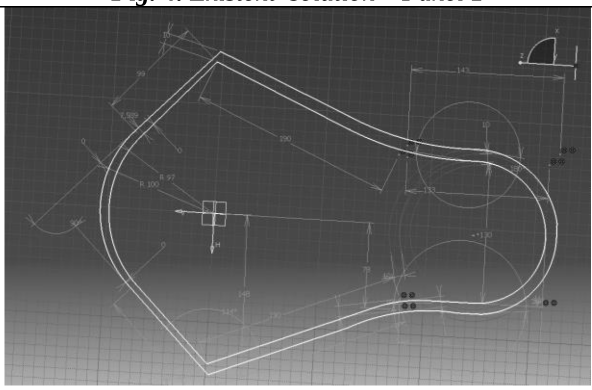
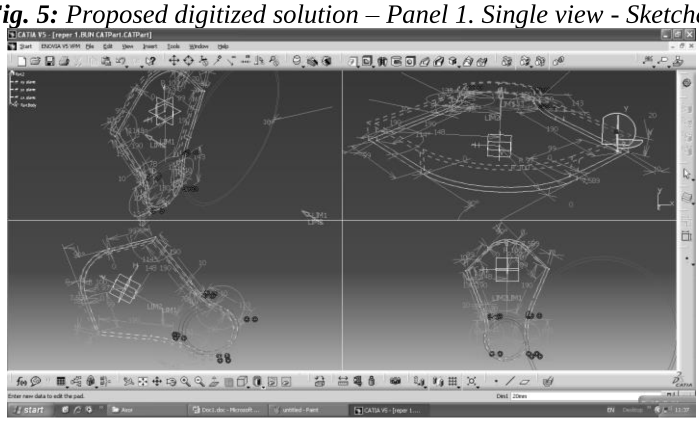
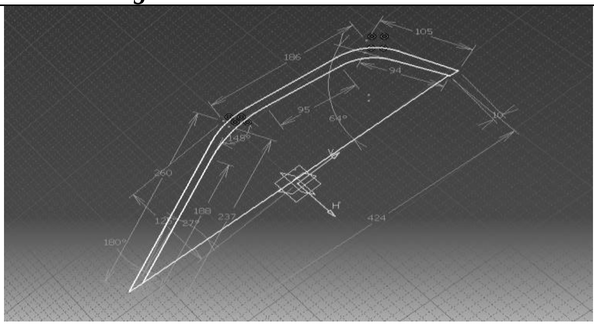
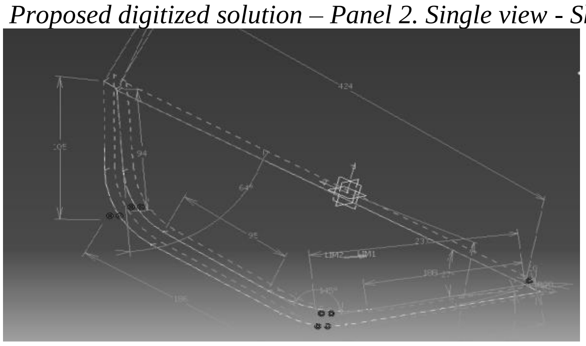
 ***Fig. 4.*** *Existent solution – Panel 1*	Narrow fabric: einface (grosgrain) Physical-mechanical characteristics: - raw material 100%PA6 - tip legatura: R2/2 - thickness: 0.61 mm - tensile strength: 380daN - elongation at break: 6% Seam type: 2x301
 ***Fig. 5:*** *Proposed digitized solution – Panel 1. Single view - Sketcher*  ***Fig. 6:*** *Multiple view - Panel 1. Part Design*	Narrow fabric: einface with scalloped edge -width 2.2 cm Physical-mechanical characteristics: - raw material 100%PA6.6 - pattern: 1/1 - thickness: 0.76 mm - tensile strength: min. 500daN - elongation at break: 18% Seam type: 2x301
	Narrow fabric: einface (grosgrain) Physical-mechanical characteristics: - raw material 100%PA6 - tip legatura: rips - thickness: 0.61 mm - tensile strength: 380daN - elongation at break: 6% Seam type: 2x301

Fig. 7. *Existent solution – Panel 2*	
 ***Fig. 8:*** *Proposed digitized solution – Panel 2. Single view - Sketcher*  ***Fig. 9:*** *Single view - Panel 2. Part Design*	Narrow fabric: einface with scalloped edge – width 2.2 cm Physical-mechanical characteristics: - raw material 100%PA6.6 - pattern: 1/1 - thickness: 0.76 mm - tensile strength: min. 500daN - elongation at break: 18% Seam type: 2x301

5. CONCLUSIONS

By adopting the new shapes of the patterns, it is expected to increase the technical resource of the narrow band fabric, especially in relation to the abrasion resistance, by eliminating wrinkles for the hardening band and by eliminating the corrugations on the surface of the part.

The rigorous calculation of the geometric elements of the band routing and their correct location within the container assembly will ensure continuity in the variation of the requirements in conditions of use and implicitly an increase of the safety in operation.

The proposed solutions could be used to transform the dedicated textile technology in real opportunities for efficiencies and increased revenue.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

EVALUATING THE COMFORT CHARACTERISTICS OF KNITTED PRODUCTS

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Abstract: *For any range of products, the main requirements requested by the beneficiaries, refer to the presentation value, the commercial one, behavior during use (functionality), durability and maintainability. For clothing products, improving the comfort function is an essential requirement, which aims at: moisture absorption and transfer, ventilation capacity, thermal insulation capacity, electro-static charging, touch, structure, etc.*
The design, evaluation and improvement of product quality involves the inclusion of representative quality characteristics, which best meet the demands of the beneficiaries, as levers to control the desired quality. Obtaining the predetermined quality characteristics requires directing the manufacturing process by: choosing the raw material in correlation with usage conditions of the products, stating structure and structural parameters, establishing knitting and finishing technologies. In the case of knitted products, the design, redesign, quality control and evaluation are based on the inclusion and appreciation of simple and complex structural parameters, as the most important indicators in assessing the functional characteristics of knitwear. For these reasons, the paper proposes to substantiate a method of rapid and correct assessment for coefficients values of structural parameters, depending on the beneficiary requirements, regarding clothing comfort (air permeability, desired compactness degree, thermal insulation capacity). The variation intervals of the two coefficients, for four groups of knitted structures, allow choosing the knitting structure according to its desired degree of compactness, adopting the optimal values for structural parameters in the knitting design stage and estimating the changes suffered by the knit during finishing operations.

Key words: *knitted, quality, comfort, parameters, structure, compactness.*

1. INTRODUCTION

Knitted have the largest industrial use, the primary purpose being manufacturing clothing products for all categories of wearers and for every season (hot, cold and transitional seasons).

Any step in quality approach is based on the correlation of beneficiary requirements to functions and the quality characteristics of the products.

In the case of clothing products, the main groups of beneficiary requirements solicited regard [1, 2]:

- ✓ the presentation value;
- ✓ the commercial value of the product;
- ✓ functionality (behaviour during use);
- ✓ product response to certain actions it is subjected to (availability);

Presentation value requirements derive from the fact that any product, in order to enter the sphere of interest of a potential customer, must transmit an aesthetic message through style, model, appearance, chromatic combination, novelty elements etc. These requirements determine the degree of product amenity and implicitly its success on the market.

Demands targeting the commercial value apply to the product's presentation approach in sales, as well as the information provided by it (or the packaging).

Functionality requirements target a products usage value, being determined by the fact that a product must protect the body from the harmful influence of the environment and give the user a comforting sensation.

Availability requirements derive from the fact that a clothing product must fulfill the functions for which is was created, in specific usage conditions, until the appearance of physical or moral ageing. During its usage period, the products must respond to the demands regarding its maintenance and remediation.

The interface between user requirements and quality characteristics is constituted by set of functions that products have to meet. Function share (their degree of importance in quality assurance) differs from one type of product to another, being determined by the requirements imposed during use.

Improving the comfort function of clothing products is an essential requirement, of prime importance and always timely, being addressed in both research and production. This function is in interdependence with the constructive, ergonomic, technological, protection and availability functions.

The comfort of clothing products, with its three components (thermophysiological, sensory and mental) aims at:

- moisture absorption and transfer (water, vapors);
- ventilation capacity;
- thermal insulation capacity;
- electro-static charging capacity;
- touch, chromatic, structure, transparency, etc.;

2. KNITTED SPECIFIC STRUCTURAL PARAMETERS

Designing, manufacturing, evaluating and improving product quality involves establishing the technical dimensions of the functions and implementing the representative quality characteristics that can best meet the beneficiary requirements, as levers for controlling the desired quality.

Obtaining the predetermined quality characteristics, depending on usage conditions of the products, requires a controlled management of the manufacturing process through:

- ✓ choosing the raw material characteristics in correlation with the usage conditions of the products;
- ✓ inclusion of specific structure and structural parameters;
- ✓ establishing knitting and finishing technologies;

In general, the design, redesign, control and assement of knitted quality is based on inclusion and evaluation of structural parameters: A – the step of the loop, B – the height of the loop, C – the density factor, l_o – loop thread length.

Nevertheless, an evaluation of knitted quality using only these simple structural paramenters is not complete, lacking an appreaciation of the characteristics of functionality.

Assessing the behavior of knitted products during use and evaluating the characteristics of thermophysiological comfort is possible by establishing and appreciating:

- compactness degree of the knitted;
- air permeability of the knitted;
- thermal insulation capacity.

These characteristics are evaluated by determining the variation intervals of the complex coefficients of the structural parameters. They establish the relationship between the structural elements of the knitted fabric (length of the stitch, surface area or volume of the loop), the properties of the thread (diameter of the thread F), the projection of the lateral surface of the loop into the knitted surface and the volume occupied by the thread.

The main complex coefficients for the structural parameters that influence the properties and behavior of knitted products during use, the calculus equation and some of their characteristics are presented in Table 1 [3, 4, 5].

Table 1: *Complex coefficients of structural parameters*

Coefficient	Characteristics	Calculus relation
Density coefficient C	• Offers information regarding the compactness degree of the knitted. • Varies in certain intervals, specific to each type of structure.	$C = \frac{D_o}{D_v} = \frac{B}{A}$
Linear cover coefficient δl	• Offers information regarding the air permeability of the knitted, as well as compactness degree. • Varies between certain limits, depending on structure type. Values placed near the inferior limit imply high surface density (low values for loop height and step, so **high compactness**), while those placed near the upper limit suggest low surface density. • Influence knitted resistance to different types of strain. • Influence dimensional stability of the knitted.	$\delta_l = \frac{l_o}{F}$
Volumetric filling factor δv	• Represents an expression of the filling capacity. • Offers information about the thermal isolation capacity of the knitted. • The more coefficient values are closer to 1, the more knitted compactness and thermal isolation capacity are higher.	$\delta_v = \frac{\pi \cdot F^2 \cdot l_o}{4 \cdot A \cdot B \cdot g_t}$

3. DETERMINING THE COEEFICIENTS OF STRUCTURAL PARAMETERS

In order to determine the variation intervals for the complex coefficients of structural parameters, for four variants of basic and derived structures, it was necessary to establish the calculus equations for:

- ✓ loop thread lenght, loop step and height;
- ✓ knitted thickness;
- ✓ the linear cover coefficient δl;
- ✓ volumetric filling coefficient δv;

In table 2 are presented the calculus relations for loop thread lenght, loop step and height, specific to the four variants of structures: single jersey, rib fabric, cross-mis 1:1 and interlock, according to the hypotheses from the literature [3, 5].

Table 2: *Equation for loop thread length for 4 variants of structure*

Structure	Hypothesis	Initial calculus relation	Final calculus relation
Single jersey (plain fabric)	**Dalidovici**	$l_o = 1{,}57 \cdot A + 2 \cdot B + 3{,}14 \cdot F$	$l_o = [(1{,}57 + 2 \cdot C) \cdot K_A + 3{,}14] \cdot F$
Rib fabric	**Hagiu**	$l_o = 1{,}57 \cdot A + 2 \cdot B + 3{,}39 \cdot F$	$l_o = [(1{,}57 + 2 \cdot C) \cdot K_A + 3{,}39] \cdot F$
Cross-mis 1:1 (plain structures)	**Dalidovici**	$l_o = 2{,}32 \cdot A + 2 \cdot B + \pi \cdot F$	$l_o = [(2{,}32 + 2 \cdot C) \cdot K_A + 3{,}14] \cdot F$
Interlock fabric	**Mihailov**	$l_o = 2{,}2 \cdot A + 2{,}8 \cdot B - 2{,}2 \cdot F$	$l_o = [(2{,}2 + 2{,}8 \cdot C) \cdot K_A - 2{,}2] \cdot F$
$A = K_A \cdot F \quad B = K_A \cdot F \cdot C$			

Calculus relations for the complex coefficients of structural parameters are presented in tables 3 and 4.

Table 3: *Equation for the linear cover coefficient for 4 variants of structure*

Structure	Calculus equation of the linear cover coefficient
Single jersey (plain fabric)	$\delta_l = (1{,}57 + 2 \cdot C) \cdot K_A + 3{,}14$
Rib fabric	$\delta_l = (1{,}57 + 2 \cdot C) \cdot K_A + 3{,}39$
Cross-mis 1:1 (plain structures)	$\delta_l = (2{,}32 + 2 \cdot C) \cdot K_A + 3{,}14$
Interlock fabric	$\delta_l = (2{,}2 + 2{,}8 \cdot C) \cdot K_A - 2{,}2$

Table 4: *Equations for the volumetric filling coefficient for 4 variants of structure*

Structure	Calculus equation for thickness	Calculus equation for the volumetric filling coefficient
Single jersey (plain fabric)	$g_t = 2 \cdot F$	$\delta_v = \frac{\pi \cdot [(1{,}57 + 2 \cdot C) \cdot K_A + 3{,}14]}{8 \cdot K_A^2 \cdot C}$
Rib fabric	$g_t = 4 \cdot F$	$\delta_v = \frac{\pi \cdot [(1{,}57 + 2 \cdot C) \cdot K_A + 3{,}39]}{16 \cdot K_A^2 \cdot C}$
Cross-mis 1:1 (plain structures)	$g_t = 3 \cdot F$	$\delta_v = \frac{\pi \cdot [(2{,}32 + 2 \cdot C) \cdot K_A + 3{,}14]}{12 \cdot K_A^2 \cdot C}$
Interlock fabric	$g_t = 4 \cdot F$	$\delta_v = \frac{\pi \cdot [(2{,}2 + 2{,}8 \cdot C) \cdot K_A - 2{,}2]}{16 \cdot K_A^2 \cdot C}$

4. DETERMINING THE VARIATION INTERVALS OF THE COMPLEX COEFFICIENTS FOR FOUR TYPES OF STRUCTURE

Based on the recommendations in specialty literature [3, 5], as well as on some practical determinations, there were established the variation intervals of:

- loop step coefficient: $K_A = 4 \div 7$
- density coefficient: for single jersey and rib fabric: C = 0,65 ÷ 1,00
- density coefficient for cross-mis 1:1and interlock: C = 0,65 ÷ 1,30.

Under these conditions, the variation intervals were determined for the complex coefficients of structural parameters, for two basic bonds (single jersey and rib fabric) and for their derived structures (cross-mis 1:1and interlock). The determined intervals are shown in Tables 5 and 6.

Table 5: *Variation intervals of complex coefficients for the structures single jersey and rib fabric*

Compactness degree	K_A	Variation intervals					
		C		δ_l		δ_V	
		Single jersey	Rib fabric	Single jersey	Rib fabric	Single jersey	Rib fabric
Very high	4 - 5	0,65 – 0,75		14,6 – 18,5	14,9 – 18,7	0,55 – 0,39	0,30 – 0,20
	5 - 6			17,5 – 21,6	17,7 – 21,8	0,42 – 0,31	0,22 – 0,16
	6 - 7			20,4 – 24,6	20,6 – 24,9	0,34 – 0,26	0,18 – 0,13
High	4 - 5	0,75 – 0,85		15,4 – 19,5	15,7 – 19,8	0,50 – 0,36	0,25 – 0,18
	5 - 6			18,5 – 22,8	18,7 – 23,0	0,38 – 0,29	0,20 – 0,15
	6 – 7			21,6 – 26,0	21,8 – 26,3	0,31 – 0,24	0,16 – 0,12
Medium	4 - 5	0,85 – 0,95		16,2 – 20,5	16,5 – 20,8	0,47 – 0,34	0,23 – 0,17
	5 - 6			19,5 – 24,0	19,8 – 24,2	0,36 – 0,27	0,18 – 0,14
	6 - 7			22,8 – 27,5	23,0 – 27,7	0,29 – 0,23	0,14 – 0,12
Low	4 - 5	0,95 – 1,00		17,0 – 21,0	17,3 – 21,3	0,44 – 0,33	0,22 – 0,16
	5 - 6			20,5 – 24,5	20,7 – 24,8	0,34 – 0,26	0,17 – 0,13
	6 - 7			24,0 – 28,1	24,2 – 28,4	0,27 – 0,22	0,13 – 0,11

Table 6: *Variation intervals of complex coefficients for the structures cross-mis 1:1 and interlock*

Compactness degree	K_A	Variation intervals					
		C		δ_l		δ_V	
		Cross-mis 1:1	Interlock	Cross-mis 1:1	Interlock	Cross-mis 1:1	Interlock
Very high	4 - 5	0,65 – 0,75		18,0 – 22,2	13,9 – 19,3	0,13 – 0,08	0,3 – 0,2
	5 - 6			21,7 – 26,0	17,9 – 23,6	0,08 – 0,06	0,21 – 0,17
	6 - 7			25,5 – 29,9	21,9 – 25,8	0,06 – 0,04	0,18 – 0,15
High	4 - 5	0,75 – 0,85		18,4 – 23,2	15,0 – 20,7	0,12 – 0,07	0,24 – 0,19
	5 - 6			22,2 – 27,3	19,3 – 25,3	0,08 – 0,05	0,20 – 0,16
	6 – 7			26,0 – 31,3	23,6 – 27,6	0,05 – 0,04	0,17 – 0,14
Medium	4 - 5	0,85 – 0,95		19,2 – 24,2	16,1 – 22,1	0,11 – 0,07	0,23 – 0,18
	5 - 6			23,4 – 28,5	20,7 – 27,0	0,07 – 0,04	0,19 – 0,15
	6 - 7			27,3 – 32,7	25,3 – 29,4	0,05 – 0,03	0,16 – 0,13
Low	4 - 5	0,95 – 1,00		20,0 – 24,7	17,2 – 22,8	0,10 – 0,06	0,22 – 0,17
	5 - 6			24,2 – 29,0	22,1 – 27,8	0,07 – 0,04	0,18 – 0,15
	6 - 7			28,5 – 33,4	27,0 – 30,3	0,04 – 0,03	0,15 – 0,13
Compactness degree	4 - 5	1,00 – 1,30		21,2 – 27,7	17,8 – 25,6	0,10 – 0,06	0,20 – 0,16
	5 - 6			24,7 – 32,6	22,8 – 31,2	0,07 – 0,04	0,17 – 0,14
	6 - 7			29,0 – 37,5	27,8 – 34,0	0,04 – 0,03	0,15 – 0,12

5. CONCLUSIONS

Assesing the behavior of knitted products during use and evaluating the characteristics of thermophysiological comfort is possible by establishing and appreaciating the compactness degree of the knitted, the air permeability, as well as the thermal insulation capacity.

Establishing the variation intervals for the complex coefficients of the structural parameters is a necessity for different types of knited, which facilitates their design, redesign and qualitative evaluation.

The method proposed in this paper allows a quick assessment of the most important quality indicators of knitted products, based on the coefficients of structural parameters, regardless of the type or count of the yarn used. The established variation intervals can constitute a database containing the values of the complex structural parameters, in the case of basic structures like single jersey and rib jersey as well as for the derived jersey and interlock structures. This database allows:

- rapid determination of the coefficient values for structural parameters, depending on the beneficiary requirements, regarding the desired comfort of the clothing products (air permeability, degree of compactness, thermal insulation capacity);
- rapid determination of the coefficient values for structural parameters, in correlation with the purpose of clothing products;
- choosing the structure of the knitted according to its desired degree of compactness;
- adopting the optimal values of the structural parameters in the knitting design stage;
- testing and examining the knitted during the manufacture of the “zero series”, regarding the degree of compactness, before launching a fabrication order;
- estimating the intervening changes in the knitted during the finishing operation;

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

MODULAR SYSTEM MEANT FOR EPIBIONTIC BIOFILTER DEVELOPMENT IN THE BLACK SEA

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Abstract: *EU policy in the field of marine biodiversity, including protected areas, is developing in the context of global, regional, and European Union commitments. In this context, the ecosystem-based approach focuses on a management system that maintains the health of the ecosystem along with the proper use of the marine environment by humans, to the benefit of present and future generations. The natural marine epibiontic filter includes all living invertebrates attached to the stiff submersible substrate. Epibiontic organisms comprise all marine invertebrates that, during the juvenile stages, are fixed on hard natural supports (rock, submerged rocky platforms) and carry out their entire life cycle. The slow and insignificant recovery process of the natural biofilter in the coastal area of the Romanian Black Sea coast requires the elaboration of ecological methods meant to increase the populations of epibiontic organisms that constitute filters, able to accelerate the restoration of the marine environment in tourist areas on the coast. In order to improve the quality of the marine environment in coastal areas affected by anthropogenic impact, it is recommended to build epibiontic biofiltration barriers throughout the water column, including the affected sedimentary substrate. In this respect, a modular system was designed, created and experimented, which has the role of allowing the development of the epibiontic material.*

Key words: *ecosystem-based approach, epibiontic organisms, modular system, experiment, composite, floating system*

1. INTRODUCTION

Knowing the major ecological role of the epibiontic biofilter in seawater cleaning and the fact that, in recent decades, its natural restoration in coastal areas of major social and economic interest has been insignificant, it is necessary to find feasible and appropriate measures to ensure a quick inspection and the efficient rehabilitation of epibiontic organisms that feed the filters, strongly affected by anthropogenic impact [1,2].

Epibiosis that develops spontaneously in the Black Sea is composed of a group of organisms (mono/ multicellular algae, protozoa, coelenterates, mollusks, crustaceans, etc.) which, during the juvenile stages, attach to the rigid surfaces in the water (natural or artificial), where it carries out its entire life cycle [1,2]. The negative effect of reducing the bio-cleaning capacity of the natural epibiontic biofilter is visible every year, especially during the summer season, due to the poor quality of marine coastal waters outside urban areas and resorts (high turbidity and high biological load) [3,4,5]. In the Black Sea coastal area, epibiontic organisms grow in varying proportions almost throughout the year. This is supported by the constant presence in the water of a variable amount of larvae [4,6]. However, at certain times, the periodic increase of reproduction leads to the occurrence in the water of extremely numerous generations of larvae [7].

2. MATERIALS AND METHOD

The operating conditions in the open sea imposed the design and manufacture of some floating elements, with a special shape that could diminish the specific mechanical shocks [1,5]. Depending on the location area, the wave force, and the current intensity (agitation of the sea), the floating elements were designed taking into account a value for the hydrodynamic resistance coefficient in the range of (0.6 - 0.7).

In order to obtain a minimum resistance to the sea current and action of the waves, the cylinder and the double cone were chosen as geometric shapes, efficient in the operating conditions of the system: buoyancy, placement of the fastening and anchoring eyelets, stability in vertical plane [1,2,3].

Furthermore, to establish the values of the geometric parameters, it was taken into account that the resistant surface of the modular system increases by growing the attached biological material. Also, the action of external forces on the anchors increases proportionally [5,6,7].

The component elements of the designed modular system, manufactured and subjected to shore experiments and in open sea conditions are represented by:

1. ***the floating superstructure;***
   - 1 floating element located offshore - ME1;
   - 1 floating element located in the shore area - ME2;
   - 1 central floating element for system support and for growth and development of biofiltrating material (mussels and oysters) - ME4;
   - 4 floating elements for the controlled growth of mussels - ME5;
   - 2 floating elements for the controlled growth of mussels and the development of oysters - ME6.
2. ***submerged enclosure for oyster larval development - ME7;***
3. ***artificial collectors for the controlled growth of mussels and the development of oysters;***
4. ***subassemblies for fixing and supporting the modular system:***
   - 1 submerged cylinder for fixing the floating elements for growth and development of biofiltrating material (mussels and oysters) - ME3;
   - 2 main anchors, mooring type;
   - 1 secondary anchor, mooring type.

The physical-mechanical parameters of the composite textile structures used in the construction of the seven experimental models are presented in table 1.

Table 1: *The physical-mechanical parameters of the composite textile structures*

Parameter	ME1	ME2	ME3	ME4	ME5	ME6	ME7	Reference document
Raw material	100% PES	50/50 PA/ PES	55/45 PA6.6/ PES	100% PES	100% PES	100% PES	100% Cotton	-
Mass, g/m^2	237	436	437	1123	301	303	312	SR EN 2127:2003

Tensile strength, daN warp/weft	232/ 225	365/ 375	412/ 410	530/ 550	210/ 220	204/ 217	287/ 172	SR EN ISO 13934-1/2013
Tear strength, daN warp/weft	65/62	25/22	38/42	55/65	20/33	25/29	12/13	SR EN ISO 13937-2/2001

The testing of the experimental model of the modular system for the development of the biofiltrating material was performed in collaboration with the researchers and the diving team from The National Institute for Marine Research and Development "Grigore Antipa“ Constanta. The test location chosen was The National Institute for Marine Research and Development "Grigore Antipa“ Constanta - *Pescarie* area, Mamaia (coordinates: 44°12'54.80" N; 28°38'55.94" E) (Fig. 1).

Fig. 1*: The experimental activities location of the experimental modular system model for the development of the biofiltrating material: Pescarie area, Mamaia*

The hydrometeorological test conditions were:
- clear sky, light wind from the SE direction (speed 10-35 km/h);
- air temperature: 20-24°C;
- seawater temperature: 18-25°C, salinity: 13‰, surge: 20-100 cm;
- seawater depth at the location: 3m.

3. RESULTS AND DISCUSSIONS

The results obtained after testing and verifying the modular system for the development of the epibiontic biofilter (Fig. 2) show that:

- The textile materials have matched the imposed requirements and the composite structures comply with the technical quality conditions stipulated by the norms in force for these types of materials [3,4].

- The characteristics for each subassembly of the system correspond to those stipulated in the norms imposed by design from the geometric, dimensions, and colors point of view.

a. b. c. d.

Fig. 2. *Dimensional and gravimetric checks of the experimental model:*
a. ME4 - Central floating element to support the system; b. ME1 - Floating element located offshore; c. ME6 - Floating element for controlled growth of mussels and oyster development; d. ME2 - Floating element located in the shore area; ME5 - Floating elements for the directed growth of mussels.

- The main and secondary anchors were fixed on the marine substrate, allowing the extension of the connecting elements of the floating elements, the entire modular system being stable and positioned appropriately for the following tests. All floating elements from the modular system, respectively: the floating element located offshore - ME1; the floating element located in the shore area - ME2; central floating element for system support and for growth and development of biofiltrating material (mussels and/ or oysters) - ME4; the floating element for the controlled growth of mussels - ME5; the floating element for the controlled growth of mussels and the development of oysters - ME6 have kept their shape and implicitly the dimensions imposed by the specifications. In addition, the loads produced in the installation under the action of external dynamic forces are evenly distributed on anchorages and anchors (Fig. 3).

a. b. c.

Fig. 3. *The floating elements transport and launch:*
a. the ME2 and ME4 transport to the waterfront; b. the ME2 and ME 4 launch into the water;
c. the ME6 transport in the test area with the help of the diving team from The National Institute for Marine Research and Development “Grigore Antipa“ Constanta

- After 10 days of exposure in open sea conditions, floating elements located offshore - ME1 and on the shore area - ME2, the central floating element for support the system and for growth and development of biofiltrating material (mussels and/ or oysters) - ME4 and the floating element for the controlled growth of mussels - ME5 remained in position, showing no damage due to open sea conditions. In addition, the loads appearing in the installation under the action of external hydrodynamic forces are evenly distributed on anchorages and anchors. Deposits of epibiontic material were not found for these floating elements either (Fig. 4).

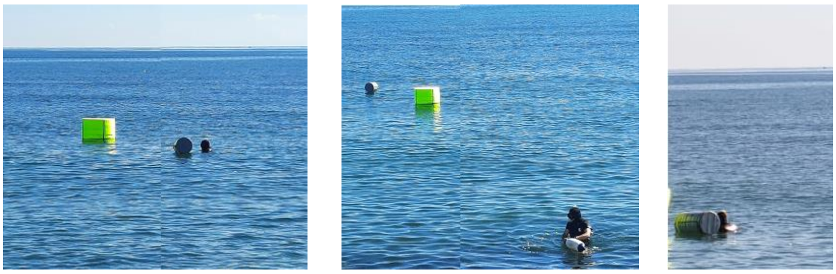

Fig. 4. *Qualitative inspections of modular system for the development of biofiltrating material (ME1, ME2, ME4) performed by the diving team of The National Institute for Marine Research and Development "Grigore Antipa" Constanta*

- Following the inspections, traces of deposits of living organisms were found on the floating elements (Fig. 5).

a b

Fig. 5. *Inspection of the floating element ME1:*
a. located offshore; b. inspected at the shore

- The immersed part of the floating elements is covered with a thin, slippery, brown film with a mucilaginous texture, represented by cyanophyte colonies (Cyanobacteria branch) (Fig. 6). No fixations of epibiontic macro-organisms (*Balanus spp.* or *Mytilus galloprovincialis*) were found.

Fig. 6. *Deposition of epibiosis on ME1 - floating element located offshore*

5. CONCLUSIONS

The experimental model of the modular system for the development of biofilter material designed made by specialists from The National Research and Development Institute for Textiles and Leather Bucharest was tested on shore and in open sea conditions in collaboration with researchers and the diving team from The National Institute for Marine Research and Development "Grigore Antipa" Constanta. The chosen test location was The National Institute for Marine

Research and Development “Grigore Antipa“ Constanta - *Pescarie* area, Mamaia (coordinates 44° 12'54.80 "N; 28° 38'55.94" E).

After 20 days of immersion in the conditions of the Romanian coast, on the floating bodies was found the formation of a thin film of micro-epibiosis, represented by the cyanophyte colonies (Cyanobacteria Branch). During the monitoring period, no fixations of epibiontic macro-organisms (*Balanus spp*. or *Mytilus galloprovincialis*) were observed.

The tests continue, according to the experimental program, depending on the biological development cycle of the epibiontic biofilter, in order to establish the technical resource of the composite materials from the system and to determine the productivity of epibiontic material on its collectors.

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ANTIMICROBIAL AND ANTIVIRAL PROPERTIES OF METAL NANOPARTICLES AND THEIR POTENTIAL USE IN TEXTILES: A REVIEW

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Abstract: *Recent global trends have put an emphasis on the importance of hygiene in all sectors including textiles. Antimicrobial and antiviral finishes are used in textiles to control bacteria, moulds, fungi and viruses on the textile substrate. Metal nanoparticles have been shown to posess antimicrobial and antiviral properties and can potentially be used in textiles for the production of fabrics with these functions. The aim of this paper is to explore the different antimicrobial and antiviral properties possessed by zinc oxide nanoparticles, titanium dioxide nanoparticles, silver nanoparticles and copper nanoparticles and their potential use in textiles. The challenges associated with these metal nanoparticles have also been assessed. Most of the metal nanoparticles studied display antibacterial properties against gram-negative Escherichia Coli and Pseudomonas Aeruginosa as well as gram-positive Staphylococcus aureus. Antiviral activities were also observed against Herpes Simplex Virus Type 1 (HSV-1), H1N1 influenza, poliovirus and foot and mouth disease. Although the metal nanoparticles showed potential for use as antimicrobial and antiviral finishes for textile substrates, environmental concerns have been raised on their use as they tend to be toxic during use and also produce a harmful washing effluent. Future studies should focus on the mitigation of the toxicity challenges associated with the use of metal nanoparticles.*

Key words: *Nanoparticles, Antimicrobial activity, Antiviral activity, Silver nanoparticles, Zinc Oxide nanoparticles*

1. INTRODUCTION

The current COVID-19 pandemic has sparked a lot of research interest in different sectors on possible ways of mitigating the spread of the virus. According to the World Health Organisation, the virus can be spread when an infected person is in close contact with other people and exhales or emits body fluids or virus-containing aerosol particles into the air. The virus can also be spread by touching surfaces that have been contaminated by the virus and then touching the mouth, nose or eyes without cleaning their hands. Textiles that consumers come into contact with on a daily basis such as clothes, bed sheets and textiles could potentially be a medium for the transmission of viruses. The global trends have therefore put an emphasis on the importance of hygiene and health in textiles, which has necessitated studies on antimicrobial and antiviral textiles. Antiviral finishes are those that reduce viruses in textile substrates. Antimicrobial textiles are used in textiles to control bacteria, moulds and fungi on the textile substrate. The use of nanomaterials has become popular in the textile industry for the incorporation of functional properties onto conventional textile materials. These properties include dirt repellency, water repellency, ultraviolet radiation, anti-odour, self-cleaning, flame retardancy, antiviral and antimicrobial properties. Inorganic finishes such as silver, magnesium, gold, titanium, copper and zinc have been used for durable antimicrobial finishes on natural, regenerated and synthestic textile materials. These metals and metal oxides have been used in nanoparticle form because of their durability to textiles, higher antimicrobial and antiviral functionality and their reduced environmental risks. Nanoparticles are materials that have all dimensions in the nanometre range, that is, less than 100nm. In textiles, the most commonly used nanoparticles are zinc oxide and silver. The aim of this paper is to explore the different antimicrobial and antiviral properties possessed by selected nanoparticles and their potential use in textiles. This paper will also assess the challenges associated with these metal nanoparticles in their use in textiles.

2. METAL AND METAL OXIDE NANOPARTICLES

2.1 Zinc Oxide Nanoparticles

Zinc metal and its oxide have special properties which include being bio-safe and hence have found application in the biomedical field. The utilization of zinc oxide in providing antimicrobial properties to cotton fabrics has been described in a study where 100% cotton plain weave substrate of 150 GSM was used. The cotton substrate was treated with zinc oxide nanoparticles (ZnO NPs) and the treated fabric recorded acceptable bacteria resistance against *staphylococcus* [1]. In another study cotton fabrics coated with ZnO NPs exhibited antibacterial effect against *staphylococcus epidermis*, *staphylococcus aureus* and *Propionibacterium acnes* with great potential for use as coatings for sport, medical and cosmetic fabrics [2]. Zinc nanoparticles have also been reported to have an acceptable efficacy against *Escherichia coli* (*E. coli*) and *sataphylococcus aureus* (*S. aureus*) bacteria. It was observed that zinc oxide nanoparticles have better antibacterial activity on gram positive (*S. aureus*) than the gram negative (*E. coli*) bacteria [3]. The efficacy and durability of the ZnO NPs on the textile substrates is affected by the treatment procedure as well as the additional reagents included in the procedure. A more durable antibacterial finish has been achieved with ZnO NPs and Gallic Acid coated fabrics which maintained efficiency even after 60 washing cycles. The enzymatic crosslinking of gallic acid resulted in the formation of a bio adhesive in which the nanoparticles were embedded thus improving the durability [4]. A single treatment process with low fabrication cost has been used in the production of zinc nanotextiles with enhanced antibacterial activity against different species of bacteria especially *K. pneumonia* [5]. Antibacterial cotton fabric has also been achieved by the single-stage in-situ growth of ZnO nanostructures on cotton fabric; the coated cotton fabrics exhibited an antibacterial efficiency towards *Pseudomonas aeruginosa* and *staphylococcus aureus* [6]. ZnO NPs have acceptable antiviral properties and these can be improved by coating with polyethylene glycol for a stronger antiviral effect against H1N1 influenza [7] and also against herpes simplex virus type 1 (HSV-1) [8]. Zinc nanoparticles have good properties such as anticancer, antioxidant, antimicrobial and have shown good antifungal activity against *Alternaria saloni* and *Slerrothum rolfi* strains. Zinc nanoparticles show good potential for use in textiles for the impartation of antimicrobial and antiviral finishes. However, as these nanoparticles will come into close contact with the skin, there is a chance that they will be absorbed into the body through skin pores and any other openings [9].

2.2 Titanium Dioxide Nanoparticles

Titanium dioxide is a material of interest because of its low-cost, non-toxicity, chemical stability and high photo-reactivity; it has been used effectively agains bacteria, viruses and fungi.

Titanium dioxide nanocomposites have demonstrated maximum bacterial inhibition against *pseudomonas aeruginosa* and antiviral activity against Newcastle virus. The nanoparticles also showed an effective antimicrobial activity against *S. aureus* and *E. coli* when applied onto knitted nylon 6.6 fabric by the layer-by-layer technique [10]. However, the main challenge with titanium dioxide is that its reactivity requires light illumination and thus its application can be limited in certain circumstances where there is limited light, for example, indoors. Therefore, titanium dioxide nanoparticles are often doped with other metals to enhance their antimicrobial properties even when used indoors. When applied onto cotton fabrics, titanium dioxide nanocrystals required the light illumination to allow for effective antimicrobial action. Significant antimicrobial effect was observed mainly against *staphylococcus aureus*. Studies have shown that polyester fabric modified by a small amout of titanium dioxide is incapable of inhibiting the growth of pathogenic bacteria due to the low photochemical activity of the coating but can inactivate gram negative bacteria when modified by metal-doped titanium oxide nanoparticles [11-12]. In another study, cotton treated with titanium dioxide/platinum nanocomposites exhibited superior antibacterial activities against both *Staphylococcus aureus* and *Escherichia coli* bacteria when compared with nano-titanium dioxide alone [13]. Apatite coated titanium dioxide when applied to cotton fabric has been shown to be effective against four types of bacteria, that is, *S. aureus*, *E. coli*, *methicillin-resistant staphylococcus aureus* and *micrococcus luteus*. Unmodified titanium dioxide and titanium dioxide modified hydroxyapatite composite have displayed strong antiviral activity against H1N1 infuenza A virus under ultraviolet light [14-15].

2.3 Silver Nanoparticles

Silver is the most commonly used inorganic finish because of its high thermal and electrical conductivity, lower contact resistance and also because it occurs in several oxidation states. Silver kills microorganisms by blocking and disengaging the intracellular proteins. Silver nanoparticle has been shown to exhibit antibacterial properties against *Escherichia coli* when applied on cotton and viscose fabrics; the treated fabrics showed good results even after washing [16]. Silver nanoparticles with protein capping have been applied onto cotton fabric and have displayed antimicrobial activities against *Candida albicans, candida parapsilosis* and *xanthomonas axonopodis*. In this study washed nanoparticles presented a more pronounced antimicrobial effect due to the lower concentration of stabilizing agents [17]. In an attempt to improve the nanoparticle adhesion, cotton fabrics were coated chemically with silver nanopartricles using polydopamine as an adhesive and then with hydrophobic polydimethylsiloxane or polyimide. The introduction of polydopamine significantly increased the bond between silver nanoparticles and cotton fibres, thereby preventing silver nanoparticles from falling off the surface. The fabric composites showed a significant antibacterial action against *staphylococcus aureus* and *escherichia coli* [18]. Silver nanoparticles have also been applied in-situ and ex-situ on cotton fabric and the study showed that the in-situ treatment resulted in fabrics with stronger antimicrobial property and durability against washing even with low concentrations of silver nitrate. There was a strong antimicrobial activity against *s. aureus* than *e. coli* for both the in-situ and ex-situ treated fabrics [19]. In another research, synthesis of silver nanoparticles was done directly on textile fabrics by use of the radiochemical process which involves the irradiation of a high-energy electron beam on an aqeous solution containing silver ions. This induces a reducing reaction that forms metallic silver nanoparticles. Textile fabrics treated with silver nanoparticles demonstrated high antibacterial activity and durability against washing regardless of the specific fabric used. The fabrics used were, cotton, rayon, polyester, polyamide (nylon 6.6), acryl, polypropylene and microfiber (polyester 80%, polyamide 20%) [20]. The antibacterial efficacy of chitosan-silver nanoparticles against *S. aureus* and *e. coli* was also observed when applied as a coating onto linen fabric. The silver nanoparticle/chitosan composites were also shown to have antiviral activity against influenza A virus. The antiviral activity of the composites increased as the amount of silver nanoparticles increased. Chitosan alone did not exhibit antiviral activity suggesting that silver nanoparticles are essential for the antiviral activity [21]. Silver nanoparticles have been eco-friendly synthesized by the electrochemical method and have inhibited non-envelop viruses at low concentrations, particularly poliovirus [22]. Numerous studies have agreed that silver nanoparticles possess antimicrobial and antiviral properties with several examples of how they could possibly be applied in textiles. The issue of toxicity of metal oxide nanoparticles has been the subject of much systematic investigation with many studies highlighting the challenge of the silver particles being released into the washing or rinsing effluent and subsequently into waste water disposal sites. These silver particles can inhibit the nitrification of waste water and hence reduce the effectiveness of water treatment [23]. Another challenge is that if they make their way to the aquatic systems, they result in oxidative stresses in marime organisms form the dissolution of the metal ions thus leading to chronic health impacts [24].

2.4 Copper nanoparticles

Copper nanoparticles are low-cost, durable and are effective nanoparticles. They have shown good antimicrobial properties against *E. coli* and *S. aureus* when prepared by electroless deposition in water; *S. aureus* was more susceptible to the copper nanoparticles than *E. coli* [25]. Novel antimicrobial nanocomposite material based on polypropylene (PP) non-woven fabric, biopolymer alginate and copper oxide nanoparticles have been prepared in a previous study. In order to introduce polar groups onto the surface of PP fibres necessary for bindimg of alginate, nonwoven fabric was activated by corona discharge. All fabricated nanocomposites provided excellent antimicrobial activity against gram-negative bacteria *E. coli*, gram-positive bacteria *S. aureus* and yeast *C. albicans* [26]. Copper nanoparticles significantly inhibit herpes simplex virus type 1 (HSV-1) infection. The inhibition occurs when copper oxide nanoparticles are added after virus adsorption to the cells [27]. However, these nanoparticles have shown toxicity towards human organs. An in vitro skin toxicity study of these nanoparticles showed that metal oxide ions released from coated fabrics could affect the epidermal tissue and the underlying dermal cells upon trans-epidermal permeation [11].

3. CONCLUSIONS

A review has been done to assess the antiviral and antimicrobial properties of metal and metal oxide nanoparticles. Most of the reviewed work does not examine how the presence of nanoparticles on the textile substrates alters other properties such as comfort, aesthetics and the physicochemical properties. Although the studied nanoparticles have been shown to have the antiviral and antimicrobial properties, some have not been tested on textile fabrics. It is important to determine their efficacy when applied onto textile fabrics. Environmental concerns have also been raised on the use of metal nanoparticles for multifunctional textile finishes as they tend to be toxic to human organs including the brain, the lungs, the liver and the reproductive organs. They may also be detrimental to the environment during and after use. It is therefore important to curb the toxicity challenges associated with the use of these metal oxide nanoparticles, either by producing greener nanoparticles or by finding ways of effectively treating the effluent produced from the nanoparticles. Despite the challenges, results have shown significant antimicrobial properties of the selected nanoparticles against gram-negative *Escherichia Coli* and *Pseudomonas Aeruginosa* as well as gram-positive *Staphylococcus aureus*. Antiviral activities were also observed against *Herpes* Simplex Virus Type 1 (HSV-1), H1N1 influenza, poliovirus and foot and mouth disease. Given all the information, and all safety and toxicity concerns being understood and considered; these nanoparticles can be used in industries where antimicrobial and antiviral properties are of importance such as the health sector and the hospitality sector.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

PERSONAL LOGO FOR A CREATION FIRM OR ATELIER

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Abstract: *The logo is a graphic element that can take the form of a letter, text, image, or even combinations of all these elements. It is used to identify a brand, product, organization or event. Any business, regardless of its size, must have a logo to define it. Nowadays, communication has become dominated by its visual composition. The world in which the rhythm is increasingly accelerated, communication strategies must emphasize what is possible to transmit instantly, with minimal effort, to the person who is looking. Starting from this premise, in this paper, we will present why it is good to create your own logo and what are the aspects to be taken into account when doing so. Well, our goal is to find a logo that has positive connotations for the business we want to promote. In this paper, a list of quality logo services and tips has been created to help people while creating an original logo for a business. Finally, we have written an idea on how to start creating a logo for a business that provides credibility in interacting with potential customers. We need a professional logo, colorful, versatile, that has positive visual impact, but at the same time it is affordable, and can be purchased by any small creative workshop.*

Key words: *Logo, personal computer, art, design, marketing, conception*

1. INTRODUCTION

In the article there will be presented steps and general characteristics of the process of logotype creating, both essential and important for the existence of any organization [1].
First, we need to understand that the logo will be displayed everywhere. This is not just a symbol that will appear on the site or as a logo of a store. It will now be a representative part of the business and should be displayed wherever this business is mentioned. It must be resized and look good printed on a poster, product, sticker, etc.

That said, it is obvious that it is not enough for people to like it, but it must resonate with all that society means are represents today. Design Buddy recently conducted an excellent analysis of the data of the best brands in the world and the things their logos have in common. Here are some key elements in that article that we should keep in mind when creating the logo, using one of these generators [2]:
- 95% logos of the world's top brands contain one or two colours
- 41% of brands use stylized logo types
- 93% are simple enough to be recognised even in small sizes.
- For 40% of the small businesses, it is very important that the logo also reflects the type of business.

A good logo is distinctive, suitable, practical, graphic and simple in form [3]. It conveys the message intended by the holder. It should follow the five principles below to ensure that its design meets all of these criterias [4]:

- a logo must be simple- A simple logo design allows its easily recognition and makes the logo versatile and memorable. The representative logo depicts an unexpected or unique thing without being too crowded.

- a logo must be memorable - Immediately according to the principle of simplicity lies that of memorability. An effective logo design should be memorable and this is possible by creating a simple and suitable logo.

- a logo must be durable - An effective logo should pass the test of time. The logo must be "immune to the future", i.e. it should be able to be effective in 10, 20 or 50 years.

- a logo must be versatile - An effective logo should be able to work in a variety of environments and applications.

- a logo must be appropriate – Understanding my target audience or my consumers is an essential component in creating an effective logo design. Knowing what's right for my audience will determine the type of font I'm going to use, the colors, and any additional graphics [4].

2. MAKING THE LOGO

To create a logo we have several graphics programs available. One of the most representative is Adobe Photoshop. This is the spearhead of the range of software products for digital image editing, photos, graphics, video and the Web. This is a program with an intuitive interface allowing a multitude of changes currently required for professionals and not only: brightness and contrast edits, color, focus, application of effects on image or areas (selections), retouch of degraded images, arbitrary number of color channels, 8, 16 or 32-bit color channel support, third-party effects, etc. There are specific situations for a professional in the field when other packages lead to faster results, but for general image processing, as it provides solid tools, to industry standard, Photoshop is effectively indispensable. The image processing software application is more than just a working tool for graphic artists [5], [6].

We start working, taking inspiration from the four online tools that can be easily used to create our logo (e.g. Locaster, Finch Goods, GraphicSprings, Hipster Logo Generator, Zillion Designs).

We're following the three steps:

- We frame the type of business;
- We choose a representative symbol for the logo;
- Customize the logo.

The following figures show steps to follow in the graphic making of a logo.

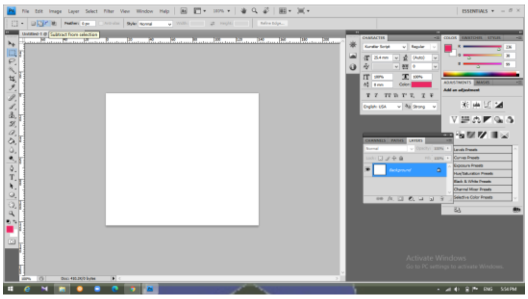

Fig. 1. *Creating a new working page*

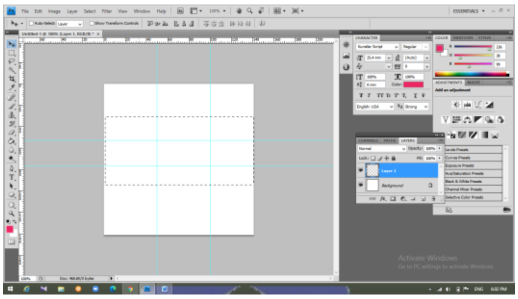

Fig. 2. *By activating the ruler we divide that rectangle into certain values.*

The color of a logo can be even more important than its graphics because it amplifies its effects on the audience [7]. Colors are the first that you notice on a logo, shape, signs and typography are observed later. It is precisely for this reason that knowledge and understanding of color psychology is important for the creation of an efficient logo [8].

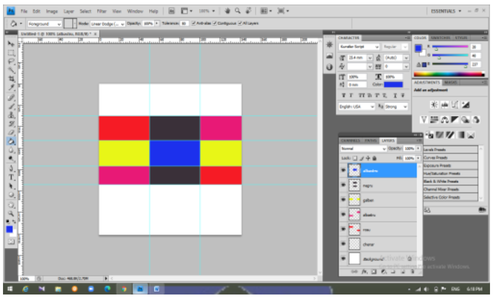

Fig. 3. *Creating a color game on different layers*

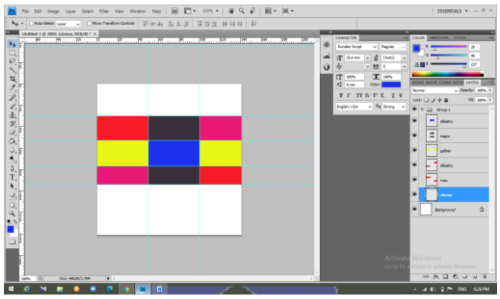

Fig. 4. *Select all layers, flatten and group them*

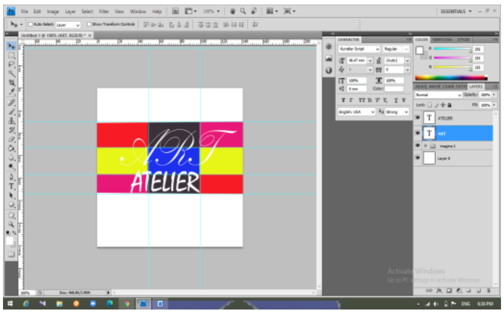

Fig. 5. *Add text*

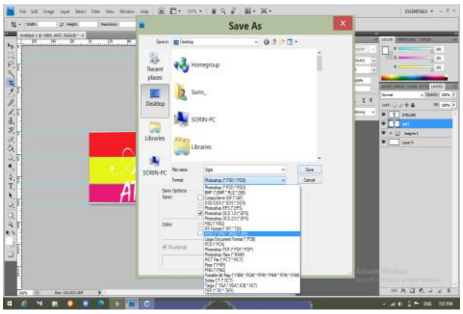

Fig.6. *Save project in JPEG format*

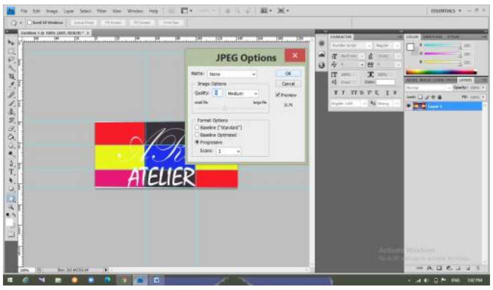

Fig.7. *Format the image JPEG*

Fig.8. *Embroidery logo applied*

Once created the logo can be exported in JPEG format, fig.8 and then processed into different softwares so that it can be printed on different media. In order to make this logo suitable for clothing products, it was embroidered on textile support, which ensures the possibility of application by sewing, and not only. To do this, the JPEG image is imported into the Drawings program so that you can create the file type. After taking the image, the necessary embroidery adjustments such as density and type of seam are made, and then exported to a file format suitable for reading by the embroidery machine [9]. Embroidery was executed within the company: S.C. Atelier Broderie Carla S.R.L, which owns state-of-the-art embroidery machines, Japanese origin, Happy, Brother, [10], [11], etc.

3. CONCLUSIONS

In conclusion, it came to the idea that sufficient time must be given to make decisions on the characteristics of the logo that attract first of all, but at the same time represent the company. For this you need to look for inspiration, search among the shelves of stores, study very carefully the advertisements on the internet, memorizing the list of symbols that we notice first. A second importance is the detailed analysis of successful companies, on the combinations of colors that evoke positive emotions and the establishment of the need for the logo to contain a symbol, initial or full name of the company it will represent. Finally, we present a selection of some of the best online resources that can be visited, in order to have the best vision for creating future logos (e.g. Locaster, Logicdesign, Logo Faves), that correspond in terms of design, are easily noticed and easy to highlight, but are also at an affordable price.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

STUDIES ON THE POSTOPERATIVE FUNCTIONAL-ADAPTIVE BRA DESIGN

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Abstract: *The development of functional clothing products for people with disabilities is one of the priority research directions in the field of the textile industry. The paper presents the results of the comparative analysis of the basic patterns construction for the bra-type product in order to obtain a methodological basis for the design of the postoperative functional-adaptive bra rational ergonomic constructions. The theme timeliness is determined by the sudden drop in the quality of life of women with breast gland cancer after conducting radical surgical treatment. The work aims to obtain data on the ability to adapt the design algorhythm of the basic patterns for the bra-type product to the functions, requirements and characteristics required for the post-mastectomy textile products in general and the postoperative functional-adaptive bra in particular. The paper mentions the problems faced by post-mastectomy women and the textile products role in their prevention. The study includes identifying the functions, requirements and characteristics needed for the post-mastectomy textile products, the development of the basic patterns constructions for the bra product, the comparative analysis of the made patterns. One of the problems that is tried to be solved in this paper is the methods identification of bra-type products design that allows the adaptation of the construction algorithm to the requirements and characteristics necessary for the post-operative bra product. The results of the study are recommended to be used in the process of developing the constructions of post-operative functional-adaptive bra type products for women wearing external breast prostheses.*

Key words: *Post-mastectomy textile products, requirements, functions, features, design method*.

1. INTRODUCTION

The fundamental problem of designing functional-adaptive clothing is obtaining the most advantageous shapes and sizes of clothing products in accordance with structural, functional, psychological peculiarities of the wearer; material properties; aesthetic and functional requirements needed for products.

The postoperative bra type product is recommended for women post-mastectomy but also in the case of other surgery on the breast gland, returning its role to prevent post-operative complications, optimal support of the breast prosthesis, ensuring the state of physiological and psychological comfort. [1-3]

2. THEORETICAL ASPECTS

The scientific design of a clothing product requires its functional structuring, a process that at the initial stage involves identifying the functions, requirements and characteristics necessary for the clothing product.

Clothing products for post-mastectomy women require the assignment of specific functions that contribute to increasing the patient's satisfaction and their life quality (figure 1).

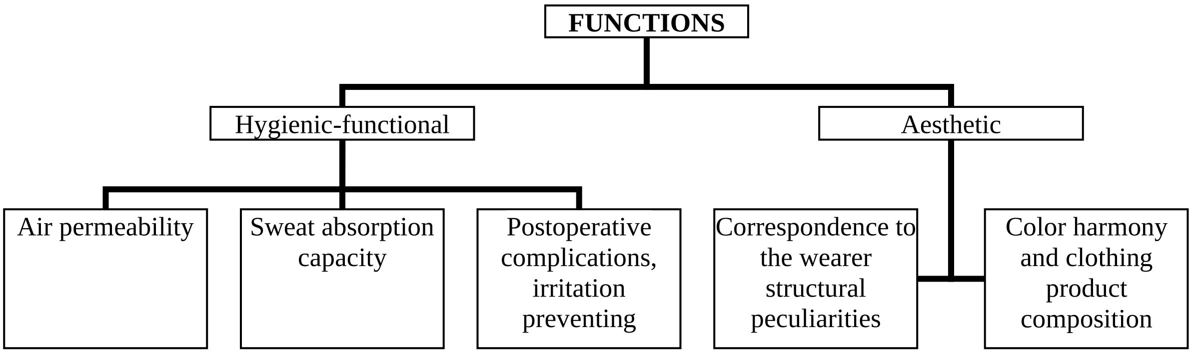


Fig. 1: *Functions required for the post-operative functional-adaptive bra type product*

The postoperative bra type product is characterized by a group of specific requirements dictated by the needs of the wearer and the functions necessary for this type of product (figure 2).

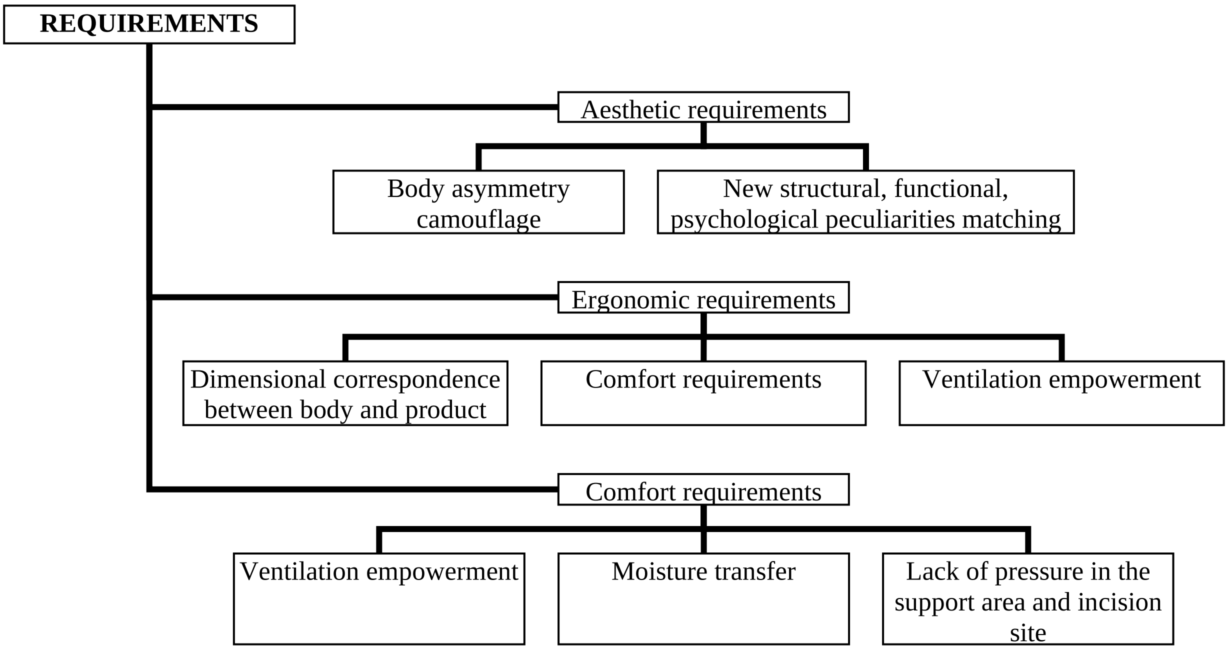


Fig. 2*: Requirements for the post-operative functional-adaptive bra type product*

The post-mastectomy bra type product is designed taking into account the possibility of complications in the postoperative and rehabilitation period. The specific characteristics required for the post-mastectomy bra are shown in Figure 3.

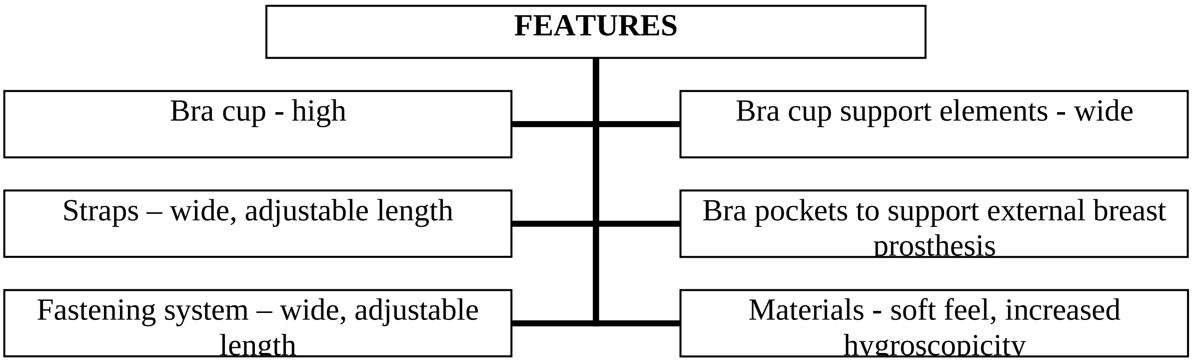


Fig. 3: *Specific features required for the post-mastectomy bra*

3. EXPERIMENTAL RESEARCH

While achieving the basic pattern construction 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 functions, requirements and specific characteristics needed for the type of designed product.

In order to obtain a methodological basis for the design of rational ergonomic constructions of the postoperative functional-adaptive bra, it is proposed to carry out some research, which at the initial stage include the analysis of existing methods of constructing the bra-type products patterns.

The paper presents the comparative analysis of the basic patterns of underwear items from the bra group, patterns obtained by various modern construction methods.

For this purpose, constructions of the basic pattern were made by 6 graphical-analytical calculation methods:

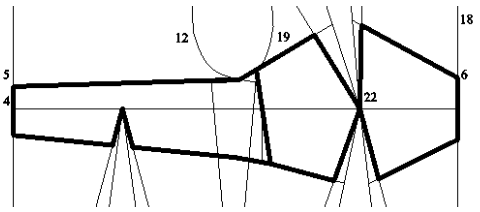
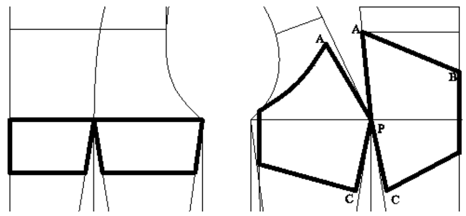
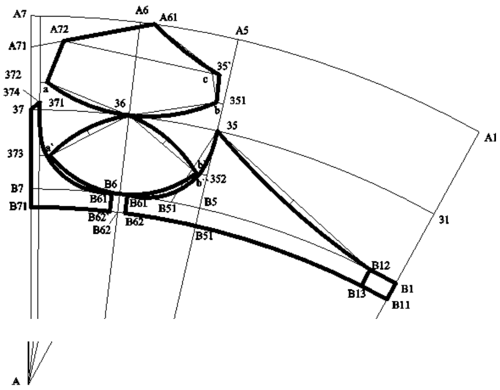
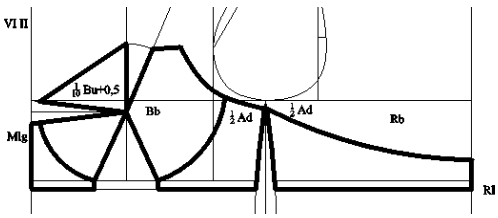
- English method Winifred Aldrich;
- French method Line Jaqe;
- method of construction in radial networks;
- method Muller&Sohn;
- method ȚNIIȘP;
- method of the Russian author L. Serova.

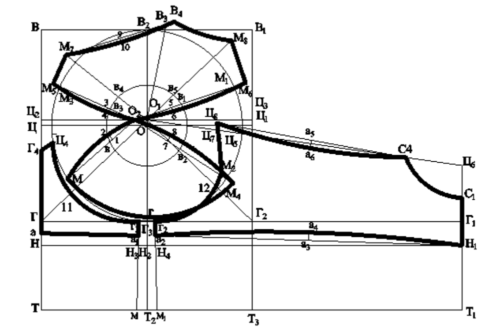
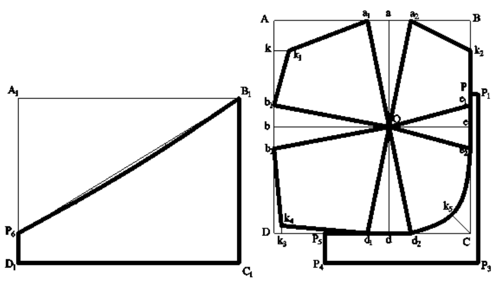
The selected methods differ from each other by the number of anthropometric dimensions used in the calculation of construction, the type of formulas for calculating constructive segments, the construction stages of the pattern. The constituent elements will be made of inextensible knit, except for the bra fastening element, which is to be made of stretchable material. The bra size is determined by the value of the bust perimeter IV and the conformation group. The conformation group is determined as the difference between the bust perimeter III and the bust perimeter IV:

- Bust perimeter III – Bust perimeter IV = 12 cm – group 0;
- Bust perimeter III – Bust perimeter IV = 14 cm – group I;
- Bust perimeter III – Bust perimeter IV = 16 cm – group II;
- Bust perimeter III – Bust perimeter IV = 18 cm – group III.

The developed patterns correspond to typedimension 100-I. The construction stages according to the selected design methods and the obtained basic patterns are presented in Table 1.

Table 1: *Bra-type product patterns construction*

Initial data		Construction stages	Basic pattern
anthropometric indicators number	**including those of the breast gland**		
English method Winifred Aldrich			
8	0	1. Choosing or drawing up the basic pattern for the product bodice; 2. Joining the front and back landmarks on the side line; 3. Construction of bra cup landmarks; 4. Construction of the back landmark.	
French method Line Jaqe			
7	0	1. Choosing or drawing up the basic pattern for the product bodice; 2. Joining the front and back landmarks on the side line; 3. Construction of bra cup landmarks; 4. Construction of the back landmark.	
Method of construction in radial networks			
7	4	1. Basic network layout; 2. Construction of bra cup landmarks; 3. Drawing the cup support element and the back landmark contour lines.	
Method Muller&Sohn			
12	0	1. Choosing or drawing up the basic pattern for the product bodice; 2. Joining the front and back landmarks on the side line; 3. Construction of bra cup landmarks; 4. Drawing the cup support element and the back landmark contour lines. 5. Construction of the back	

		landmark.	
Method ȚNIIȘP			
9	2	1. Basic network layout; 2. Construction of bra cup landmarks; 3. Drawing the cup support element and the back landmark contour lines.	
Method of the Russian author L. Serova			
5	1	1. Construction of bra cup landmarks; 2. Drawing the cup support element and the back landmark contour lines; 3. Construction of the back landmark.	

The basic patterns constructions are analyzed by the details number and dimensions, the possibilities of adaptation to the requirements and characteristics needed for the post-operative functional-adaptive bra type product.

The results obtained from the comparative analysis of the developed basic patterns construction are presented in Table 2.

Table 2: *Comparative analysis of the basic construction for the bra-type product*

Construction method	Details number			Details dimensions, cm						
				cup			Cup support element		back	
	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
English method Winifred Aldrich	2	-	1	13	24	17	-	-	17	11
French method Line Jaqe	2	-	1	10.5	21.4	7.6	-	-	7.6	7.6
Method of construction in radial networks	2	1	1	11.8	23.5	10.8	2.5	14.3	13.3	2.5
Method	3	2	1	13.6	21.5	16.2	1.0	13.6	16.2	3.5

Muller&Sohn										
Method ȚNIIȘP	2	1	1	9.6	25.1	7.5	1.6	10.2	13.5	5.9
Method of the Russian author L. Serova	4	1	1	18.6	28.4	17.9	4	22.6	22	4.5

5. CONCLUSIONS

The algorithm for calculating the method of construction in radial networks, the ȚNIIȘP method and the method of the Russian author L. Serova includes formulas using values of the dimensional parameters of the breast gland, which gives a better correspondence shape-dimensions-body-product. The number of details and their dimensions also correspond to a greater extent to the characteristics required for the concerned product construction. It is recommended to use the results of the study in the process of developing the constructions of post-operative functional-adaptive bra type products intended for women wearing external breast prostheses.

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QUALITY FUNCTION DEPLOYMENT IN TEXTILE INDUSTRY: A CASE STUDY FOR EMBROIDERY MACHINES

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Abstract: *According to existing literature, quality function deployment is a tool that can be used to relate the requirements of customers with the technical characteristics of products in order to satisfy these requirements. Since its development in Japanese industry, quality function deployment is subject to much literature that describes its employment in different fields. The existing literature also illustrates the use of quality function deployment in different areas of the textile industry. Nevertheless, quality function deployment has been less used for embroidery machines. Within this context, the aim of this study is to present the employment of quality function deployment for the linkage of the requirements of customers with the technical characteristics of embroidery machines. A case study illustrates the approach, which was conducted taking into account three embroidery machines (one of the machines was considered as Our Product, the other two were considered as Competitor A and Competitor B). Following the approach described in the existing literature, the main steps of the employment of quality function deployment for embroidery machines are shown: the establishment of the requirements of customers; the establishment of the technical characteristics; the devopment of the matrices of the quality function deployment: the planning, relationship, correlation and technical matrix.*

Key words: *qfd, customer requirements, technical characteristics, embroidery, machines*

1. INTRODUCTION

Quality function deployment (QFD) is a quality tool that can be used to establish the characteristics of products that are necessary to satisfy the requirements of customers [1]. Since its development in Japanese industry, it is subject o much literature that describes the employment of QFD in different fields [2]. In the textile industry QFD has been used in different areas, such as the apparel design [3], selection of cotton fiber [4], improvement of quality of T-shirt [5] or lifecycle evaluation of products [6].

However, QFD has been less used for embroidery machines. Therefore, the aim of this article is to illustrate the employment of QFD for the linkage of the requirements of customers with the technical characteristics of embroidery machines in order to accomplish these requirements.

2. MATERIALS AND METHODS

The research was conducted taking into account three embroidery machines. One of the machines was considered as our product, the other two were considered as Competitor A and Competitor B.

3. RESULTS

Following the approach described in [7], the next steps presents the employment of QFD for embroidery machines:

a) The establishment of the requirements of customers (WHAT's List)

The following requirements of customers were determined:

a1) reliability;
a2) noise;
a3) serviceability.

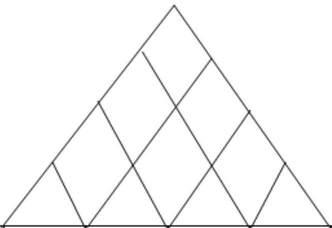
b) The establishment of the technical characteristics (HOW's List)

The following technical requirements were determined:

b1) thickness of the material <1 mm;
b2) embroidery area 2080 cm^2;
b3) sewing speed 1000 stitches/minute;
b4) memory storage capacity 40000000 stitches.

c) Planning matrix

The planning matrix is depicted in figure 1.

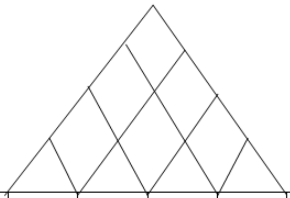


Technical characteristics (HOW's) / Requirements of customers (WHAT's)	Thickness of the material	Embroidery area	Sewing speed	Memory storage capacity	Inortance of WHAT's	Competitive analysis: Our product	Competitive analysis: Competitor A	Competitive analysis: Competitor B	Planned coefficient	Improvement factor	Market leverage point	Overall importance
Reliability					4	3	4	3	4	1.2	1.2	5.76
Noise					5	4	4	4	4	1	1.5	7.5
Serviceability					4	4	4	5	5	1.2	1.2	5.76
Importance of HOW's												
Percent importance of HOW's (%)												
Competitive benchmarking: Our product												
Competitive benchmarking: Competitor A												
Competitive benchmarking: Competitor B												
Competitive benchmarking: Target values for our product												

***Fig. 1**: The planning matrix*

d) The relationship matrix

The (9, 3, 1, 0) scale was used to establish the relationship between each requirement of customers and each technical characteristic. The relationship matrix is shown in figure 2.



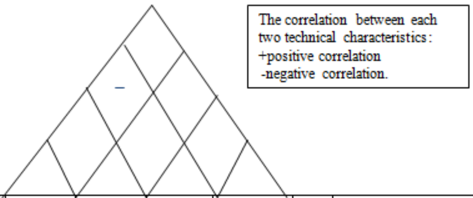
Technical characteristics (HOW's) / Requirements of customers (WHAT's)		Thickness of the material	Embroidery area	Sewing speed	Memory storage capacity	Imortance of WHAT's	Competitive analysis: Our product	Competitor A	Competitor B	Planned coefficient	Improvement factor	Market leverage point	Overall importance
Reliability		1	1	3	1	4	3	4	3	4	1.2	1.2	5.76
Noise		3	1	9	0	5	4	4	4	4	1	1.5	7.5
Serviceability		0	1	1	1	4	4	4	5	5	1.2	1.2	5.76
Importance of HOW's													
Percent importance of HOW's (%)													
Competitive benchmarking	Our product												
	Competitor A												
	Competitor B												
	Target values for our product												

Legend
Relationship scale: 0=no relationship, 1=weak relationship, 3= moderate relationship, 9=strong relationship.

***Fig. 2**: The relationship matrix*

e) The correlation matrix

The correlation matrix between each two technical characteristics is presented in figure 3.



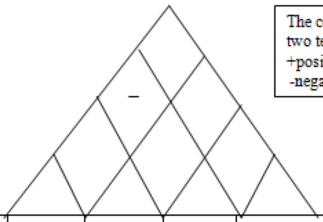
Technical characteristics (HOW's) / Requirements of customers (WHAT's)		Thickness of the material [mm]	Embroidery area [cm²]	Sewing speed [stiches/minute]	Memory storage capacity [stiches]	Imortance of WHAT's	Competitive analysis: Our product	Competitor A	Competitor B	Planned coefficient	Improvement factor	Market leverage point	Overall importance
Reliability		1	1	3	1	4	3	4	3	4	1.2	1.2	5.76
Noise		3	1	9	0	5	4	4	4	4	1	1.5	7.5
Serviceability		0	1	1	1	4	4	4	5	5	1.2	1.2	5.76
Importance of HOW's													
Percent importance of HOW's (%)													
Competitive benchmarking	Our product												
	Competitor A												
	Competitor B												
	Target values for our product												

Legend
Relationship scale: 0=no relationship, 1=weak relationship, 3= moderate relationship, 9=strong relationship.

***Fig. 3**: The correlation matrix*

f) The technical matrix, which is depicted in figure 4.

The importance of HOW's for each technical characteristic was computed by multiplying each value in its column of the relationship matrix with the corresponding values of the overall importance (e.g. thickness of the material: 1*5.76+3*7.5+0*5.75=28.26). The target values of the competitive benchmarking were established by comparing the ones of Our Product with those of the Competitor A and Competitor B.



The correlation between each two technical characteristics:
+positive correlation
-negative correlation.

Technical characteristics (HOW's) / Requirements of customers (WHAT's)	Thickness of the material [mm]	Embroidery area [cm²]	Sewing speed [stiches/minute]	Memory storage capacity [stiches]	Imortance of WHAT's	Competitive analysis: Our product	Competitive analysis: Competitor A	Competitive analysis: Competitor B	Planned coefficient	Improvement factor	Market leverage point	Overall importance
Reliability	1	1	3	1	4	3	4	3	4	1.2	1.2	5.76
Noise	3	1	9	0	5	4	4	4	4	1	1.5	7.5
Serviceability	0	1	1	1	4	4	4	5	5	1.2	1.2	5.76
Importance of HOW's	28.26	19.02	90.54	11.52								
Percent importance of HOW's (%)	18.92%	12.74%	60.63%	7.71%								

Competitive benchmarking		Thickness of the material [mm]	Embroidery area [cm²]	Sewing speed [stiches/minute]	Memory storage capacity [stiches]
	Our product	≤1	2080	1000	40000000
	Competitor A	≤1	2000	1000	40000000
	Competitor B	≤1	1920	1200	40000000
	Target values for our product	≤1	2080	1200	40000000

Legend
Relationship scale: 0=no relationship, 1=weak relationship, 3= moderate relationship, 9=strong relationship.

***Fig. 4**: The technical matrix*

4. CONCLUSIONS

In this work, quality function deployment was used for linkage of the requirements of customers with the technical characteristics of embroidery machines in order to accomplish these requirements. A case study illustrates the employment of the approach.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

MANAGEMENT OF LEATHER SCRAPS AMONG SENIOR HIGH SCHOOL VISUAL ART STUDENTS IN GHANA

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Abstract: *The importance of leatherwork cannot be overemphasised in society. In Ghana, leatherwork creates a source of livelihood for visual art students and graduates. However, leatherwork activities lead to the generation of hazardous waste which can negatively impact the environment and society. These wastes, if managed properly, could serve as low-cost inputs for artwork that would provide benefits to the environment and artists. This study investigates how visual art students in one senior high school in Ghana use their leather scraps for up-cycled artwork. Items produced, techniques used and factors considered in determining the usefulness of leather scraps generated from practical leatherwork activities are considered. The research used a descriptive qualitative research design. The principal instrument used to collect data was interviews and observation. A total of 21 students, selected purposively, formed the sample population. Thematic data analysis approaches were used to make meaning from the data. Findings from the study revealed that most students use leather scraps to make small to medium-sized items for non-commercial purposes. Patchwork, thonging and applique featured as the most prominently used techniques. The size and extent of defects also determined the usefulness of leather scraps. It was concluded that leather scraps can be used either as a supporting or dominating material for making leather articles; and joining is a prerequisite for using leather scraps as a dominating material. It is recommended that further studies be conducted to understand the effect of joining techniques on product durability, effort and time efficiency.*

Key words: *Leatherwork, Waste Management, Up-cycled Art, Upcycling Techniques, Waste as Resource*

1. INTRODUCTION

Leatherwork can be considered an important activity in any economy. The leatherwork sector serves as a source of livelihood to individuals and provides access to basic human needs such as footwear, containers and furniture among others [1]. Nevertheless, leatherwork activities lead to the generation of waste that can be harmful to mankind and to the environment [2, 3]. Therefore, there is the need to manage it properly for positive results.

In Ghana, leatherwork features as one of the major courses in visual art education at secondary level aimed at training students with vocational skills, for self-employment [4]. This training requires students to plan and execute artefacts during the teaching and learning process which leads to the generation of wastes such as leather scraps. Currently, there is limited understanding of how these scraps are managed by students; specifically, the extent to which recycling strategies are employed.

This study explores how senior high school visual art students utilize leather scraps for up-cycled art. It sheds light on the ways that students handle leather scraps, specific items made, and techniques used. It also highlights the factors considered by students in determining the usefulness of leather scraps for up-cycled art. The rest of the paper 1) reviews the literature on how leather scraps are employed for up-cycled art by artists, 2) explains how the study was conducted and, 3) reports on key findings, discussions, conclusions and recommendations drawn from the study.

2. LEATHER SCRAPS FOR UP-CYCLED ART

The production process of any leather artefact involves the generation of leather scraps. Leather scraps can refer to multiple things. According to the literature, leather scraps include excess pieces of leather (e.g. trimmings) derived from the cutting stages of the leather product manufacturing process [5] as well as discarded prototype samples [6]. Scraps usually come in varied sizes depending on the nature of the product being manufactured. In this study, leather scraps refer to leftover leather pieces obtained at the end of a semester's practical work activities.

Upcycling is a form of re-cycling that converts wastes into valuable products [7]. Up-cycling in visual art involves transforming waste and discarded materials into an artwork. Several studies [8, 9, 10] have shown how waste materials from plastic, cans, electronic items, scratch cards and car tyres can be recycled for beautiful artwork. Thus, advocating the concept of waste as resource for environmental and societal benefit.

Very few studies [11, 12, 13] have looked at leather scraps for up-cycled art. The first study [11] focused on leather scraps and textiles to make fashion accessories like table mats, wallets, jewellery, handbags, and cushion covers among others. The second study [12] also experimented with leather scraps to create items such as belts, footwear, handbags, and decorative ornaments. The third study [13] employed scientific approaches to change leather scraps into composite sheets to create artefacts like mouse pads, key chains, wallets and interior decorations items. Items produced were generally small to medium-sized and decorative techniques such as applique and patchwork featured prominently.

In the three studies mentioned above, leather scraps were utilized mainly for small items. However, observations of images presented in these studies show that leather scraps could also be manipulated to create larger items provided pieces are joined together or combined with other materials. Joining techniques applied included gluing and machine stitching.

It is suggested in the literature [14] that deterioration of leather is inevitable if the leather is exposed to things such as heat, water, salts and chemicals. To this end, it can be argued that even though leather can deteriorate, its life span can be extended as leatherworkers follow some general principles of care, storage [15]. This suggests that leather scraps could be beneficial for up-cycled art provided the needed care is given.

3. RESEARCH METHOD

The descriptive qualitative research design was adopted. Interviews and observation served as the main tools for data collection. A single case study focused on one senior high school in the Cape Coast Metropolis was employed with a target population of forty-seven (47) second and third-year leatherwork students. A total of 21 students constituted the sample population who were selected purposively due to their exposure to practical leatherwork projects. Data collection was guided by the inductive thematic saturation model [16] where data collection was halted at the point where no new themes came up. Open and axial coding strategies were applied in addition to the general qualitative data analysis process of data reduction, data display and data verification [17].

4. RESULTS AND DISCUSSION

Overall, results indicated that most students in the study up-cycled their leather scraps for personal, academic or non-academic purposes. For academic purposes, leather scraps were utilized for practicing decorative techniques, making templates and prototypes, testing dyes and creating thongs for testing slit holes. For non-academic purposes, leather scraps were employed primarily for producing small and medium-sized items. Small leather articles produced by most students included key holders, bracelets, pendants, watch straps, tags and bag handles while medium-sized leather articles included cases for holding pencil, water bottles, phones and cutlery, as well as purses and book jackets.

Observation of artefacts made by students indicated that leather scraps either supported or dominated production. When supporting production, leather scraps were assembled to make specific parts of items or join parts together. As a dominating material, leather scrap constituted the main body of the artefact after joining together to create a large sheet. Figure 1 below features two of the ways in which students utilized leather scraps to make the straps of a sandal and a weaving decoration on a footrest. In figure 2, there is evidence of the joining of different types and colours of leather via hand stitching to make water bottle holders. Figures 3 also shows the use of leather scraps by students in the study as a thread to join different parts to make purses, decorative ornaments, jewellery box and table mat. These items produced by students in this study are similar to some of the articles produced in upcycling art projects mentioned in the literature [11, 12, 13]. Nevertheless, there appeared to be more use of manual processes in the work produced by students in contrast to the consistent use of machine stitching for joining in studies identified in the literature.

Fig. 1. *Leather scraps used for sandal straps and weaving decoration*

Fig. 2. *Bottle holders made from leather scraps joined together by hand stitching*

Fig. 3*. Leather scraps used as a material for joining parts to make purses, jewellery box and table mat.*

In addition to specific items for which leather scraps were used, respondents referred to decorative and joining techniques they had to employ in making their leather scrap articles (see Figures 1 to 4). Results showed that techniques such as patchwork, thonging, and applique' (in-lay and on-lay) were used among most respondents (15 out of 21). Also, observation of artefacts made from leather scraps by students showed the use of additional decorative techniques such as incision, weaving, marbling and braiding. There was evidence of the use of leather scraps in combination with other non-leather accessories (e.g. rivets, grommets, metal ornaments). This mirrors techniques used in other studies [11, 12, 13] in the execution of their work on leather scraps.

Fig. 4*. Leather scraps used in combination with other non-metal accessories*

Using phrases like "my actual work'' "my friends and family", "in school projects" "gift to friends and family", "for a friend's birthday and myself", respondents explained that most of their production efforts were for non-commercial purposes. Therefore, it appeared that most respondents were missing out on an opportunity to earn while studying because findings in the literature [11] indicated that 98% of respondents in a sample of 50 people they studied were willing to buy up-cycled products made from leather scraps. Despite this, one respondent highlighted her involvement in selling the artwork she produced from leather scraps for money.

In another instance, a respondent explained that she usually gave her scraps to the cobbler when going to mend her shoes, thus decreasing the amount she paid to the cobbler for his services. It is interesting to note that in one case, the student suggested swapping leather scraps as a prerequisite for up-cycling. According to her, there are times when the scraps she has are not useful to her due to their properties in terms of size, type, texture and colour specification. In such cases, she exchanged the leather scraps with colleagues for ones that suited the work she needed to do; and sometimes she had to give more than usual to incentivize the other party to swap.

Findings showed that most respondents (20 out of 21) believed that there came a time when leather scraps were no longer useful and had to be discarded. Students argued that leather scraps were not up-cyclable when they developed certain characteristics or overflowed the space available to store them. This contrasts with the response of the last respondent who argued that no matter their condition, leather scraps can always be up-cycled. It appeared that most respondents were not very knowledgeable about the principles of care suggested in the literature [15] for extending the life span of leather scraps, hence their willingness to throw away leather scraps once defects were observed.

Only a few students demonstrated an understanding of leather care and restoration. According to these individuals, they usually "cleaned their leather scraps to clear moulds", "washed them in lime water and stretched", "burnished scraps to improve appearance" and "placed leather scraps in open spaces to allow for proper ventilation". Nevertheless, most students believed that such maintenance strategies did not always yield the desired effect of restoration due to the size of the leather scraps.

Regarding characteristics, phrases like "too small to serve any purpose", "some parts are too thin and others too thick", and "no shape can be cut out of it" suggests size as an important determinant of whether scraps should be discarded or not. Further, respondents suggested that physical appearance was another criteria for disposal and this was evidenced by the use of phrases like discard when they "develop mould", "become crumpled", "start to peel off," "become hard and brittle", "change colour", and "have holes in them". For most students in the study, the results suggest, that deterioration of leather scraps was quicker and this may have been due to the use of improper storage practices and the type of leather that most students were using i.e. vegetable-tanned leather.

5. CONCLUSIONS

The above study has presented ways in which visual art students in one senior high school in Ghana use leather scraps. Findings from the study lead to the conclusion that leather scraps can be useful as a supporting or dominating material for the artwork. When used as a supporting material, leather scraps may not require joining irrespective of their size. Nevertheless, it appears that joining is a prerequisite for using leather scraps as a dominating material, especially for making medium to large-sized leather articles. There is a need for further studies to investigate which joining techniques offer the best durability and efficiency in terms of time and effort required for completing large leather articles made predominantly from leather scraps.

Findings from the study lead to the conclusion that characteristics such as size and extent of defect are significant in determining the usefulness of leather scraps. In addition, it could also be inferred from the study that features such as shape and colour play an important role in creating artefacts with the right aesthetic features. This means that if leather scraps do not offer good options in terms of shape, there may be a need for cutting to the required shape; thus there would still be some leftover waste which will still need proper management. Regarding colour, it can be argued that the inability of upcycled artists to find contrasting or harmonious colours in the leather scraps obtained can pose problems. Therefore, there is a need for further research into the characteristics of leather scraps generated to enable proper planning for upcycling art. Additionally, researchers need to explore production processes and techniques that allow for all leather scraps to be reused without any leftovers to protect the environment.

Further, findings from this study lead to the conclusion that the reuse of leather scraps is not always possible due to deteriorating properties. Therefore, producers of leather scraps need to be educated on the care and maintenance principles that can make the reuse of leather scraps for upcycling possible. There is also a need for up-cycled artists to explore production techniques that can hide deteriorating properties if needed to make leather scraps reusable for up-cycled art.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

CIRCULAR TECHNOLOGY FOR SHEEPSKIN TANNING

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Abstract: *The circular economy is synonymous with the production of "zero waste" in the context in which valuable resources are lost and the European development agenda aims for a program of smart, sustainable, inclusive growth. At present, finding alternatives to tanning with chromium salts is considered one of the most important objectives of the leather industry.*
The present paper includes original results regarding the formulation, characterization and testing of some organic pre-tanning composites for the processing of sheepskins within the concept of circular technology. The collagen hydrolysate extracted from untanned and organic pre-tanned sheepskins was used to design a new circular technology. Four kinds of pre-tanning agents were formulated based on renewable materials such as collagen hydrolysate, whey and/or vegetable tannins. The characterization of new products by ATR-FTIR spectra showed common wavelength bands of whey and vegetable tannin suggesting a potential interaction and less carboxylic and methyl groups for oxidized pre-tanning agents. The new pre-tanned sheepskin leathers were retanned with a full organic formulation and showed different affinity for anionic chemical auxiliaries due to different chemical functional group activation. Physical-chemical, softness determination and SEM images confirmed the similar morphology with vegetable leathers, with more compact structure of leathers pre-tanned with oxidized products as compared to non oxidized composite products, with a more soft and relaxed aspect. The non oxidized pre-tanning agents were selected for further experiments at pilot level in view of circular technology design with prospect to save 40% sheepskin waste.

Key words: *biotechnology, waste recycling, biodegradable pre-tanning, organic tanning, circular economy, bio-based technology, renewable materials*

1. INTRODUCTION

The circular economy is the economy in which the product is designed to be manufactured and used without generating waste, as an alternative to the linear economy which involves: production, consumption and creation of waste [1].

The circular economy is synonymous with the production of "zero waste" in the context in which valuable resources are lost and the European development agenda aims for a program of smart, sustainable, inclusive growth [2]. European targets include a ban on the storage of recyclable and biodegradable waste until 2025 and even their disposal by 2030 [3].

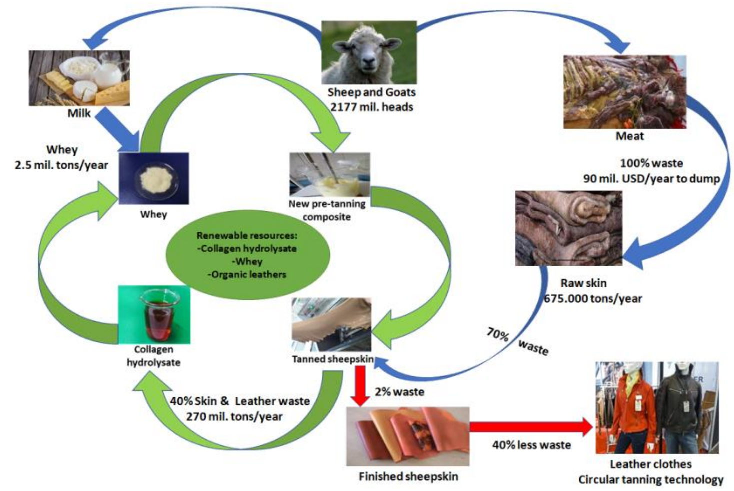
The leather industry represents an intensely globalized economic sector, which capitalizes on a by-product generated by the meat industry. The processing yield of natural leathers is 20-40% [4], leather waste being a valuable, important source of protein. In the last 18 years [5] skin processing has made many advances in terms of environmental impact, water consumption has fallen 2.5 times, energy consumption has fallen 1.96 times, and waste has remained at the same level.

The need to design leather processing technologies to reduce the amount of unused waste is an imperative of the leather industry auxiliary chemicals industry. In this European and global context, the concerns regarding the innovation of leather processing technologies, the recovery and recycling of solid waste represent the main research direction.

At present, finding alternatives to tanning with chromium salts is considered the most important objective of the leather industry [6].There is an increased interest for new plant extracts formulation [7] or for the use of protein resources crosslinked with tannins intented to be used as fillers for leather retanning [8, 9]. All these approaches contribute to leather biodegradability increase and waste circularity improvement.

In this context, the capitalization of the protein resources from the leather as well as the food industry, the finding of new natural sources in the formulation of the agents of ecological processing of the natural skins, represent current topics.

The present paper includes original results regarding the formulation, characterization and testing of some organic pre-tanning composites for the processing of sheepskins within the concept of circular technology in agreement with Scheme 1.



Scheme 1- Circular technology concept for sheepskin processing

2. EXPERIMENTAL

2.1 Pre-tanning materials preparation

Four kinds of pre-tanning agents were prepared by using renewable materials: a) collagen hydrolysate processed from delimed pelt wastes in Leather Research Department by acid hydrolysis, with MW=23000 Da, pH=3; b) whey powder with 12.5% protein and 75% carbohydrates; c) vegetable tanning materials: commercial mimosa extract powder with 65% tannin and tara powder with 38% tannin; $Fe_2SO_4.7H_2O$ and H_2O_2 30% of analytical grade. Pre-tanning TZC and MZC products were prepared by mechanical mixing the collagen hydrolysate, whey and vegetable tanning materials at 40^0C for 4h, when a homogenous paste was obtained. The obtained paste was dehydrated to solid flakes state in an oven with convective air (Caloris SA) at 50^0C. Pre-tanning products ZCox and MZCox were prepared from whey, collagen hydrolysate (ZCox) and mimosa extract, respectively by catalytic oxidation with $Fe_2SO_4.7H_2O$ and H_2O_2 30% for 24 hours, at 50^0C under mechanical stirring [1]. Figure 1 shows the pre-tanning products in paste form and Fig.1 the dried product MZC as flakes or milled powder and leathers pre-tanned with TZC, ZCox, MZC and MZCox new materials.

TZC **ZCox** **MZC** **MZCox**

Fig. 1: *Pre-tanning products prepared from renewable materials*

2.2. Sheepskin pre-tanning and retanning

The technology for skeepskin leather processing was carried out from the pickling stage at a value of pH=2.8-3, and by dosing 15 wt% pre-tanning material in 3 doses every 60 minutes with continuous stirring, for 4 hours in a FA.VE. experimental drum (220 x 500 mm), until the cross section of leather was completely penetrated, followed by a static contact for 24 h. The next day the leathers were stirred for 60 minutes at 40^0C, the float was drained and the pre-tanned leathers were deposited for another 24 h when samples were prelevated for shrinkage temperature control analyses. All pre-tanned leathers were neutralized, retanned, dyed, fatliquored and acid fixed together by following an organic formulation for classical chromium tanned soft sheepskin leathers. Figure 2 shows the four leathers processed with new pre-tanning materials and retanned with a fully organic formulation.

Fig. 2*: Pre-tanning materials MZC and sheepskin leathers: TZC, ZCox, MZC, MZCox*

2.3. Pre-tanning materials and leather characterisation

The characterisation of pre-tanning new products was performed by ATR-FTIR (JASCO4200) for specific functional chemical groups identification, by physical-chemical analyses for dry substance, tannin, ash content and pH, using standardized methods: SR EN ISO 4684; SR 1883; SR ISO 4047; SR EN ISO 4045. Crust leathers were analysed for shrinkage temperature, softness, volatile matters, ash, total nitrogen and hide substance, extractible substances, water soluble minerals, pH of aqueous extract by standardized methods: SR EN ISO 3380; SR EN ISO 17235; SR EN ISO 4684; SR ISO 4047; SR EN ISO 5397; SR EN ISO 4048, SR EN ISO 4098 and SR EN ISO 4045. The morphology of collagen fibers was investigated in crust leather cross sections with FEI Quanta 200 Scanning Electron Microscope (FEI, Eindhoven, The Netherlands).

3. RESULTS AND DISCUSSIONS

3.1. Pre-tanning materials characterization

The ATR-FTIR spectra analyses of oxidized and non oxidized pre-tanning agents showed different specific wavelengths of components, especially of whey and vegetable tannin. In figure 2 can be seen the ATR-FTIR spectra of pre-tanning materials with characteristic wavelength for –OH group at 3200-3400 cm^{-1} and a maximum intensity for C=O at 1630-1655 cm^{-1}. The intensity of C=O at 1630-1655 cm^{-1} is higher for ZCox (Figure 3 a) as compared to whey and collagen hydrolysate components (not showed here). TZC product showed more similar chemical functional groups with whey and tara tannin (Figure 3 b), and very similar with product MZC spectra. MZC product has common wavelengths with whey attributed to carbohydrates at 3250-3500 cm^{-1} and at 1500 cm^{-1}, specific for phenolic compounds from mimosa taninng extract, proving the interaction of these materials. By oxidation, MZCox has lost some carboxylic groups (1429-1399 cm^{-1}) and CH_3 group from aromatic compounds (1030 cm^{-1}), as well as some -OH groups from 875 cm^{-1}, as compared to MZC product (Figure 3 c).

The main physical-chemical characteristics of MZC pre-tanning products in paste state were: 40% dry substance, 12% protein, 23% carbohydrates, 2% tannin, 1% ash and pH= 4.

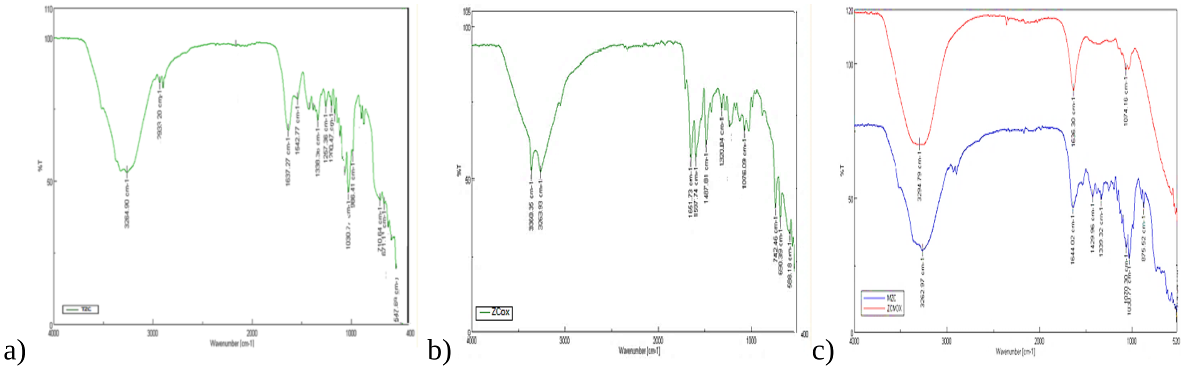


Fig. 3. ATR-FTIR spectra for a) TZC; b) ZCox; c) MZC and MZCox

3.2. Sheepskin leather characterization

The influence of the new pre-tanning compositions on leather characteristics were investigated, starting with collagen crosslinking ability of MZC (an increase of Ts by 22^{0}C) and lower affinity for the other products (Ts increase by 12^{0}C), as can be seen in Figure 4a. The interaction of oxidized products (ZCox, MZCox) with sheepskin collagen released more chemical functional groups for retanning materials which crosslinked as much as the pre-tanning materials (an increase of 12 and 9^{0}C, respectively). Similar behaviour can be observed for TCZ product (an increase of 11^{0}C).

The influence of new pre-tanning materials on leather softness was distinctly different for oxidized products and not oxidized products, with improved softness and more relaxed surface for MZC and TZC leathers (Fig.4b). The SEM images from Figure 5 show a more compact structure with deposited pre-tanning materials in interfibrilar spaces for leathers pre-tanned with oxidized products and more free spaces for MZC and TZC sheepskin leathers, which is in agreement with softness determinations.

The physical-chemical characteristics of organic sheepskins are presented in Table 1 and show similar properties with vegetable leathers, with 33-40% chemical material deposited inside fibrilar leather matrix or crosslinked with collagen, similar extractible materials content (slightly higher quantity on MZC leather), and pH value in the range of classical processed sheepskins (pH= 4.6-4.8). Low content of water-soluble minerals can be an advantage as compared to chromium tanned sheepskin leathers.

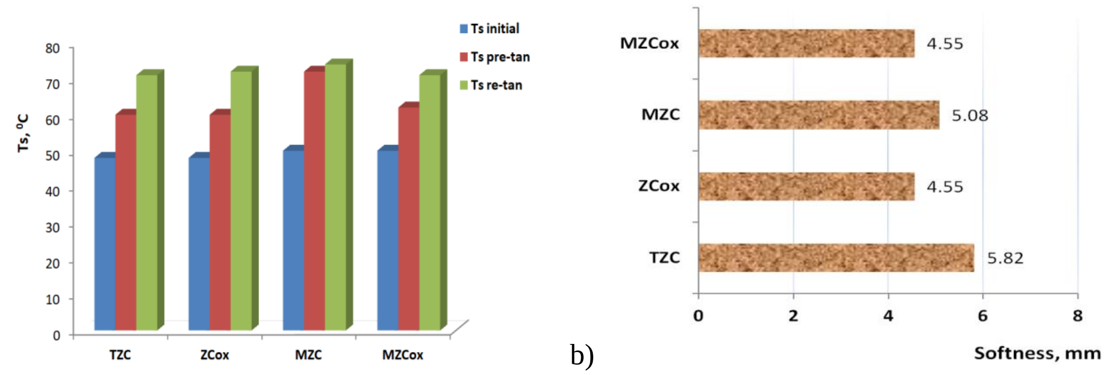


Fig. 4. *Shrinkage temperature of organic tanned sheepskin (a) and their softness (b)*

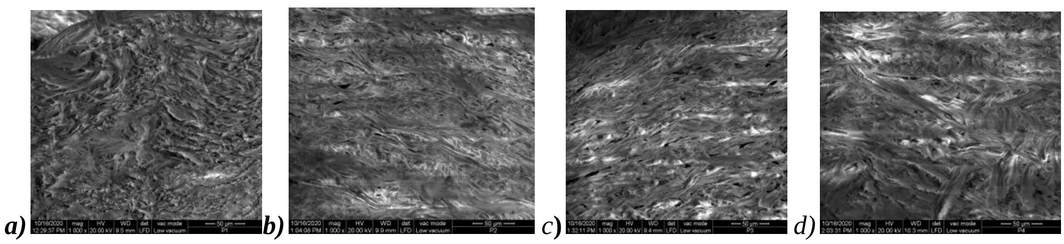


Fig. 5. *SEM images of leather cross sections: a) TZC, b) ZCox, c) MZC, d) MZCox*

Table 1. *Physical-chemical characteristics of organic tanned sheepskin leathers*

Characteristcs	TZC	ZCox	MZC	MZCox
Volatile matter,%	9.44	9.43	8.60	8.91
Ash, %	4.05	2.95	3.48	4.29
Total nitrogen, %	11.93	12.06	10.51	11.61
Hide substance, %	67.03	67.76	59.08	65.28
Extractible matters, %	15.15	14.83	16.59	15.08
Water soluble minerals,%	0.41	0.41	0.37	0.44
pH, aqueous extract, pH units	4.75	4.70	4.60	4.60

This research results has demonstrated the potential of renewable materials to be recirculated in sheepskin tanning process. The use of collagen hydrolysate extracted from pre-tanned leathers with MZC/TZC products will enable the design of new pre-tanning composites in a circular technology with prospect to save 40% of waste sheepskin from 70% total waste [10].

4. CONCLUSIONS

Four pre-tanning agents based on renwable materials (whey, collagen hydrolysate, vegetable tannin materials) were prepared for sheepskin leather processing. The collagen hydrolysate extracted from untanned and organic pre-tanned sheepskins was used to design a new circular technology. ATR-FTIR spectra showed common wavelength bands of whey and vegetable tannin for MZC and

TZC agents which suggest a chemical interaction and less carboxylic and methyl groups for oxidized pre-tanning agents, ZCox and MZCox. The new pre-tanned sheepskin leathers were retanned with a full organic formulation and showed different affinity for anionic chemical auxiliaries due to different chemical functional group activation. The product MZC showed the highest affinity for pickled sheepskins and the products TZC, ZCox and MZCox enabled retanning agents to additionally crosslink sheepskin collagen. Physical-chemical, softness determination and SEM images confirmed the similar leather morphology with vegetable leathers, with more compact structure of leathers pre-tanned with oxidized products as compared to TZC and MZC composite products, with a more soft and relaxed aspect. MZC and TZC products were selected for further experiments at pilot level in view of circular technology design with prospect to save 40% sheepskin waste.

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COMPLIANCE WITH THE ENVIRONMENTAL ASPECTS OF THE APPAREL MANUFACTURERS IN THE REPUBLIC OF MOLDOVA

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Abstract: *compliance with environmental aspects is the first step to be undertaken by the apparel manufacturers to reduce the environmental footprint. In the Republic of Moldova, the apparel manufacturing industry is based on several international cooperation practices, which leads to increased levels of environmental pollution, mainly through the generated waste. The manufacturing processes and the applied technologies increase electricity consumption and generate significant amounts of waste. Obviously, many companies do not know the basic responsibilities and environmental obligations, nor do they know how they can be applied. Under these conditions, the development of proactive practices becomes a natural approach, especially to prevent sanctions for non-compliance with mandatory requirements. The article highlights the steps to be undertaken by the factories to ensure maximum compliance with mandatory requirements imposed by the authorities and the voluntary requirements selected autonomously, in respect to the environmental issues reflected by the legal provisions of the Republic of Moldova harmonized with the European Union law. The authors conducted a qualitative analysis of all requirements and reflected how several apparel factories from the Republic of Moldova apply these pratices in their activities. The results of the analysis provide valuable and useful insights for application and will generate several beneficial effects, such as awareness and compliance with environmental issues, control of economic activity in terms of environmental impact, and confidence to create and provide sustainable value to stakeholders. The presented materials provide a framework through which apparel manufacturers in the Republic of Moldova will take responsibility for their contribution and impact on the ecosystem in which they operate.*

Key words: *requirements, obligations, environmental protection, clothing, analysis, pollution, waste.*

1. INTRODUCTION

The amount of clothes bought in the EU per person has increased by 40% in just a few decades, driven by a fall in prices and the increased speed with which fashion is delivered to consumers. Environmental impacts of EU consumption of textiles and clothing are difficult to estimate due to their diversity and the fact that they occur around the globe. Clothing accounts for between 2% and 10% of the environmental impact of EU consumption. This impact is often felt in third countries, as most production takes place abroad [1]. This is characteristic to the Republic of Moldova, the country where most garment factories provide services for the manufacture of clothing for famous European brands.

Apparel manufacturing implies a significant amount of energy consumption for sewing, gluing, welding, and seam taping, which has a direct impact on the environment. The cut-offs that are left over after the patterns for the clothes have been cut out are also responsible for about 20% of the industry's fabric waste [1].

In this context, we consider that Moldovan apparel manufacturers should align to the United Nations sustainable development goals, and namely to the goal no. 12 “Responsible consumption and production”, to reduce the environmental impact generated as result of apparel manufacturing activities. One of the first steps to be taken in this direction includes the analysis of the environmental compliance obligations. According to the explanation offered by the ISO 14001:2015 standard “Environmental management systems. Requirements with guidance for use”, compliance obligations are legal requirements to which an organization is obliged to comply and other requirements to which an organization is obliged or chooses to comply [2]. The standard states that compliance obligations may arise from mandatory requirements, such as applicable legal and regulatory requirements, or voluntary commitments, such as organizational and sectoral standards, contractual relationships, codes of good practice, and agreements with community groups or non-governmental organizations.

The basic purpose of this article is to provide an analysis of the applicable legal and regulatory requirements, the voluntary commitments and those arising from the contractual clauses of the apparel factories in the Republic of Moldova with respect to environmental issues. Apparel factories should take a strong stand in protecting the environment and responding to changes in environmental conditions, while also responding to the socio-economic needs. To ensure a great contribution to the sustainability pillar, apparel factories must demonstrate an increased awareness towards environmental issues.

2. THE DETERMINED OBLIGATIONS OF THE APPAREL FACTORIES TOWARDS THE ENVIRONMENT

2.1 The apparel industry of the Republic of Moldova and its trends

Moldova’s Apparel Industry is a key sector of the Moldovan economy, building on strong longstanding manufacturing traditions that date back more than 75 years ago.

It is among the most important, largest, and best-performing industry of the Moldova’s manufacturing industry (5+ percent), table no.1.

Table 1. *Dynamics of the value of industrial production manufactured by types of activities*

Indicators	2015	2016	2017	2018	2019
Manufacture of wearing apparel, million MDL	1 973,3	2 257,2	2 528,4	2 653,4	2 628,7
Volume indices of industrial production, manufacture of apparel (previous year =100)	111,7	114,4	112,0	104.9	99,1
Manufacturing industry, million MDL	37 706,6	39 654,3	43 931,5	46 486,9	49 862,3
The share of Apparel Industry in total Manufacturing Industry, %	5,23	5,69	5,76	5,71	5,27

Source: National Bureau of Statistics of the Republic of Moldova www.statistica.md

The apparel manufacturing industry has experienced a continuous increasing trend during the last five years (2015-2019) from 1,973.3 to 2,628.7 million MDL or approx. 1.3 times growth, mostly due to export of services provided to international clients.

As of 2019, this mature and women-centric industry accounts an average annual number of employees of about 16,000 or about 20% of all manufacturing industry. Over 90 percent of the jobs are held by women. This makes light industry an important employment generator, especially for unqualified women with few employment options in rural areas.

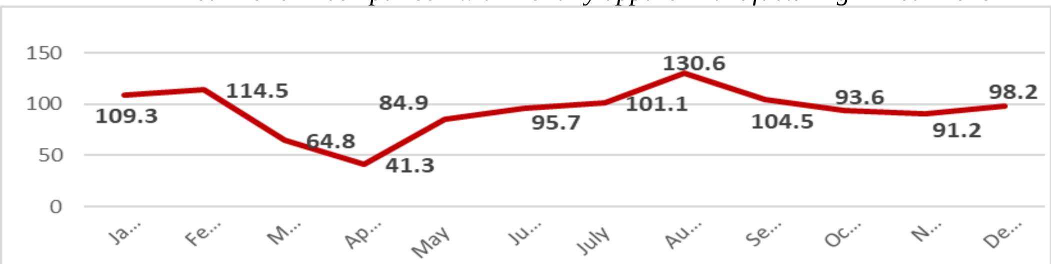
Over the last five years, the industry experienced a continuous growth trend in exports of over 10% annually, except for 2019, when the industry registered an 11% decrease compared to the previous year, due to the reduction of orders from European customers. Figure 1.

Fig. 1. *Export dynamics of garment manufacturing industry, million US$*

Source: National Bureau of Statistics of the Republic of Moldova [*www.statistica.md*](http://www.statistica.md)

The Moldovan apparel manufacturing went through a difficult year in 2020 due to the COVID-19 pandemic, which led to a 12% decrease in exports in comparison with 2019. Since May, the industry has experienced a recovery trend. Figure 2.

Fig. 2. *Volume indices of monthly apparel manufacturing*
in Year 2020 in comparison with monthly apparel manufacturing in Year 2019



Source: National Bureau of Statistics of the Republic of Moldova [*www.statistica.md*](http://www.statistica.md)

2.2 Determining compliance obligations.

The first step in ensuring compliance with environmental issues lies in the apparel factory's ability to determine and access these compliance obligations, as well as to understand their applicability.

Apparel factories can have two types of compliance obligations: mandatory legal requirements and voluntary commitments.

The mandatory legal requirements are provided by the authority responsible for implementing the state policy in the field of environmental protection. In the Republic of Moldova, this authority is the Environment Agency, subordinated to the Ministry of Agriculture, Regional Development and Environment. The Environment Agency ensures the implementation of the environmental legislation, harmonized with the European Union legislation established in the Association Agreement between the Republic of Moldova and the European Union, in the chapters "Environment", "Climate change" and "Trade and trade-related issues" (about 50 EU directives, regulations and decisions). The Agency is responsible for the implementation of new environmental tools such as: the creation, maintenance and management of the environmental impact assessment system deriving from economic activities, the strategic environmental assessment system, the integrated environmental information system, the monitoring system of the quality of the environment, the monitoring system of natural resources, the integrated environmental authorization system, etc. [12]. The official website of the Environment Agency provides links to the current legislative and normative acts referring to environmental protection, which considerably simplifies the mechanism of searching and studying the legal provisions valid for an apparel factory.

To determine its voluntary commitments towards the enviroment, an apparel manufacturer may select:

- the international standards it intends to implement to reduce its environmental footprint. The category of these standards may include the standards of the ISO 14000 series, issued by the International Organization for Standardization;
- the contractual clauses from international customers regarding apparel manufacturing. This practice is characteristic for European customers who aim to manufacture wearing apparel under their own label in conditions that minimize the impact on the environment;
- the requirement of business partners to implement social audit, according to one of the amfori BSCI or SMETA methodologies, which includes elements of compliance with the environmental requirements.
- the formalization of the environmental commitment by approving the factory's Environmental Policy, in alignment with its purpose and context, including the nature, scale and environmental impacts of the factory’s activities, products and services, in compliance with environmental protection requirements, including pollution prevention.

2.3 Analysis of the determined obligations’ method of application

The next step in determining apparel manufacturers’ degree of compliance with the environmental aspects includes assessing the validity and applicability of the selected compliance obligations. The results of the analysis of the applicability of the environmental obligations for the apparel factories provided by the legislation of the Republic of Moldova are presented in table no.2.

Table 2. *Analysis of the apparel factories’ applicability of the environmental obligations*

No. d/o	Category of environmental obligations	Name of the environmental obligations	Basic provisions	Applicable	Non-applicable	No information	Comments on compliance with environmental obligations
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Legislation of the Republic of Moldova	Law no. 1515-XII of June 16, 1993 about environmental protection	Description of the economic agents’ obligations	X	□	□	Assessment of electricity consumption. Measurement of environmental pollution indicators
		Law no. 1540 of February 25, 1998 about payment for environmental pollution	Establishes how to calculate and make payments for pollutant emissions	X	□	□	EMPOLDEP Report (Pollutant Emissions, Discharges and Waste Disposal)

Tabel 2 (continued)

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
		Law no. 209 of July 29, 2016 on waste	Article 12. Extended producer responsibility. Article 14. Reuse and recycling of waste	X	□	□	Contract with the economic agent that recycles industrial waste (paper, fabric pieces, polyethylene, etc.)
		Law no. 1422 of December 17, 1997 about protection of atmospheric air	Obligation to request and obtain authorization for the emission into the atmosphere of pollutants from fixed sources of pollution from the Environmental Agency	X	□	□	Authorization to emit pollutants into the atmosphere from fixed sources
2	Government Decisions	Government Decision no. 99 of 30.01.2018 about the approval of the List of Waste	Establishes the list of wastes. It is applied for information purposes.	X	□	□	Selecting codes for accumulated waste
		Government Decision no. 501 of 29.05.2018 on approval of the Instruction for waste records keeping and reporting of information on the waste management	Basic responsibilities: 1. Monthly chronological evidence of the quantity, nature and origin of the waste generated. 2. Annual reporting of the total amount of waste generated and their management	X	□	□	Reports made by each company
3	Standards	Sedex Members Ethical Trade Audit (SMETA) Measurement Criteria Version 6.1 May 2019	The Measurement Criteria covers the mandatory 2 pillars of Labour Standards and Health and Safety, as well as the additional options of Environment and Business Ethics.	X	□	□	Compliance with measurement Criteria by Clause

Source: elaborated by the authors

Obviously, the list of legal requirements, which become the environmental obligations for apparel factories represented in table no. 2 is not complete, but it can certainly be used to assess compliance through their application.

Following the results obtained in the analysis of the applicability of environmental obligations, apparel factories will have to develop action plans to increase compliance with environmental obligations and reduce the environmental impact if their compliance with the environmental requirements is not backed up by evidence of application or has insufficient information for analysis.

3. CONCLUSIONS

The general conclusion on the development trends of the apparel manufacturing industry in the Republic of Moldova focus on its key role in the development of the national economy, both in terms of employment (especially for women) and its contribution to the country's export. To ensure the export of garments to EU countries, Moldovan apparel factories must align their production systems to the sustainable growth models adopted by the European Commission. The development of ecological technologies is one of the EU's main competitive advantages, which determines the relevance of promoting sustainable development of apparel manufacturers in Moldova.

The study conducted by the authors allowed a detailed analysis of the elements of the apparel manufacturers' business, who are largely involved in the provision of raw material processing services for European brands. Determining compliance obligations and assessing their degree of applicability will increase the apparel factories' capacities to create sustainable value.

The JRC 2014 study on the Environmental Improvement Potential of textiles recommends several approaches to reducing the environmental impacts of the processing and manufacturing phase, including reducing the consumption of chemicals. It also recommends integral knitting, where a whole garment is produced in one piece without the need for cutting and sewing (however, the gains in lifecycle impacts may be offset by the high energy use of the integral knitting machines). Some companies are experimenting with different cuts, computer-controlled tools for pattern making to use more of the fabric with fewer cut-offs, garments with no or fewer seams, bonding or gluing instead of sewing, etc.

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[5] Law no. 209 of July 29, 2016 on waste

[6] Law no. 1422 of December 17, 1997 about protection of atmospheric air

[7] Government Decision no. 99 of 30.01.2018 about the approval of the List of Waste

[8] Government Decision no. 501 of 29.05.2018 on approval of the Instruction for waste records keeping and reporting of information on the waste management

[9] *Sedex Members Ethical Trade Audit (SMETA) Measurement Criteria*, Version 6.1 May 2019

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

NATURAL LEATHER FOOTWEAR PROTECTION AGAINST FUNGI USING ESSENTIAL OILS

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Abstract: *Biocides used in the leather and footwear industry, based on beta-naphthol, benzothiazole and sulfone derivatives, etc. are toxic to humans and environment, some of these being prohibited by the directives in force.*
Many studies revealed utilization of essential oils for leather and leather objects protection against fungi. Fungi grow quickly under high humidity conditions and temperatures ranging between 25 and 30°C. Research aims the replacement of potentially toxic biocides with ecologic materials – essential oils extracted from plants. The biological activity of essential oils depends on their composition. Essential oils that contain substituted phenols (eugenol) exhibit strong antibacterial and antioxidant effects.The paper presents the possibility of using essential oil of laurel as alternative preservatives for skin treatment. Essential oil isolated from laurel (Laurus Nobilis) containing: eugenol – 46.95%, DL limonene – 43.37% and alpha terpinolene – 7.14%. Testing of essential oil of laurel was carried out monitoring the manner in which mold growth is influenced by the treatment applied to the sample through the resistance to mold in simulated contamination conditions. Following the study, it is concluded that the selected essential oil of laurel can be used as an antifungal agent in the field of natural leather footwear processing. The natural leathers for linings can be treated with new product based on essential oil with antifungal and antibacterial effect.

Key words: *natural leather footwear, essential oils, Gas Chromatography Mass Spectrometry (GC/MS), FT-IR spectrometry, Aspergillus niger*

1. INTRODUCTION

Both tanned and finished leather may be damaged by fungi from *Aspergillus flavus* and *Aspergillus niger*, *Trichoderma viride*, *Penicillium glaucom* and *Penicillium cyclopium*, and *Paecilomyces variotii* species which irreversibly damage leather through the enzymes (collagenases, lipases and proteases) they produce.

Many natural antimicrobial agents have been identified over the last decades, such as essential oils.

Essential oils from aromatic and medicinal plants have been known to possess potential as natural agents for leather preservation, including antibacterial and antifungal.

The essential oils have been qualified as natural biocides and offered as potential substitutes of synthetic biocides in specific steps of leather processing [1-3].

Many studies revealed utilization of essential oils as biocides for leather and leather objects protection against fungi (in leather manufacture and in footwear) [4-7].

2. EXPERIMENTAL

2.1 Materials

• The nappa bovine leathers, mineral tanned and wet finished by retanning, fatliquoring and dyeing (1.0-1.2 mm thick, dyed brown) (INCDTP – Division Leather and Footwear Research Institute Bucharest, Romania).

• Laurel essential oil, Laurus Nobilis (Adams, Romania) containing: eugenol – 46.95%, DL limonene – 43.37% and alpha terpinolene – 7.14%.

• Ethanol (Chemical Company, Germany), density – 0.789 g/cm^3 at 20^{0}C, boiling point – 78^{0}C, melting point –114^{0}C, water solubility – in any proportion;

• Biologic Material: *Aspergillus niger*.

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2.2. Methods

• Gas Chromatography Mass Spectrometry (GC/MS) Analysis: Analysis of the essential oils carried out by using Agilent 7890 A GC System equipped with Agilent 5795 C MS, and HP-5 MS (0.25 mm x 30 m i.d., film thickness 0.25). The carried gas helium (99.9%) at a flow rate of 1 mL/ min; ionization energy was 70 eV. Mass range m/z 50-650 amu. Data acquisition was scan mode. MS transfer line temperature was 250 $_0$C, MS Ionization source temperature was 230 $_0$C, the injection port temperature was 250 $_0$C. The samples were injected with 250 split ratio. The injection volume was 1 µL. Oven temperature was programmed in the range of 50 to 250 $_0$C at 3$_0$C/ min. The structure of each compound was identified by comparison with their mass spectrum (Nist 05 and Wiley 7 library) [8].

• Attenuated Total Reflectance Fourier transform infrared spectroscopy (ATR-FTIR) measurements were run with a Jasco instrument (model 4200), in the following conditions: wavenumber range – 600-4000 cm$_{-1}$; data pitch – 0.964233 cm$_{-1}$; data points – 3610: aperture setting – 7.1 mm; scanning speed – 2 mm/s; number of scans – 30; resolution – 4 cm$_{-1}$; filter – 30 kHz; angle of incident radiation – 45$_o$ [9].

• Applying essential oil of laurel on leather samples was made by dropping 0.2, 0.4 and 0.6 mL oil and ethanol 1:1) on the surface of 2.0 x 2.0 cm2.

The samples treated with essential oil and untreated were placed in each Petri dish in the center of the surface of the culture medium, then the culture medium was seeded in 3 points around the sample, as an equilateral triangle. Petri dishes were placed in thermo-hygrostat at 30°C temperature and were analized after 7, 14, 21 and 28 days. *Aspergillus niger* strain development was assessed by ranking: 0 – absence of stems and a strong fungitoxic effect, 5 – an almost non-existent effect (the mold covers the entire surface of the specimen) [10].

• The goal was to monitor the influence of the treatment applied to the sample on mold growth through the mold resistance under simulated contamination, according to no.12697/A 9:2008 „Finished leathers. Mold resistance testing”.

• Optical microscopy images were captured using a Leica stereomicroscope S8AP0 model with optic fiber cold light source, L2, with three levels of intensity, and magnification 40X.

• Chemical characteristics of the uncoated leathers were determined according to the following standards: moisture (%) – SR EN ISO 4684:2006; the content extractables (%) – SR EN ISO 4648:2008; the content of chromium oxide (%) – SR EN ISO 5398:2008.

2.3. Identification of compounds in the composition of laurel essential oil

Laurel essential oil was analysed using GC-MS [8].

Chromatogram for laurel oil is shown in Figure 1, and identification of compounds in their composition is presented in table 1.

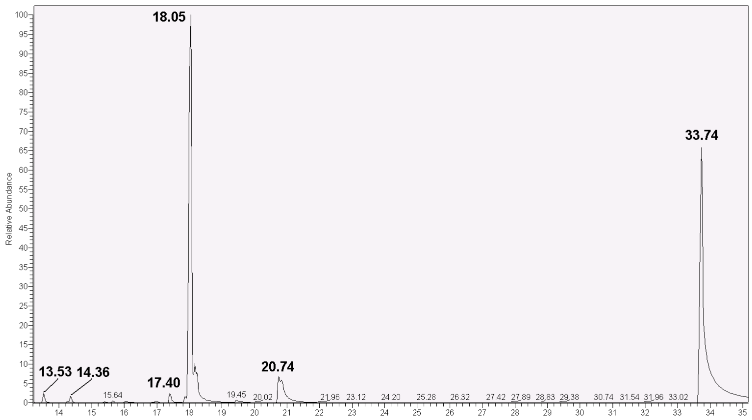


Fig.1. *Chromatogram of organic compounds in the laurel essential oil*

Table 1. *Identification of organic compounds in the laurel essential oil by GC-MS*

No.	RT	Amount, %	Compounds
1	13.53	0.88	Alpha Pinene
2	14.36	0.71	Camphene
3	17.4	0.93	Alpha Terpinene
4	18.05	43.37	DL Limonene
5	20.74	7.14	Alpha Terpinolene
6	33.74	46.95	Eugenol

The following compounds are found in the highest amount: eugenol – 46.95%, DL limonene – 43.37% and alpha terpinolene – 7.14%.

Laurel essential oil was analyzed using FT-IR. [9]

FT-IR (ATR) spectrum of laurel essential oil is shown in Figure 2.

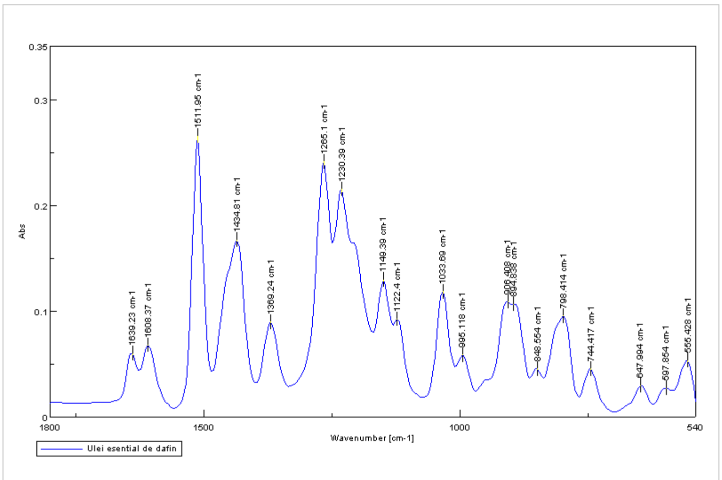


Fig. 2. *FT-IR spectrum of laurel essential oil*

The main bands of laurel oil are (Fig. 2): 1639 cm-¹ and 1608 cm-¹ – indicating the presence of C=O group from ester, 1511 cm-¹, 1434 cm-¹ and 1360 cm-¹ – assigned to the C-H group, 1265 cm-¹, 1230 cm-¹, 1149 cm-¹, 1033 cm-¹, 906 cm-¹ given by the C-O-C group from ether.

3. RESULTS

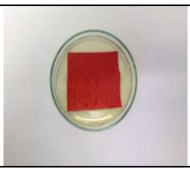
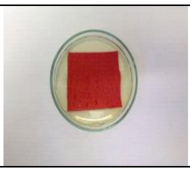
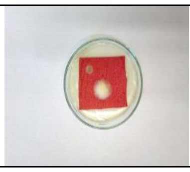
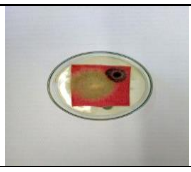
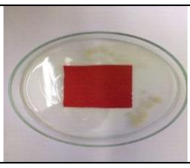
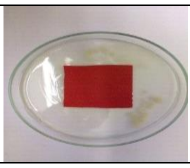
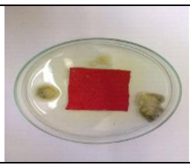
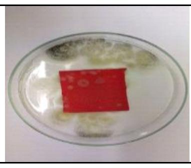
3.1. Biological characterisation of the leather samples

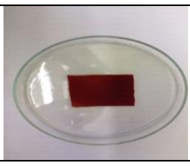
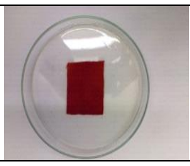
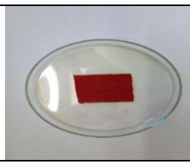
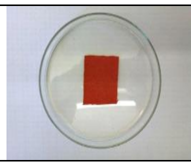
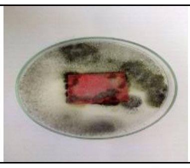
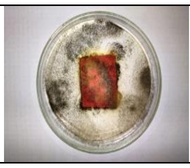
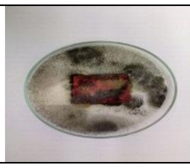
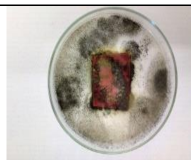
The samples treated with different amounts of laurel essential oil on the surface of unfinished leather, L1 (0.2 mL oil and eyhanol 1:1), L2 (0.4 mL oil and ethanol 1:1) and L3 (0.6 mL oil and ethanol 1:1), were inoculated with biological material – *Aspergillus niger* spores.

Mold development on leather specimens, and macroscopic images of samples treated with L1-L3, after 7, 14, 21 and 28 days from treatment, are presented in table 3.

The numbers under the images are the marks given according to the standard.

Table 3. *Macroscopic images of samples treated with laurel essential oil after 7, 14, 21, 28 days*

Sample/ day	7	14	21	28
L1				
	0	0	2	3
L2				
	0	0	0	1

L3				
	0	0	0	0
Control				
	4	5	5	5

The antifugal effect of the essential oil of laurel is higher as the amount of oil applied to the skin is higher.

The laurel essential oil used to treat nappa bovine leathers, improves their quality and resistance to fungi and bacteria.

The sample L1 does not develop fungi for 14 days – mark 0.

The sample L2 does not develop fungi for 21 days – mark 0.

The sample L3 does not develop fungi for 28 days – mark 0.

Leather Control sample untreated with the laurel essential oil develops fungi, as shown by marks ranging between 4 after 7 days and 5 after 14-28 days.

3.2. Chemical characterization of the leather samples

Chemical characteristics of the uncoated leathers used to obtain bovine hides into natural grain nappa determined in accordance with standards no. 1619:1994 (Table 4).

***Table 4**. Chemical characteristics of bovine hides into natural grain nappa*

Sample/Characteristics	L1	L2	L3	Control	ST 1619:1994
Moisture, %	14.92	14.74	14.86	14.65	14-15
The content extractables, %	9.68	9.77	9.64	8.97	Max.10
The content of chromium oxide, %	5.45	5.86	5.78	5.40	Min.3.5

Chemical characteristics of the natural grain nappa bovine are within the limits specified in standard.

4. CONCLUSION

• Laurel essential oil containing: eugenol – 46.95%, DL limonene – 43.37% and alpha terpinolene – 7.14%.

• The laurel essential oil used to treat nappa bovine leathers, improves their quality and resistance to fungi and bacteria, reducing the surface defects of natural skin caused by fungi and bacteria.

• The selected essential oil of laurel can be used as an antifungal agent in the field of natural leather footwear processing.

• The natural leathers for linings can be treated with essential oil of laurel with antifungal and antibacterial effect.

ACKNOWLEDGEMENTS

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

RECENT TECHNICAL & ENVIRONMENTAL DEVELOPMENTS IN WORLD LEATHER SECTOR AND FUTURE TRENDS IN THE MIDST OF COVID-19

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Abstract: *World leather tanneries process 16 to 18 million tonnes of hides & skins per year. Nearly 60% of world leather production is carried out in Asian region and tanneries discharge more than 1200 MLD. Leather process in India ranges from 1.0-1.2 million tones per year and in an average wastewater generation is about 120 MLD. There has been major reduction during COVID-19 due to poor demand from hotel industries, tourism, cancellation of mass religious activities and functions, etc. The tannery operations particularly raw to semi-finished processes reduced by 30-60%.*
Sustainable cleaner production and treatment technologies have been engineered in many countries in India, China, Turkey & other leather producing countries. Effluent discharged from conventional processes in textile dyeing and tanneries are unable to meet some of the discharge parameters such as Total Dissolved Solids (TDS) to the level of 2100 mg/l in existing physiochemical and biological treatment units. In addition to TDS management, the control of volatile solids in hazardous category sludge is also becoming a necessity. The unutilized fleshing is converted into biological liquefaction and anaerobic digestion with bio-energy generation. Anaerobically digested sludge is converted into bio-fertilizer. The technical paper deals with recent technical and environmental developments and future trends in the midst of COVID-19 in India & other countries.

Key words: *Leather production, Environmental sustainability, Anaerobic digestion, COVID-19, Trends in Revival.*

1. INTRODUCTION

The process of hides and skins are mostly in the same level of 16-18 million tonnes per year during the past 10 years. China is the world leader in leather production with a share of 20-24%, followed by Italy 15-17%, Brazil 12-14%, India 4-5%. The other leather producing countries are Turkey, Vietnam, Russian Federation, Bangladesh, Pakistan, Spain, East Europe & African countries. During the process of 16 to 18 million tonnes of hides & skins per year an average of 2000-2200 million liters per day (MLD) of wastewater is generated from the world tanneries. Nearly 60% of the world leather production is carried out in Asian region and the tanneries discharge more than 1200 MLD. The leather process in India ranges from 1.0-1.2 million tons/year with an average wastewater generation of 120 MLD [1].

Slaughtering and meat consumption reduced by 30% in high meat-consuming Latin American countries such as Brazil, Argentina, etc. from 2008 onwards due to economical recession and health awareness. Furthermore, reduction occurred during COVID-19. Brazil & Italy are the most affected countries by COVID-19. Tannery operations, particularly raw to semi-finish operations, reduced by 30-60% in most of the European, Asian countries including China and India due to occupational safety, logistics problems, low market demand for fashion and high-value leather articles. In many countries, the export level reduced and there are no buyers for raw hides & skins generated from slaughter houses.

Tanneries in most of Asian countries are located in clusters. Common Effluent Treatment Plants (CETPs) which had been established in many leather producing countries such as Italy, India, China, Turkey, Spain, Bangladesh, Pakistan, etc. There are 18 operating CETPs in India. The treatment technologies are depending upon the final mode of treated effluent, enforcement of regulations and local conditions such as availability of domestic sewage for dilution/mixing with treated effluent for TDS management such as in Kanpur, Pallavaram in Tamilnadu and discharge into backwater such as in Kolkata, Bangladesh, Italy, etc. The first Zero Liquid Discharge (ZLD) technology with water recovery was implemented in Lurka, Spain for a capacity of 5.0 MLD during 2005-2010 and enforced in CETPs located in Ambur, Vaniambadi, Ranipet, Perundurai (Erode), etc. in South India.

The world leather sector learned a costly lesson from the ZLD system implemented in one of the CETPs in Lurka, Spain which is not sustainable due to combined treatment without proper segregation and cleaner production at source. High capital investment and O&M cost resulted in the closure of ZLD system. This trend is also being reflected in the reduction of leather production in South Indian Tanneries adopting ZLD system. Their market share in India is reduced from the level of 40% to less than 25% during the past 10 years. The O&M cost is also a major variable which ranged from 1.0 to 4.0 Euros/m^3 of effluent. Highest in South Indian tanneries which adopt ZLD system and it is followed by Italy. Lowest in Kolkata, India & Bangladesh due to the provision for discharge of treated effluent into sea without reduction in TDS.

2. CHALLENGES DURING 2010-2020 & EFFECTS OF COVID-19

The slaughtering and meat consumption started reducing from 2008 onwards in high meat-consuming countries (i.e.Brazil, Argentina, South American countries) due to economical recession and health consideration. The average meat consumption in Argentina which was about 80kg per capita per annum the highest in the world is reduced to less than 50kg per capita per annum during the recent period.

The tannery operations in United States (USA, Germany, Australia & other developed countries) reduced drastically during the past recent decades due to high environmental cost and labour. The tannery activities were shifted to Asian countries and 60% of the World Leather Production is made in Asian region mainly in China with a share of 20-24%[2]. The main leather production and development of tannery activities in Latin America during 2000-2010 is in Brazil with a world share of 12-14%. However due to economical recession, enforcement of environmental regulations, etc. resulted in the declining of leather production during the past decades. Further reductions during COVID-19 due to poor demand from hotel industries, tourism, cancellation of mass religious activities & functions, etc. Brazil is the worst-affected country due to COVID-19 pandamic and unforeseen developments.

The tannery activities particularly raw to semi-finish operations reduced by 30-60% due to occupational safety, logistics problems, low market demand for fashion, high value leather articles and poor exports. In many countries, there are not many buyers for raw hides & skins during COVID-19.

The tannery operations in USA, Germany, Australia and other countries further reduced and preferred in exporting salted hides & skins and the Research & Development in US and West European countries such as Germany, Spain, etc. had to come to a standstill. Most of the fashion and high-ended leather products shops were closed. The international trade and restriction in logistics and travel resulted in stagnation of raw material & finished products. Sales and prices came down even for industrial and leather products for regular use. Confidence level in using and maintenance of leather articles against protection measures such as sanitizer for COVID-19 need to be established.

Italy, the second major leather producer and leader in high fashion & value products, international trade & promotion activity is the first affected European country due to COVID-19. Their international trade and promotional activities have come to a stand still.

3. EFFECTS OF COVID-19 IN TECHNOLOGICAL DEVELOPMENT & DISSEMINATION

Due to gradual closure of tanneires in United States, United Kingdom, Germany and other Western European countries, the leather production started shifting to Asian countries and partly to East Europe during the past two decades. Most of the US & European institutions carrying out Research & Development (R&D) were closed down and practically there was no acitivty during 2020 due to COVID-19. There is no scope of revival or restarting of technical institutions in most of the countries.

During the past two decades the R&D Institutions, Universities in China & India were active mainly focussing on Cleaner Production, Solid Waste Management and Environmental Protection to meet the requirements of the leather tanneries and upgradation of effluent treatment plants. Due to COVID-19, the R&D activities, mainly physical participation were affected. Only in few countries such as Russian Federation & African Countries, the effect of COVID-19 is not much serious in leather production and they have reported that it is improving mainly for local consumption.

The 8th International Conference on Advanced Materials and Systems (ICAMS 2020) in Bucharest, Romania during October 2020 was changed into Zoom/ Virtual conference. Similarly XVI International Scientific-Practical Conference Leather and Fur in the XXI Century: Technology, Quality, Environmental Management, Education in Russian Federation during November 2020 was also organized in Zoom program as a webinar. Though presentations were good, responses & interactions are not very effective when compared to conferences organized with physical participation.

There is no clear picture about the mode of organizing the proposed 2021 IULTCS Congress in Addis Ababa, Ethiopia during November 2021 due to COVID-19 pandemic situation. The situations not clear due to the re-occurrence of COVID-19 pandameic in India and other countries from March 2021 onwards. The publications from physical form have been mostly converted into e-communications.

The industrial activities in leather processes drastically reduced in South India particularly by the tanneries catering the need of high-value fashion items. Uttar Pradesh (Kanpur, Unnao, Agra, etc.) region is not much affected. This is mainly due to the production of leather for common and industrial usage products.

Environmental protection measures and expansion of tannery operation activities are being shifted from South India and other parts such as Kanpur & Kolkata. The upgradation and expansion of industrial units and CETPs with major funding from Government are taking place by adopting sustainable technologies.

4. CHALLENGES AND INDUSTRIAL OPERATIONS IN INDIA & ASIAN COUNTRIES DURING 2010-2020

- Leather process from raw to semi-finish is reduced by 50% due to stringent environmental action in South Indian States such as Tamil Nadu during the past 10 years.
- Share of Tamil Nadu in leather processes reduced from 40% to less than 25% mainly due to the high environmental costs and stringent regulations such as adoption of ZLD system, etc.
- The leather production share in Kolkata in India has increased from 15% to more than 20% due to the expansion of industrial units and low operation & maintenance cost of the CETP system. In Kanpur region, which is the Northern part of India, the leather production has increased from 15% to more than 25% during the recent period mainly due to the integration of industrial effluent treatment with domestic sewage treatment system [3].
- In all regions, during COVID-19, the capacity utilization was in the range of only 30-60%. The revival after COVID-19 is positive in Kanpur region, moderate in Kolkata and poor in South India.
- There was no new license or expansion for the tanneries during the past 10 years. Recently, Environmental Clearances have been accorded for a Mega Leather Complex with the production capacity of about 600 tonnes/ day of raw hides and skins near Kanpur and expansion of units and CETP.
- New regulations and directions have been given for cleaner production, segregated centralized treatment, mode of effluent disposals, etc. by Ministry of Environment and Forests & Climate Change (MoEF-CC), National Green Tribunal (NGT), National Mission for Clean Ganga (NMCG), Central Pollution Control Board (CPCB) & State Governments.
- In China, for sustainability, small scale tanneries (about 400) with less than 10-15 tons/ day capacities closed as per new regulations. Water recovery and reuse is also adopted with advance oxidation to increase the production capacity.
- About 13 major Effluent Treatment Plants (ETPs) had been built in China’s Leather Sector during the growth period of 2000-2010. The utilization capacity is reduced gradually from 2010 onwards and further reduced during 2019 & 2020 due to COVID-19.
- In recent times, China outsourced the Raw to Semi-finish process of hides & skins in countries such as Vietnam, Bangladesh, etc. due to stringent environmental requirement and sustainability. Incentives are provided for exports in China after COVID-19.
- Japan developed special breed for signature meat such as “KOBE” meat and getting high quality hides in limited capacity.
- R & D activities on Cleaner Leather production and Environment are being carried out by mainly in Asian Universities (China & India). Industry associations such as China Leather Industry Association (CLIA) & Indian Leather Technologists Association (ILTA) are playing active roles in promotion and dissemination of technologies through publications.

5. NEW DEVELOPMENTS IN CLEANER PRODUCTION & TREATMENT SYSTEM

As per the new regulations of MoEF-CC, NMCG, NGT, CPCB and State Governments, the tanneries have to adopt specific cleaner production processes, segregate and treat the saline and chrome stream separately for recovery of quality water, salt and chemical[4].

The safe disposal of solid wastes from tanneries and sludge from effluent treatment plants are major challenges and also cost of sludge disposal in the Secure Land Fill (SLF) system is becoming very expensive. This is similar to the challenges faced by tanneries and CETPs in Italy, Spain, etc.

A typical model which is being implemented in the CETPs of UP is given below:

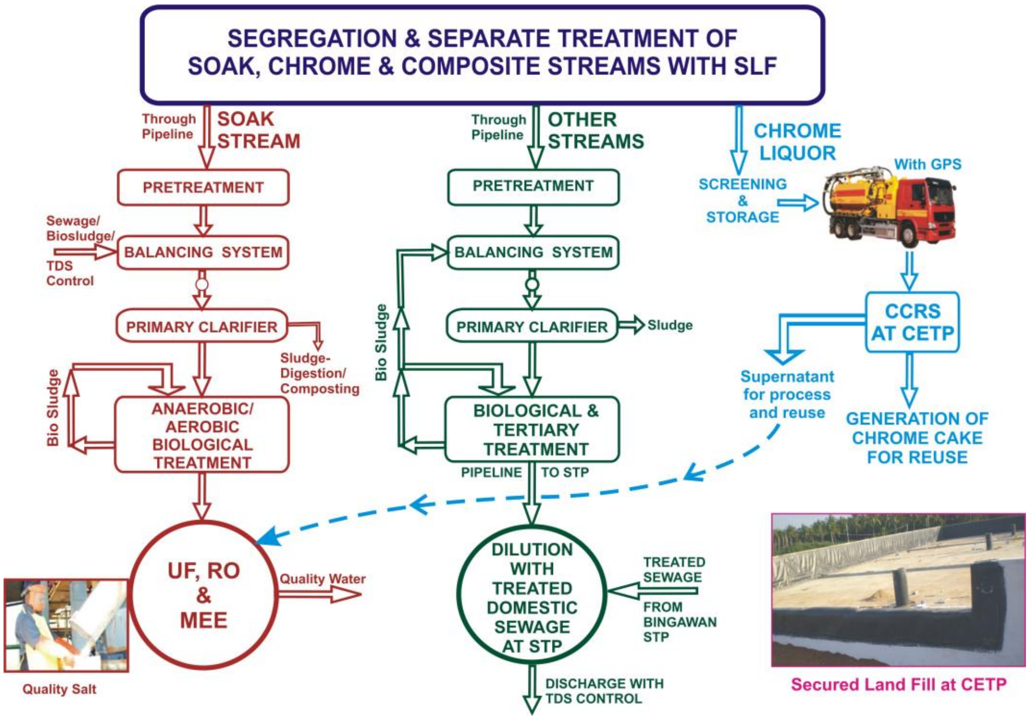

Fig 1. *Segregation and Separate treatment of Effluent Streams from Tanneries*

It is becoming necessary to convert the chemical treatment to anaerobic / aerobic biological treatment to reduce the sludge generation and to achieve the required treatment standards. These are all the following developments which are being applied in the upgradation and expansion of effluent treatment plants in India.

- Upgradation of equalization system into first-stage aerobic biological treatment with sulphide oxidation.
- Adoption of improved aeration system such as Jet Aspirator linked with integrated compressors for providing improved mixing, oxygen transfer upto 2.2 kg/kWh and odour control. An improved equalization cum sulphide oxidation system adopted in one of the CETPs is shown in the following figure.

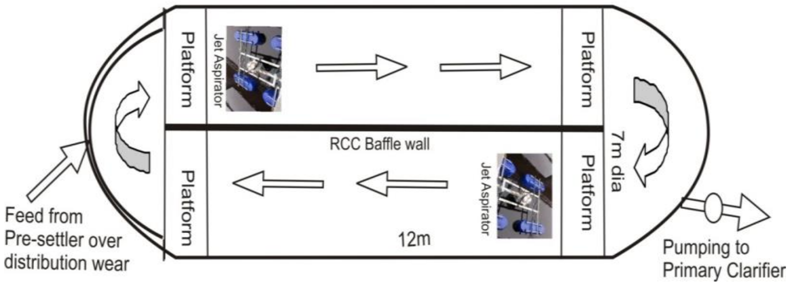

Fig 2. *Improved Equalization-cum-Sulphide Oxidation System*

The conventional effluent treatment system, though, could remove suspended solids, chromium, BOD, etc., but it is difficult to achieve COD norms and clarity in the treated effluent. With a view to overcome this problem, advanced oxidation using liquid oxygen and ozone are adopted to reduce residual COD, colour and microbes in treated effluent and make it fit for safe reuse. It is also reported from health care field that ozone treatment improves the immunity of human body against Cancer & COVID-19 viruses.

The disposal of large amount of sludge and un-used solid wastes such as fleshing are becoming challenges in India and many countries. In view of this, technological developments such as biological liquefaction of fleshing, anaerobic digestion with bio-energy generation and composting of digested sludge are being introduced in pilot and commercial scale [5]. The process flow diagram of biological liquefaction and anaerobic digestion are shown in the following figures.

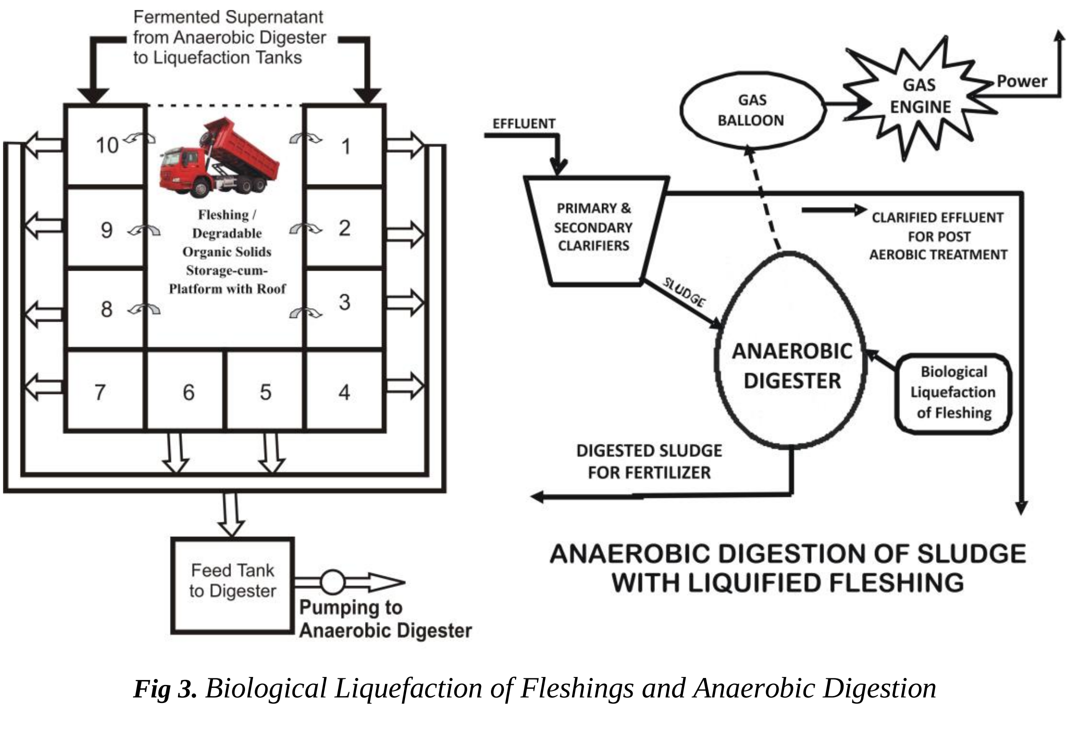

Fig 3. *Biological Liquefaction of Fleshings and Anaerobic Digestion*

6. LESSONS LEARNT ON SUSTAINABILITY IN CLEANER PRODUCTION AND EFFLUENT TREATMENT

- The sustainability of any cleaner technology would depend upon how it is made simple and acceptable by field technicians in commercial-scale operation.
- Many countries in US, Germany & European Union due to high labour cost and unsustainable environmental regulations resulted in closure of tanneries and export of salted raw hides & skins. Correspondingly R&D institutions are also closed down[6].
- Operation & Maintenance cost of effluent treatment is a major variable (1.0 to 4.0 Euros/ m^3) depending upon mode of disposal and regulations. First ZLD project with capacity of 5.0 MLD connected with 25 tanneries in Lurca, Spain closed down.
- Highest cost is in Tamil Nadu, South India due to the adoption of ZLD system, then in Italy, due to the total conversion into biological system to manage the sludge disposal issues.
- Lowest O&M costs are in Kolkata, Bangladesh, Vietnam, etc. mainly due to the provision for discharge of treated effluent into backwaters and to the sea.
- Cost of effluent treatment from land-locked tanneries such as Kanpur, Tamil Nadu, Jalandhar, etc. in India would be sustainable if the treated effluent from tanneries is able to be mixed with treated effluent domestic sewage, if available for TDS management.
- The 12th Asian (AICLST) Conference is scheduled during Oct. 2022 in Queenstown, New Zealand and XXXVI IULTCS Congress is scheduled during 2023 in Chengdu, China. However, there is uncertainity in organizing the conferences with physical participation due to the re-occurrence of COVID-19.

7. CONCLUSIONS AND RECOMMENDATIONS

- Separate treatment of saline soak stream & conversion of physiochemical treatment to biological treatment, recovery of quality salt, generation of bio-sludge & bio-fertilizer and reduction in sludge by more than 50% in effluent treatment plants would be achievable.
- Discontinued R&D in leather sector would resume in US and Europe, only if salted hides & skins are banned for export under health & safety reasons and restarting of tannery operations.
- Continued applied R & D in cleaner production, reduction/ recovery of chromium and other salts in all levels, utilization of solid wastes / sludge etc. to reach sustainable carbon footprint is necessary.
- Due to COVID-19 major challenge is faced by World Leather Sector mainly for fashion oriented high-value products.
- Revival would depend upon the occupational health & safety measures, control of COVID-19, flexibility in mobility and economical condition.
- High environmental cost such as adoption of total ZLD for composite stream in the absence of safe salt usage/ disposal is one of the major threats. The occupational health and safety in the context of COVID-19 pandemic situation would become a major threat for sustainability of world leather sector.
- Similar to the improved image of cotton textiles & organic farming, image of genuine leather usage shall be improved and disseminated for sustainability.

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COMPARISON OF WATER PERMEABILITY AND WATER ABSORPTION PERFORMANCE OF SHOE UPPER LEATHERS

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Abstract: *Today, leather footwear is preferred for the comfort, convenience, and durability properties. In addition to these features, it is expected to have high water performance especially in winter and outdoor leather shoes. For this purpose, in the present study twenty–one shoe upper leathers differentiated in finishing techniques (finished, printed and patent) were investigated in terms of water performance tests such as dynamic water absorption/penetrometer (TS EN ISO 5403-1), static water absorption (TS EN ISO 2417) and water vapor permeability (TS EN ISO 14268). The upper leather samples, collected from different leather manufacturing plants in Turkey, were prepared and conditioned according to TS EN ISO 2419 standard prior to tests. The results revealed that patent leathers gave the highest penetrometer values compared to finished and printed shoe upper leathers. Besides, finished, and printed shoe upper leathers provided the highest water vapour permeability values compared to patent leathers. As a result, the sample of R gave a water vapor permeability value of 7500 mg/cm^2.h along with the best penetrometer and static water absorption results. As a conclusion, the results obtained from the study would help in improving the quality standards of shoe upper leathers in terms of water performance tests and could show the current situation in the production of shoe upper leathers.*

Key words: *Upper leather, finishing techniques, water vapour permeability, water absorption, penetrometer*

1. INTRODUCTION

Leather has been used since centuries to protect the bodies of human beings from external conditions. In particular, footwear has developed and designed to wrap the feet of human being and itimproves the walking characteristics and is the indicator of the people’s social status [1]. Today it is well known that upper leathers are used in footwear manufacturing as a main material considering the spent of time in a footwear. They have positive effects on foot health and comfort and are produced by using different types of leather depending on the usage purposes. In addition, upper leathers form the upper surface of the footwear and they are manufactured with different production methods which give different properties and functions [2].

The quality of shoe upper leather is generally evaluated by its behavior towards water rather than the external appearance. The water resistance of the upper leather is an important feature for footwears that are comfortable to wear even in wet and cold conditions [3,4]. It is especially important for the winter leather footwears to pass the water performance tests for the comfort of the wear material. Herrmann, 2006, indicated the usage requirements of the waterproof leathers such as no water penetration, controllable water up-take, high water vapor permeability, heat and cold insulation, lightweight, wearing comfort and second breathing skin [5]. Also, the testing requirements are explained by Herrmann by water droplet test, static water up-take (absorption), soaking-up test (wicking-test), bally penetrometer, maeser and water vapor permeability [5].

In the present study, the effect of different finishing techniques on the water performance properties of the shoe upper leathers were investigated by determination of water vapor permeability, static (kubelka) and dynamic (penetrometer) water absorption properties. For this purpose, twenty-one shoe upper leathers obtained from various producers were collected and separated into three groups depending on the finishing types of the leathers in order to test the water performance properties.

2. MATERIALS AND METHODS

2.1 Materials

In this study, twenty-one upper leathers (UL) finished with different techniques were used as a material. They were collected from different upper leather manufacturers oriented in İzmir, İstanbul and Bursa. Each upper leather sample was entitled as follows (Table 1) and the finishing techniques and the classification of the upper leathers were given in Table 1 and Table 2 respectively.

Table 1. *Upper leathers used in the study*

Upper leathers		
(A): Finished leather	**(H):** Printed leather	**(O):** Printed leather
(B): Soft matte patent leather	**(I):** Matte patent leather	**(P):** Printed leather
(C): Finished leather	**(J):** Patent leather	**(R):** Printed leather
(D): Suede rustic finished leather	**(K):** Waxed matte patent leather	**(T):** Soft finished leather
(E): Printed leather	**(L):** Printed leather	**(U):** Finished leather
(F): Matte patent leather	**(M):** Printed patent leather	**(V):** Finished leather
(G): Patent leather	**(N):** Printed nacreous patent leather	**(Y):** Printed leather

Table 2. *Classification of the upper leathers*

Groups	Finishing type	Sample codes
I	Finished leathers	A-C-D-I-T-U-V (7 pieces)
II	Patent leathers	B-F-G-J-K-M-N (7 pieces)
III	Printed leathers	E-H-L-O-P-R-Y (7 pieces)

2.2 Methods

Upper leathers finished with different techniques were prepared and conditioned in accordance with physical and mechanical tests-sample preparation and conditioning standard (TS EN ISO 2419) [6] prior to tests. After conditioning of the upper leathers, penetrometer (TS EN ISO 5403-1) [7], static water absorption (TS EN ISO 2417) [8], and water vapor permeability (TS EN ISO 14268) [9] were performed to determine the behaviour of the upper leathers against water.

3. RESULTS AND DISCUSSION

3.1. Performance Values of Group I

The physical characteristics of the upper leathers classified as group I are given in Table 3.

Table 3. *Physical test results of the upper leathers belongs to group I*

Samples	Thickness values (mm)	Water vapour permeability ($mg/cm^2.h$)	Static water absorption (24h/ml/100g)	Penetrometer (Water absorption %)	Penetrometer time (min)
A	1.29	1.87±0.08	194.93	8.80	123
C	1.47	5.24±0.14	130.04	4.47	5
D	0.88	5.87±0.59	101.18	22.56	7
I	1.00	5.65±0.08	221.32	21.20	1
T	0.97	14.10±0.53	253.27	28.94	1
U	1.69	14.01±0.88	112.21	8.78	35
V	1.17	4.47±0.30	94.38	5.21	22

The upper leather entitled as A gave the highest penetrometer test results with 123 minutes and 8.80% water absorption. These results indicated that the upper leather A met the requirement of waterproof upper leathers [10,11]. Besides, the penetrometer test results of U and V were found above 20 minutes with less than 30% water absorption that shows the requirement of water performance standards of upper leathers was provided [10,11].

The static water absorption values of the upper leathers in Group I was found higher than the recommended value given for upper leathers (<85 ml/100 g). Although the upper leather entitled as A has the highest penetrometer value, the static water absorption value of the leather was found as 194.93 ml/100gr which was higher than the standard recommended value in terms of physical testing [10,11].

The finished leathers provided the expected values of WVP from upper leathers according to the standards [10,11]. The lowest WVP value was obtained from the sample of A due to the wet-end and finishing techniques of the upper leathers. The leathers C, D, I and V had similar WVP results although they were processed in different plants in addition to the similar results obtained from T and U leathers. The WVP results of the study were found higher than the results of Kanli et al., 2010 (1.36 and 1.95 $mg/cm^2.h$ for pigmented box and calf leathers) [12] and similar with Adiguzel Zengin et al., 2017 (4 $mg/cm^2.h$ and 10 $mg/cm^2.h$ pigmented calf leathers respectively).

3.2. Performance Values of Group II

The results of the upper leathers classified as group II (patent leathers) are given in Table 4.

Table 4. *Physical test results of the upper leathers belongs to group II*

Samples	Thickness values (mm)	Water vapour permability ($mg/cm^2.h$)	Static water absorption (24h/ml/100g)	Penetrometer (Water absorption %)	Penetrometer time (min)
B	0.87	0.44±0.05	173.32	11.11	96
F	0.89	1.06±0.06	113.23	11.92	150
G	1.25	0.43±0.06	132.10	6.67	83
J	1.25	0.24±0.00	92.91	10.40	113
K	0.78	0.21±0,001	155.55	9.10	205
M	0.81	0.63±0.08	190.19	14.05	135
N	1.01	0.16±0.00	161.05	10.90	27

Patent leathers have higher performance in terms of penetrometer test results compared to Group I and II. All group samples gave higher penetrometer values than 20 minutes as expected from upper leathers. Besides, the penetrometer water absorption results (%) were determined under 30% maximum water absorption value which is the limitation for the corrected grain upper leathers [10,11]. Additionaly, the samples of F, K and M fulfilled the requirement of IUP 10 prepared for the waterproof upper leathers (120 minutes, 25% water absorption) [11]. The sample K provided the highest value of penetrometer test among all the upper leather samples by determination of 9% water absorption at 205 minutes.

Although the patent leathers in group II fulfil the criteria of penetrometer test, they did not provide the minimum standard value of static water absorption for the corrected grain upper leathers. The static water absorption values of patent leathers were determined above the standard value of 85ml/100gr given in literature [10,11]. Only the sample J (92.91ml/100g) had the closest value to the standard among the patent leather samples.

The water vapor permeability values of the patent leathers were found lower than the group I and II due to the finishing technique applied to leathers. Adiguzel Zengin et al., 2017 were found similar WVP results for the patent leathers among the values of 0.2 and 0.4 mg/cm^{2}h for goat and calf leathers, respectively. But the results of Kanli et al., 2010 were determined higher than the study with the values of 1.14 ± 0.32 and 1.68 ± 0.98 for the calf and goat leathers [12].

3.3. Performance Values of Group III

The results of the upper leathers classified as group III are given in Table 5.

Table 5. *Physical test results of the upper leathers belongs to group III*

Samples	Thickness values (mm)	Water vapour permability (mg/cm^2.h)	Static water absorption (24h/ml/100g)	Penetrometer (Water absorption %)	Penetrometer time (min)
E	2.32	0.54±0.06	117.48	16.94	136
H	0.72	15.37±1.07	323.33	20.84	1
L	2.50	0.85±0.03	200.25	4.74	21
O	0.99	7.27±0.91	141.57	17.00	4
P	1.44	11.13±1.53	177.38	27.62	3
R	2.5	1.61±0.02	38.39	4.87	136
Y	0.97	5.92±0.45	230.23	13.21	4

The penetrometer test values of printed upper leathers found similar to Group I. Only the samples of E and R provided higher penetrometer results (136 minutes) in comparison with the standard value [10,11] and met the IUP10 standard value [11]. The water absorption (%) values of the penetrometer test were found between approximately 28% and 5%. The sample of R gave one of the highest penetrometer test results with the minimum water absorption among all groups.

When the static water absorption values of the printed leathers were examined at 24 hours, it was determined that the static water absorption values of the samples except the sample of R were found to be quite high. With a value of 38.39ml/100g, the R sample gave the best result among all upper leather samples. Besides, it can be revealed that the sample of R had the highest performance in terms of dynamic and static water absorption values.

The sample of H had the highest water vapor permeability with a value of nearly 15.37±1.07mg/cm^{2}h compared to all upper leathers. The sample of E has the lowest water vapor permeability with 0.54±0.06 mg/cm^{2}h in Group III. This could be due to the difference in thickness values of the leathers as well as the thickness of the finishing coats. Because Śmiechowski et al., 2014 mentioned the importance of the finishing coats thickness especially for thick leathers, although leather thickness was one of the most precious parameters on water vapor permeability [13].

Consequently, the upper leathers entitled as A, K and R gave the best penetrometer results among the groups (Figure 1). They were differentiated in finishing techniques and the sample of K, belongs to the patent leathers group, showed the best penetrometer result among the upper leathers.

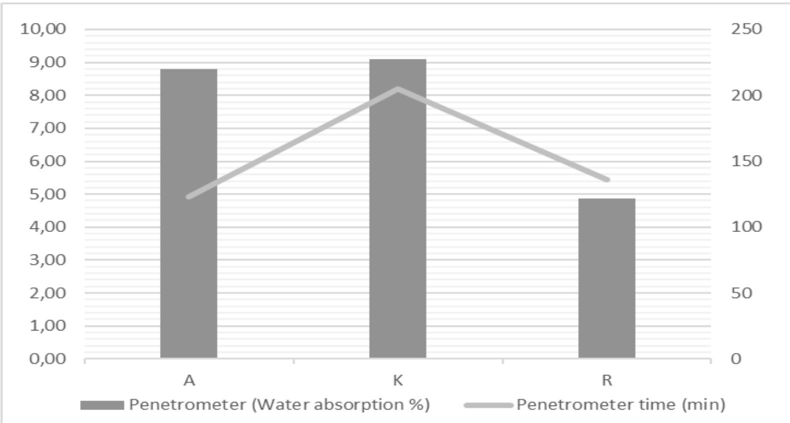

Fig. 1. *The penetrometer results of the upper leathers entitled as A, K and R*

As expected, the water vapor permeability of patent leathers (N) are found lower than printed and finished (T) leathers. However, the static water absorption of printed leather (H) had the highest value compared to other groups. This could be due to the type of the finishing technique, products as well as the wet-end operations that is applied.

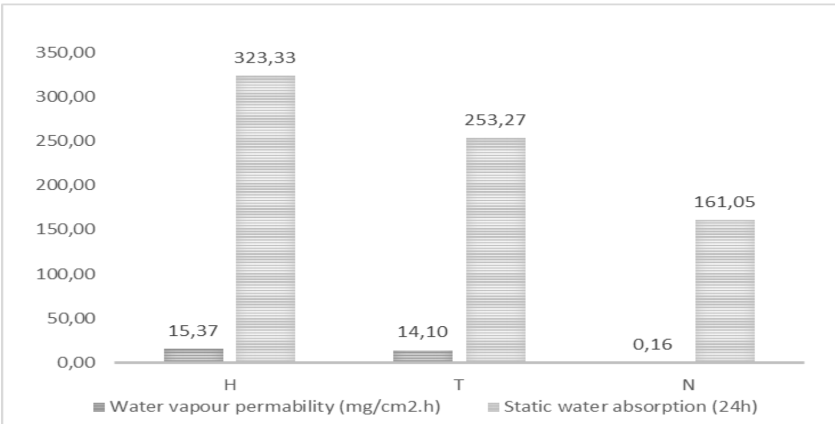

Fig. 2. *The water vapor permeability and static water absoption results of the upper leathers entitled as H, T and N*

4. CONCLUSIONS

The results obtained from this study show that the performance values of the upper leathers against water varies depending on the type of finishing as well as the production techniques used in the leather industry. Patent leathers gave the highest values of penetrometer test among the groups of finished and printed upper leathers. Finished and printed upper leathers have the highest water vapour permeability test results compared to patent leathers and the diffentiated values of water vapour permeability of these two groups of leathers occurred due to the wet-end and finishing production techniques. These results would help considerably in improving the quality standards of shoe upper leathers produced in leather industry and help to present the current circumstances in the production of the shoe upper leathers.

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