35th INTERNATIONAL COTTON CONFERENCE BREMEN 2021

Presentation

Session: **Innovative Textile and Technical Products (C4)**

Title: **3D design of cotton/flax clothing aiding the medical treatment of skin diseases**

Speaker: **Agnieszka Cichocka,** Lodz University of Technology, Lodz, Poland

Presentations are available on the conference archive: https://baumwollboerse.de/en/cotton-conference/lectures/

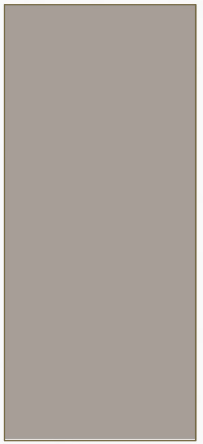
Conference Organization
Faserinstitut Bremen e.V., Bremen, Germany. E-Mail: conference@faserinstitut.de
Bremer Baumwollboerse, Bremen, Germany. E-Mail: info@baumwollboerse.de

INTERNATIONAL Cotton CONFERENCE BREMEN 2020

3D DESIGN OF COTTON/FLAX CLOTHING AIDING THE MEDICAL TREATMENT OF SKIN DISEASES

Agnieszka Cichocka[1], Iwona Frydrych[1], Małgorzata Zimniewska[2], Małgorzata Muzyczek[2], Przemysław Mikołajczak[2], Katarzyna Schmidt-Przewoźna[2], Barbara Romanowska[2], Mariola Pawlaczyk[3], Izabella Krucińska[4], Agnieszka Komisarczyk[4], Stanisława Kowalska[4], Lucyna Herczyńska[4], Monika Urbaniak[5]

[1]Lodz University of Technology, Institute of Textile Architecture, [2]Institute of Natural Fibres and Medical Plants, [3]Poznan University of Medical Science, [4]Lodz University of Technology, Department of Material and Commodity Sciences and Textiles Metrology, [5]Marko-Kolor Sp.



BIOAKTYWNA ODZIEŻ O WŁAŚCIWOŚCIACH LECZNICZO-PIELĘGNACYJNYCH

PBS 1- Projekt nr 177463, Ścieżka A

Lodz University of Technology
Institute of Architecture of Textiles

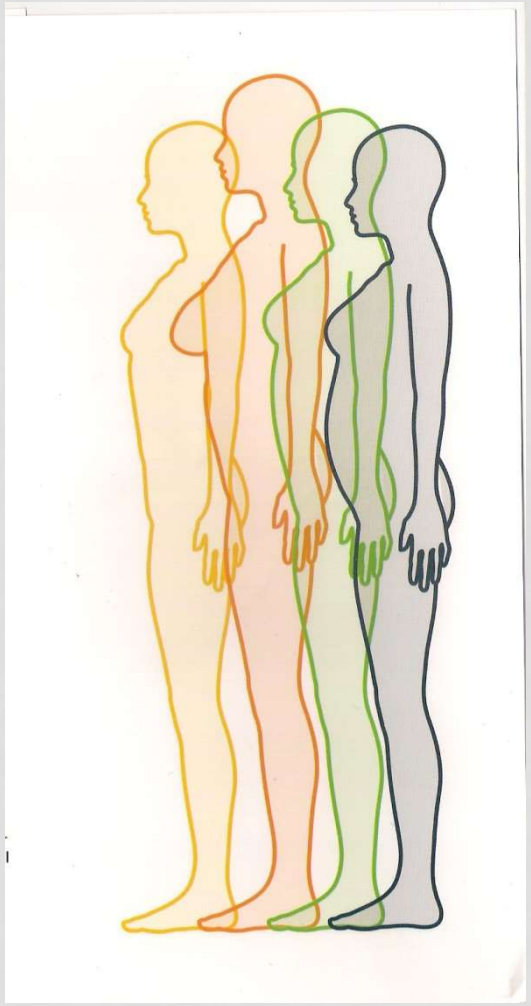
Faculty of Material Technologies and Textile Design

Major fields of study:

- Textiles & Fashion Industry,
- Design,
- Material Engineering,
- Industrial Design Engineering,
- Labor Safety Engineering,
- Commodity science.

OUTLINE

- Genesis of research problem
- Aim of research
- Introduction
- Experimental approach
- Methodology of study
- Results
- Conclusions



GENESIS OF RESEARCH PROBLEM

- Increase of the average age of European society,
- Forecast from EUROSTAT – an increase from 17.1% in 2008 to 30% in 2060 of the population aged over 65 years,
- According to expectations in 2020 about 25% of the European population is accounted as the elderly or disabled.

AIM

Objectives of the study were to develop the functional clothing made of natural fibers containing microcapsules with active herbal extracts characterized by properties enhancing the treatment of dermatoses, and to confirm the efficiency of the clothing's activity by testing its effect on the biophysical parameters of human skin.

The clothing products should be worn during the day and night by old people with some disfunctions of the body and some skin deseases. The clothing should assure comfort of use, should be easy taken on and off and should be inspired by the nature.

In reserach we investigated an effect of developed functional clothing on biophysical parameters of the skin in the course of maintaining the curing proces of dertmatisis in order to ensure the proper care during the pharmacological therapy.

AIM

DESIGN OF ECOLOGICAL TEXTILES

colors

Inspirations by nature can be considered on the level

Raw materials, patterns

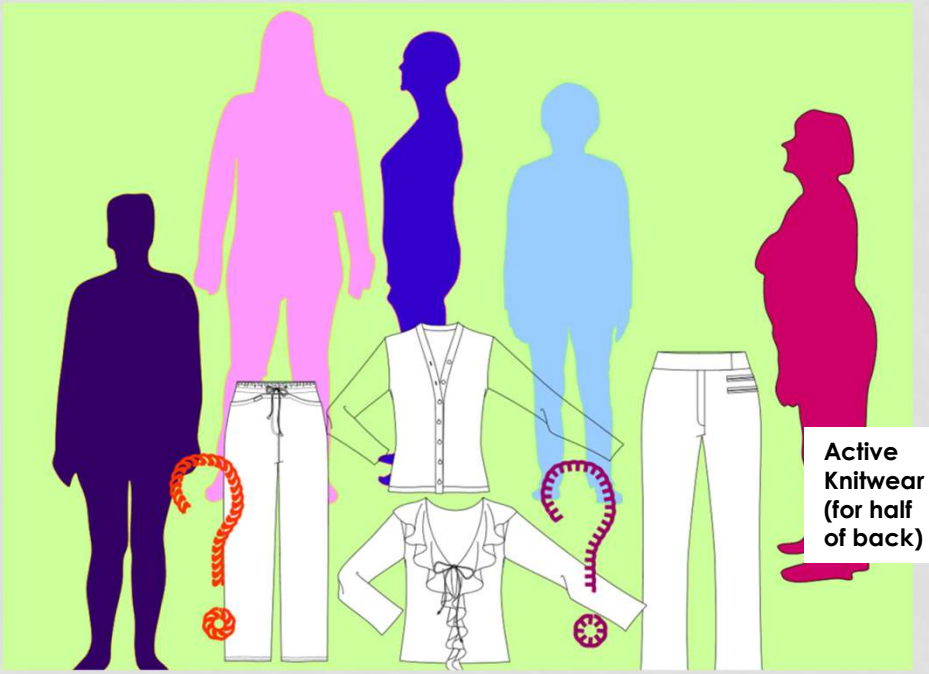
Textureweave

Clothing products should offer:

- liberty of body movement,
- walking/travelling easiness.

INTRODUCTION

Additional functionality expected in the clothing means that the proposed clothing need to cover the human body in an aesthetic way and give comfort of use it, but also should bring an adding value in the health of people with the skin oversensitivity.



Active Knitwear (for half of back)

INTRODUCTION

OVERSENSITIVITY OF SKIN

- Important health problem that can be caused by allergies or different skin diseases, which are long-lasting and recurrent bearing, causing itching, dry skin and increased skin stretching.

- Patients with different skin diseases such as: egzemas (a), especially atopic dermatosis, psoriasis (b), shingles (c), lyme disease and others can be numbered among people with the oversensitive skin.

a) 

b) 

c) 

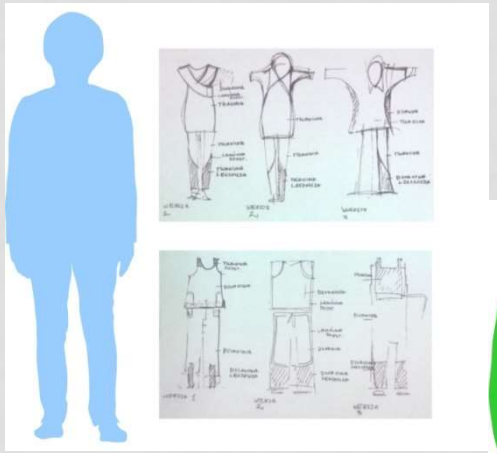
INTRODUCTION

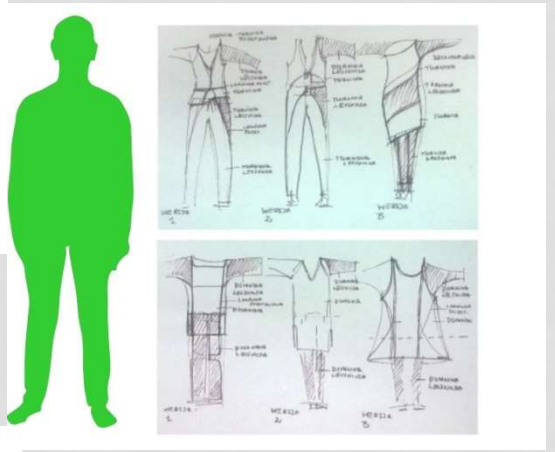
- The development of microencapsulation technology has caused the creation of a new type of clothing, e.g. cosmetotextiles. The cosmetotextiles are usually enriched with microcapsules containing substances such as herbal extracts, compounds containing vitamin E, aloe vera or others to ensure the delivery of active substances with specific action to the skin.
- Cosmetotextiles, via a direct contact with the skin, contribute to the improvement of moisture content, skin condition and vitality, delay in the ageing process or have a slimming or anti-cellulite effect, among the others.
- In this study, the encapsulation technology using herbal extracts was applied to develop the natural fiber clothing supporting the skin disease treatment.

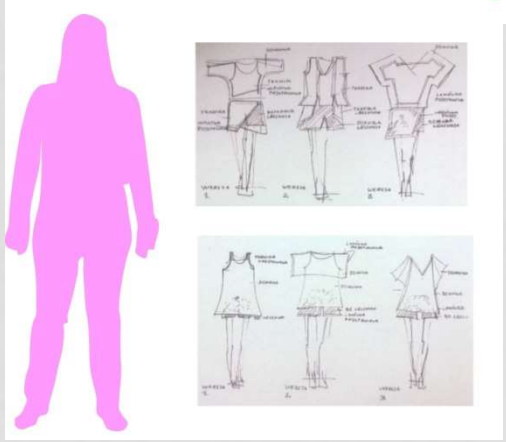
EXPERIMENTAL APROACH

Proposal of garment design takes into account the different parameters such as silhouette types, customer age, garments function, dermatosis area.

To aid the healing process the inner layer of the clothing was covered with microcapsules containing herbal extracts.







EXPERIMENTAL APPROACH

The fabrics designed in the project under the special conditions release appropriate substances causing in this way the aiding the treatment process. The designed clothing made of such kind of fabric should be:

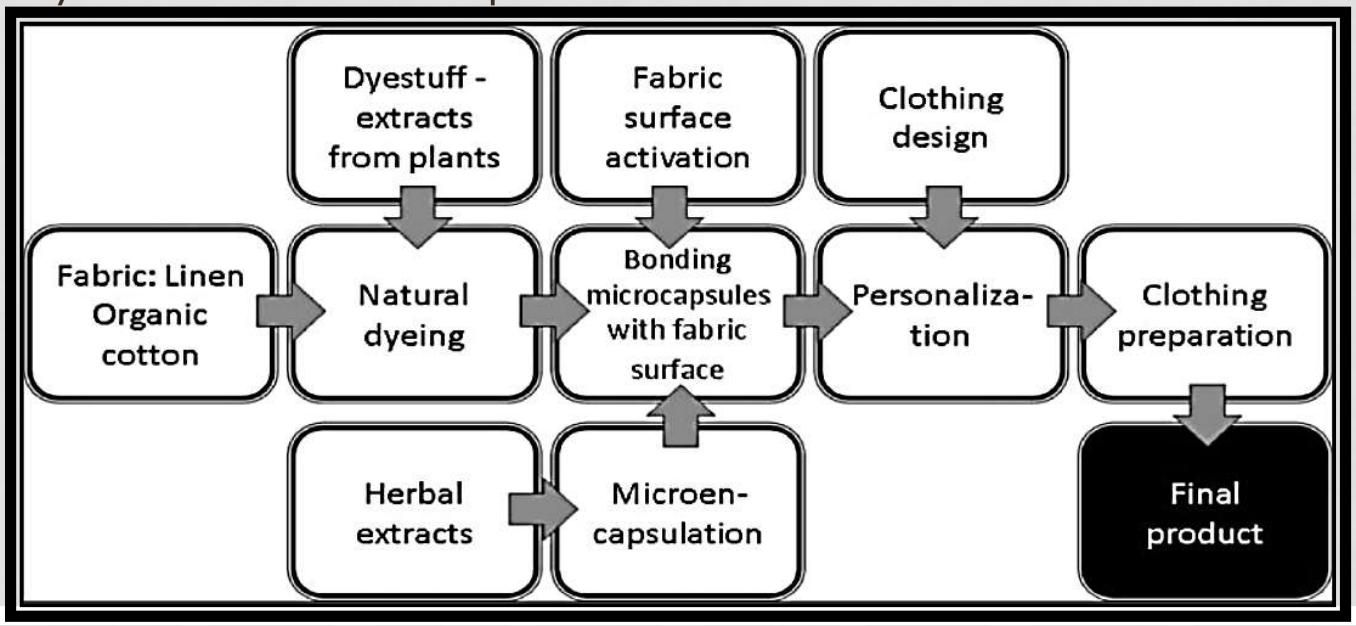
- from one side - tight to assure the contact of the skin with the fabric,
- and from the other not too tight to assure the appropriate utility comfort of users.

EXPERIMENTAL APPROACH

In our approach new technologies from CAD system such as:
3D human body scanner (TC^2),
and software for the virtual simulation of clothing – (Lectra), were used to made a **Clothing Personalization.**

EXPERIMENTAL APPROACH

Multi-level personalization included an individual selection of the bioactive herbal extracts for encapsulation in microcapsules, characterized by the ability to support the treatment of dermatoses of specific patients, placing the active elements in the clothing structure depending on the location of skin lesions and adjusting the clothing to the patient's body shape, taking into consideration individual stylistic and color preferences.



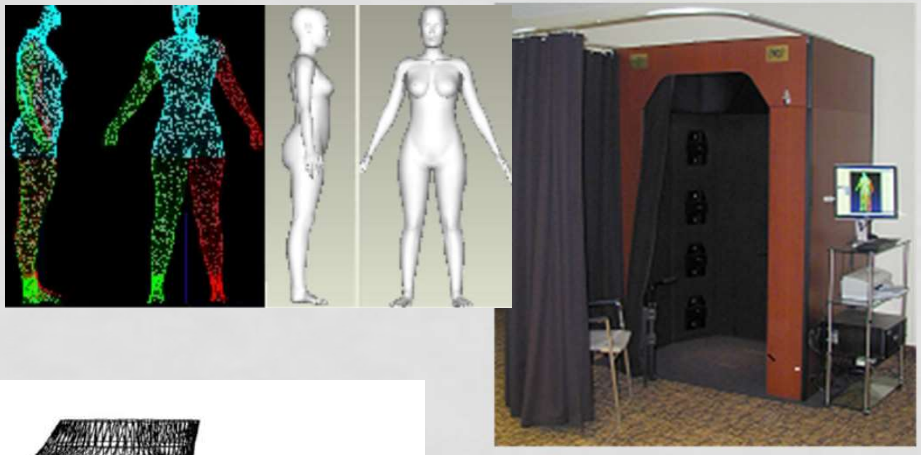
EXPERIMENTAL APPROACH

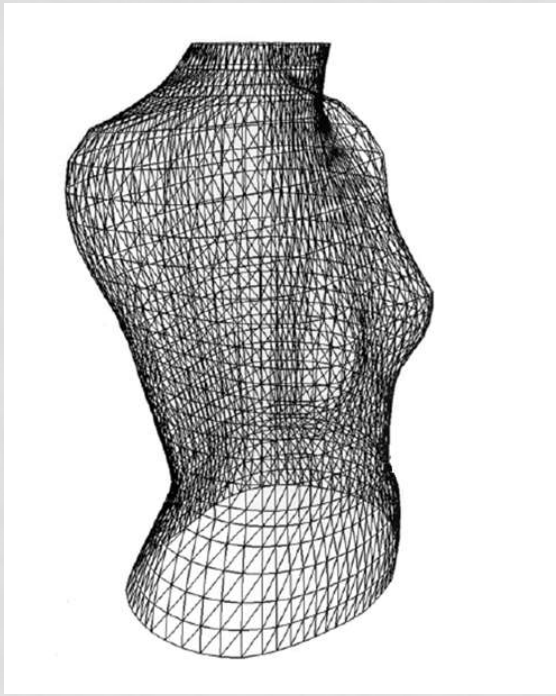
Clothing virtual simulation software allows for generating the "fit" of clothing on the avatar in the virtual 3D space in order to achieve its appropriate level to treat skin disorders.

Parametric avatars or those issued from the 3D scanner represent an interesting alternative for the people with disabilities, with specific anatomical defects or dysfunctions.

METHODOLOGY OF STUDY

3D scanner allows for avoiding errors resulting from measurements done by different people or errors arising from wrong written data or incorrect identification of anthropometric points.

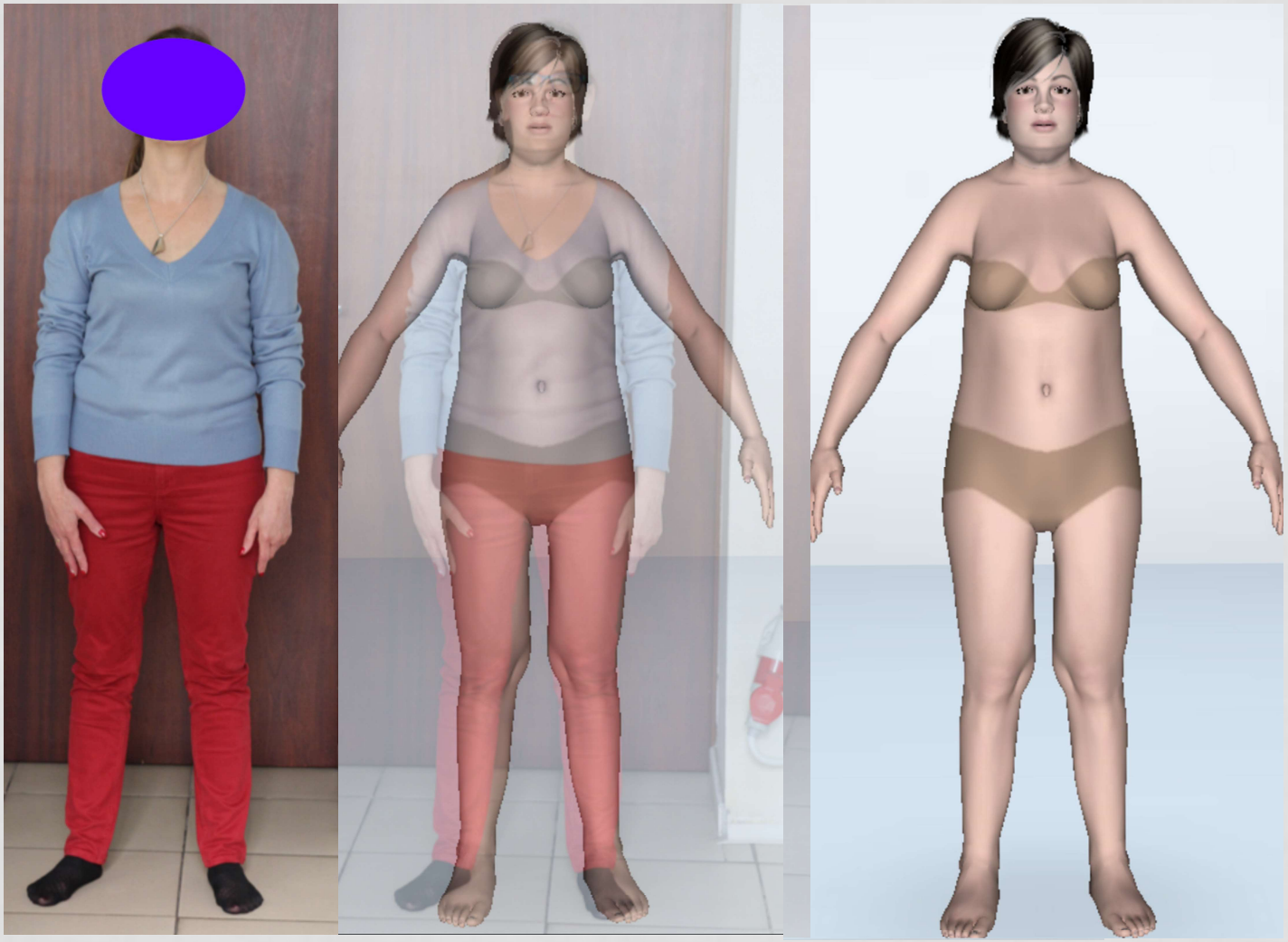




METHODOLOGY OF STUDY

METHODOLOGY OF STUDY

METHODOLOGY OF STUDY



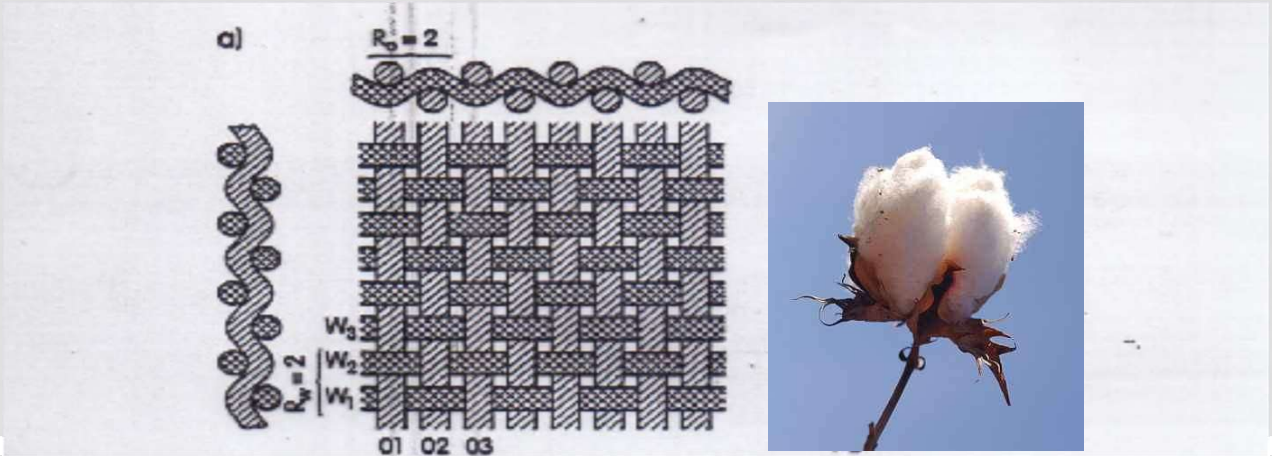
METHODOLOGY OF STUDY

MATERIALS

Clothing supporting the skin therapy was produced from the following fabrics:

- Cotton (CO) fabric of plain weave – 150 g/m^2,
- Pure linen (PL) knitted fabric of plain stitch - 225 g/m^2,
- knitted fabric made of blend 96% linen/4% elastane (EL) of plain stitch – 166 g/m^2.

No chemicals hazardous for human health were used in order to reduce risk of allergic reactions and skin irritation.



IFI1

METHODOLOGY OF STUDY

CHARACTERISTICS OF MATERIALS

TEST		Organic cotton				Linen 96%/Elasthane4%,				Pure Linen			
		warp		weft		wale		course		vale		course	
		Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD
1	*Mass per square meter, g/m² (PN-ISO 3801:1993, PN-P-04613:1997)*	151	0,09			166	0,03			225	0,06		
2	*Fabric density, 1/10 cm (PN-EN1049-2:200, PN-EN 14971:2007)*	338	0,00	209	0,45	114	0,74	135	0,27	72	0,57	73	0,00
3	*Hygroscopicity, 65% (PN-P-04635:1980)*	6,95	0,20			7,53	0,15			8,79	0,18		
4	*Hygroscopicity, 100% (PN-P-04635:1980)*	12,51	0,31			14,63	0,37			15,09	0,86		
5	*Water sorption (drop method), s (JIS 1090:1990)*	10	1,94			17	1,92			292	51,84		
6	*Air permeability, mm/s (PN-EN ISO 9237:1998)*	309,00	7,35			1585,00	72,44			2654,01	165,28		
7	*Thermal resistance, m² K/W (PN-EN 31092:1998/Ap.1:2004)*	0,032	0,007			0,034	0,015			0,046	0,001		
8	*Water vapour resistance, m² Pa/W (PN-EN 31092:1998/Ap.1:2004)*	3,88	0,18			4,83	0,09			5,38	0,60		
9	*Breaking force, N (PN-EN ISO13934-1:2013)*	779,5	34,26	477,05	12,58	180,68	26,89			357,71	34,88		
10	*Abrasion resistance, number of cycles (PN-EN ISO 12947-2:2000)*	20000	0,00			1000	500,0			2000	816,9		

Folie 20

IFI1 brak norm

Iwona Frydrych I41; 12.09.2019

IFI2 Iwona Frydrych I41; 08.11.2019

METHODOLOGY OF STUDY

WHY SUCH RAW MATERIALS?

Clothing made of natural cellulosic fibers such as flax and organic cotton provide a relaxation and general well-being of users.
Additionally, flax fibers from specific varieties of the plant, extracted from stems via dew retting method, have inherent bioactivity and antimicrobial properties, what justifies the use of natural/knitted fabrics from flax and cotton for the production of clothing with care and therapeutic properties.
Textile materials were dyed with natural dyestuffs obtained from plants: madder (*R. tinctorium)*, plain (*coreopsis C. tintoria)* and dyers's broom (G. tintoria*)*. They are characterized by anti-inflammatory, antibacterial and antioxidative properties.

METHODOLOGY OF STUDY

HERBAL EXTRACTS

In our study, we used a solution with ethyl cellulose microcapsules filled with herbal extracts (*V. tricolor* and green tea) for bonding with linen knitted fabric surfaces to ensure that the active substances were released during the theraphy.

Green tea (*Camelia sinensis*) is used mostly for deodorization and UV protection as it contains active components across a wide biological spectrum such as polyphenols, flavanoids and phenolic acid and displays anti-inflammatory, antioxidative and antibacterial action.

Heart sease (*Viola tricolor*) due to its anti-inflammatory and antioxidant properties of flavanoids and anthocyanins was regarded as a traditional remedy against several skin diseases.

METHODOLOGY OF STUDY

THE CONTENT OF ACTIVE SUBSTANCES IN HERBAL EXTRACTS

Table 4. The content of polyphenolic compounds in ethanol–water extracts (1:1) from the tested raw materials

The extract	Flavonoids expressed as quercetin (%)	Polyphenols Expressed as rosemarinic acid (%)	Tannins expressed as pyrogallol (%)
Green tea	1.01 ± 0.01	5.63 ± 0.38	15.14 ± 0.15
Viola tricolor	7.61±0.06	0.44 ± 0.03	0.72 ± 0.12

It was found that green tea extract contained over 10 times more polyphenols as compared to the *V. tricolor* extract (5.63% vs. 0.44%).

Moreover, the green tea extract (15.14%) had over 15 times more tannins than the *V. tricolor* extract (0.72%).

However, the *V. tricolor* extract had over seven times more flavonoids (7.61%) than were found in the green tea extract (1.01%).

METHODOLOGY OF STUDY

PREPARATION OF ACTIVE FABRIC

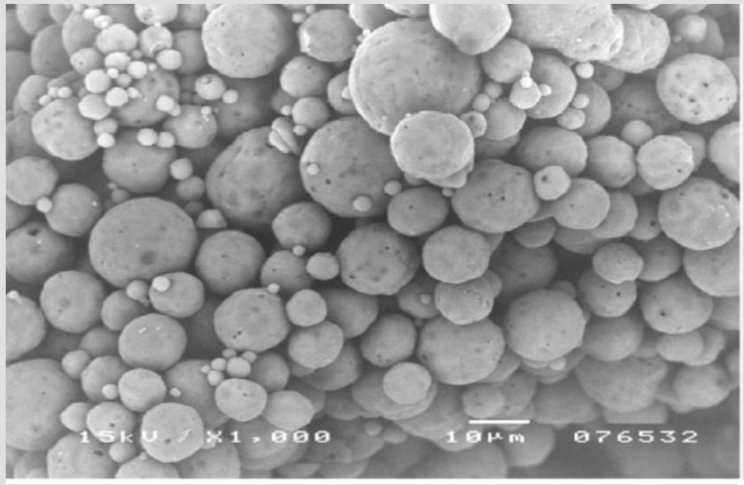
The flax knitted fabric, after the preliminary dying with natural dyes, was sprayed with a 3% sodium alginate in water solution, which is used as a binder. The microcapsules were deposited onto the knitted fabric surface prepared in this way.

The amount of microcapsules applied onto the knitted fabric surface was estimated at the level of 6 g/m^2.

Then the fabric was sprayed with sodium alginate solution again. The binder was transformed into a product insoluble in water by immersing the material in 10% calcium chloride solution.

The microcapsules containing green tea extract are light beige, whereas those containing *Viola tricolor* extract have slightly greenish hue.

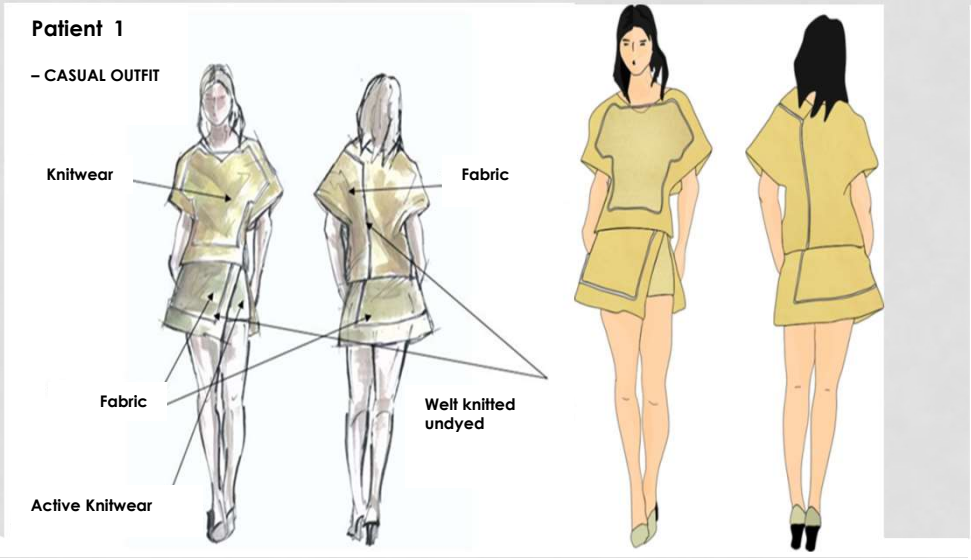
The size of microcapsules affects their funcionality, mechanical properties and appearance. Large microcapsules are more susceptible to damage.

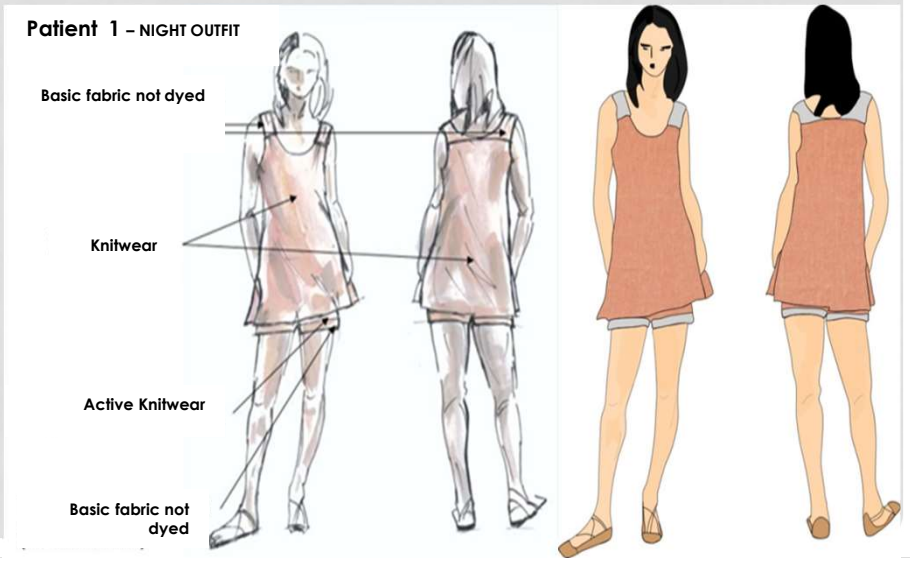


METHODOLOGY OF STUDY

DESIGN OF BIOAKOD CLOTHING COLLECTION

The potential of the CAD system, in terms of modern technologies used for the **DESIGN OF BIOAKOD CLOTHING COLLECTION** is presented using the KALEDO STYLE program. Digitizing the designer ideas allows for the effective managing the entire process of designing and creating the clothing, also at the design stages. Each change is introduced into the project independently, without causing the need to generate the project structure again, and modifications of the color, the structure of clothing etc. are available directly.



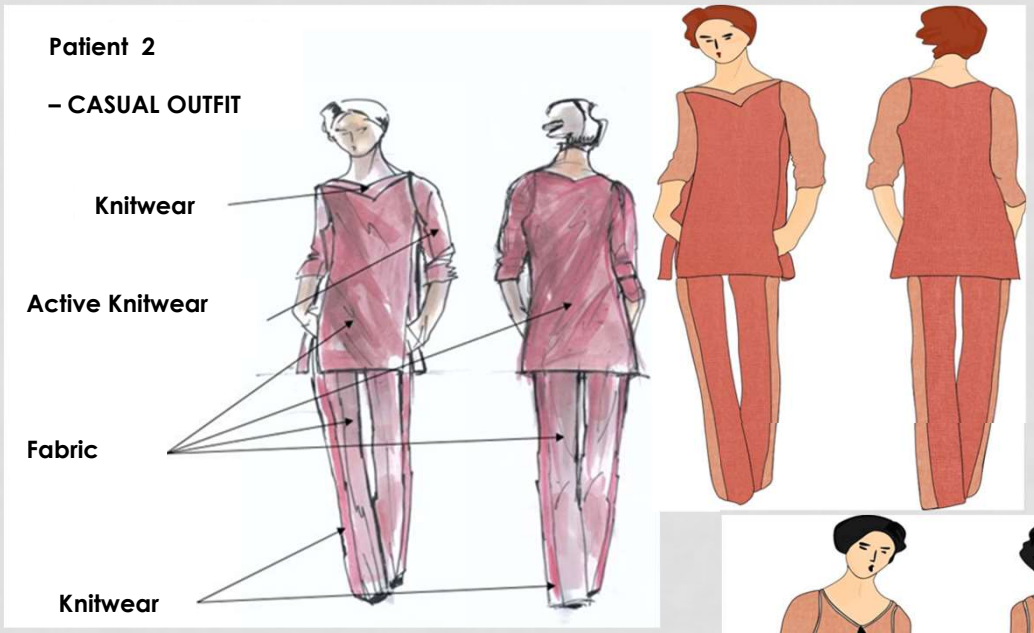


METHODOLOGY OF STUDY

DESIGN OF BIOAKOD CLOTHING COLLECTION

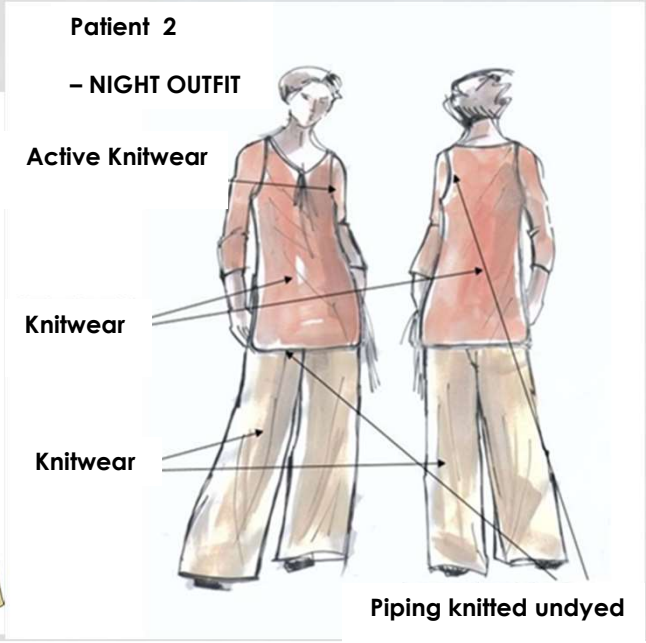
Patient 2

– CASUAL OUTFIT



Patient 2

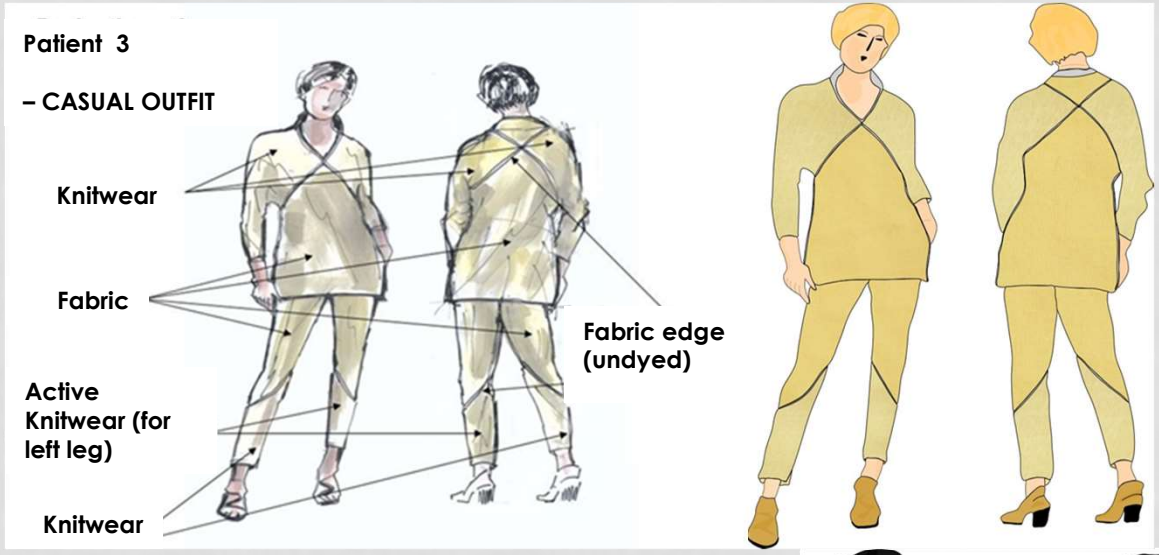
– NIGHT OUTFIT

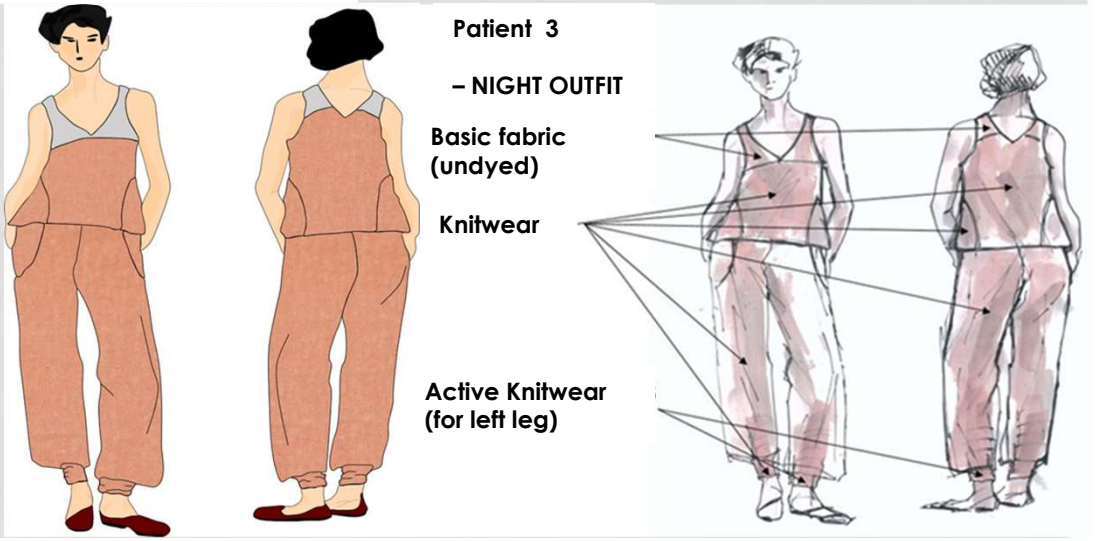


Piping knitted undyed

METHODOLOGY OF STUDY

DESIGN OF BIOAKOD CLOTHING COLLECTION





METHODOLOGY OF STUDY

DESIGN OF BIOAKOD CLOTHING COLLECTION

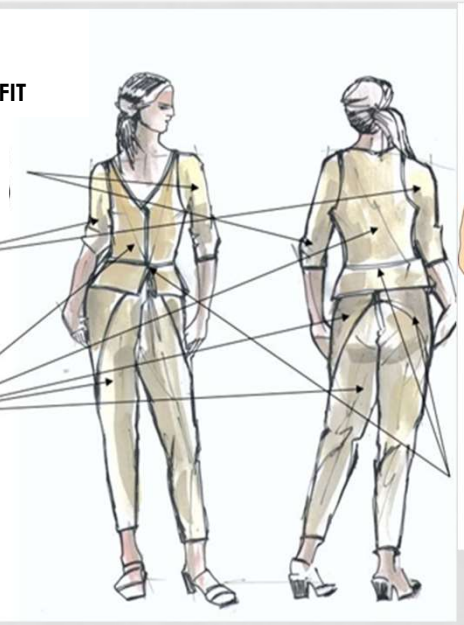
Patient 4

– CASUAL OUTFIT

Active Knitwear (for left arm)

Knitwear

Fabric



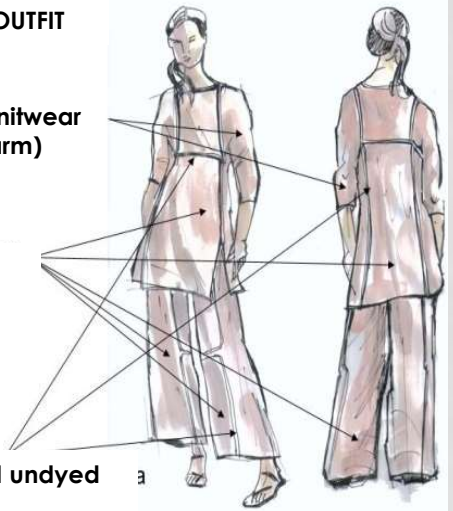
Pacjentka nr 4

Patient 4
– NIGHT OUTFIT

Active Knitwear (for left arm)

Knitwear

Weft knitted undyed



METHODOLOGY OF STUDY

DESIGN OFBIOAKOD CLOTHING COLLECTION

Patient 5

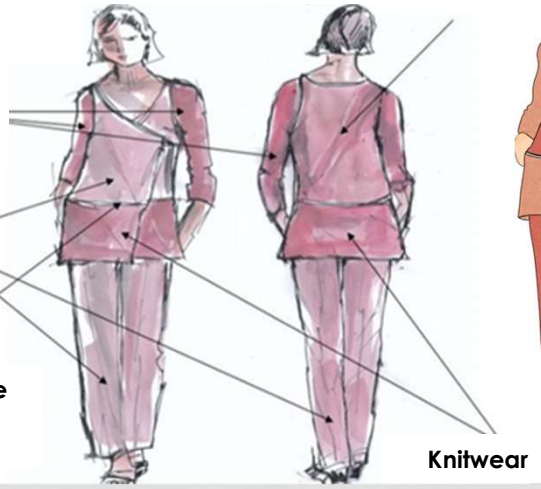
– CASUAL OUTFIT

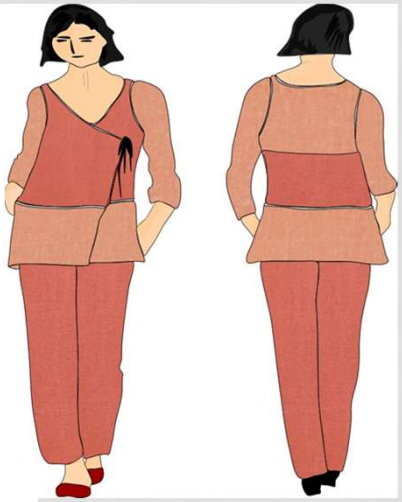
Active Knitwear (for left arm)

Fabric

Fabric edge (undyed)

Active Knitwear (for half of back)





Knitwear

Patient 5

– NIGHT OUTFIT

Knitwear

Knitwear

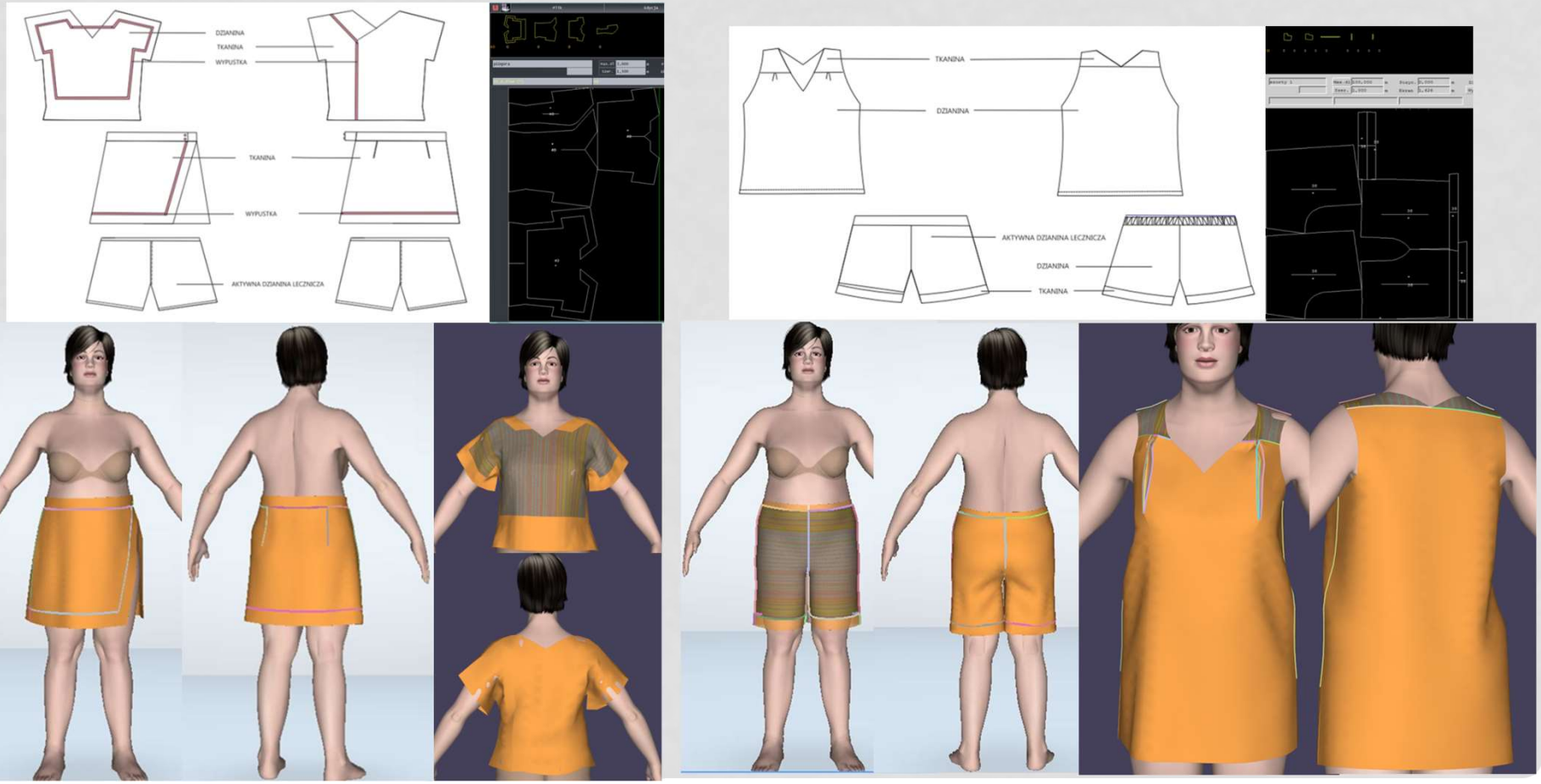
Active Knitwear (for half of back)

Welt knitted undyed

Fabric

METHODOLOGY OF STUDY

CLOTHING FOR DAY AND NIGHT - OUTFITS FOR PATIENT 1



METHODOLOGY OF STUDY

WEAR TEST

- The efficiency of functional clothing was assessed with the wear test. Women suffereing from dermatoses have worn the functional clothing for 5 weeks during days and nights.
- After qualifying for the study, a personalization of the clothing was conducted, then the clothing was designed and sewn.
- Skin examination was performed twice: before the wear test and after 5 weeks of the usage of functional clothing. Itching intensity was assessed with the Numerical Rating Scale.
- At the end of experiment, all women validated comfort and the aesthetic value of functional clothing rating from 0-10. The experiment was approved by the Bioethics Committee of the Poznan University of Medical Sciences.

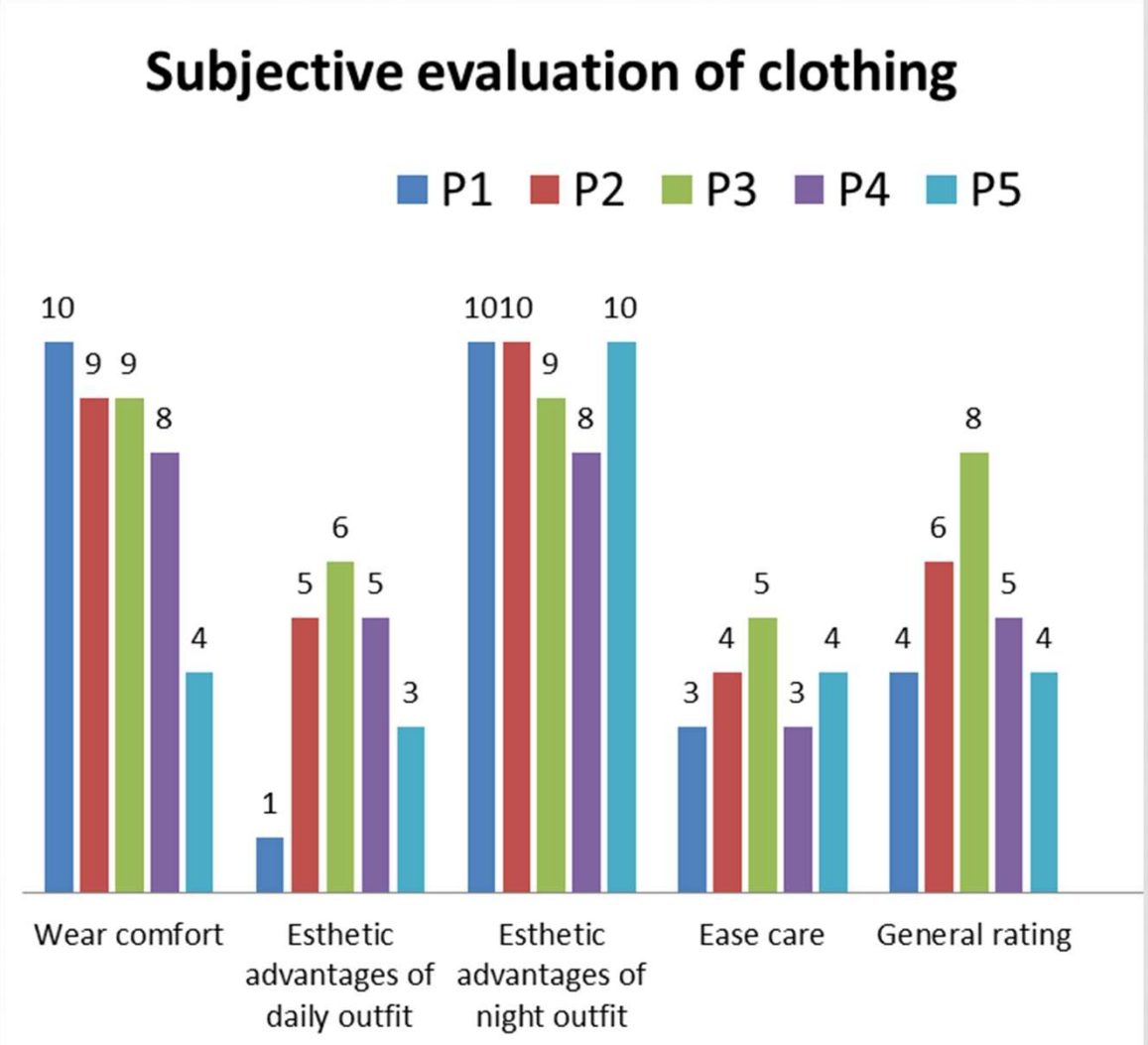
RESULTS

- The results of high hygroscopicity and air permeability of the materials used for the clothing ensure unrestricted breathing for the patients skin.

- Thermal resistance of all the tested textile materials ranged between 0.0322 and 0.0459 m^2K/W, which meant that under conditions of moderate physical activity of the patients wearing the clothing (activity at 58-92.8 W/m^2 , i.e., 1-1.6 met) in ambient conditions at 24-30°C, 50% relative air humidity and relative air movement below 20 m/s, the clothing would ensure physiological comfort of user.

- The carried out tests on the barrier properties against UV radiation showed that the natural dyeing process improved the UPF. It results partially from the density of material structure, which was most visible in the case of CO fabrics.

RESULTS



Subjective patient opinions about wearing the developed clothing are expressed in the range 1-10, where 1 is the lowest satisfaction and 10 means the greatest satisfaction.

The test results confirm that the new method of administering herbal medical substances to the patients' skin by wearing the functional clothing, for patients with chronic pruritic dermatoses, is efficient and leads to a reduction of TEWL (transepidermal water loss) and better skin hydration. As a result, the skin barrier function is enhanced; together with a dermatological therapy, this can help to reduce symptoms associated with the diseases.

RESULTS

- The results confirm the long-term bioactivity of the developed clothing.

- Evaluation of wearing and washing fastness indicated that after 5 weeks of use as the everyday clothing and 20 cycles of washing (with an application of gentle process without detergents), some microcapsules were still present on the knitted fabric surface and release of active extracts was reduced to 8% of the initial level, which was 53%.

CONLUSIONS

- Clinical tests of proposed garment collection of BIAOKOD project checked out for 5 women patients wearing the suits for days and nights during 4 weeks as well as personal questionnaire proved that developed outfits truly confirmed the supporting activities of dermatoses treatment.

- The test results confirmed that the linen/cotton clothing enriched with medicinal plant extracts enclosed in microcapsules had an effect on the reduction of itching intensity, increase of skin moisture, reduction of transepidermal water loss and reduction of pathogenic bacterial colonies residing on the patients' skin.

CONCLUSIONS

- It was confirmed that the new method of administering herbal substances to the skin of dermatological patients via wearing the functional clothing is effective and leads to the symptom relief.

- The studies allowed for the filing a patent submission, number P 411869, titled ‘‘The clothing acting as a dressing supplement in the therapy of dermatological diseases.’’

- THANK YOU FOR ATTENTION !!!!

BIOAKTYWNA ODZIEŻ O WŁAŚCIWOŚCIACH LECZNICZO-PIELĘGNACYJNYCH

PBS 1- Projekt nr 177463, Ścieżka A

INTERNATIONAL Cotton CONFERENCE BREMEN 2020