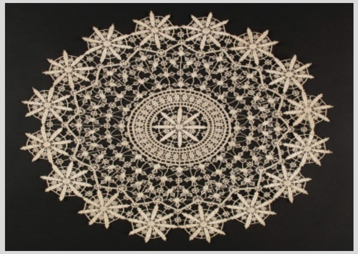
NEW, MODERN TEXTILES AS WRAPPING MATERIAL FOR STERILIZATION

CROATIA

VLATKA TURCIC, M.Sc.

Greetings from Croatia



Beti Rogina-Car, Ph.D.

Vlatka Turcic, M. Sc.

Ana Budimir, Ph. D.

Drago Katovic, Ph.D.

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Drago Katovic, Ph.D.

This scientific research was conducted for the dissertation of candidate **Beti Rogina – Car** in cooperation with:

- **Faculty of Textile Technology Zagreb**
- **University Clinical Hospital Centre Zagreb, Croatia**

The Use of Textiles in Medicine






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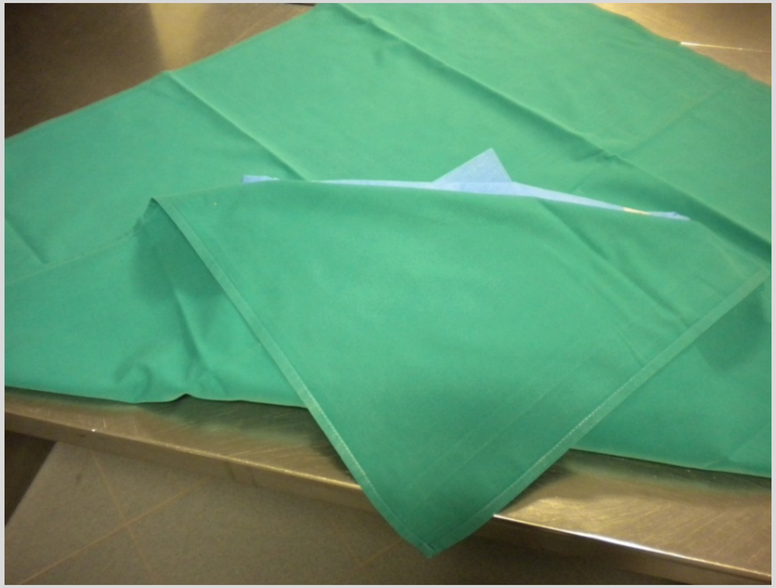

The Use of Textiles in Sterilization

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Cotton

- **undeclared quality**
- **microbial barrier - questionable**

No data about a range of other characteristics of cotton fabrics required for ensuring microbial barrier

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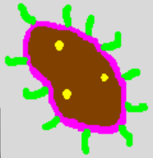
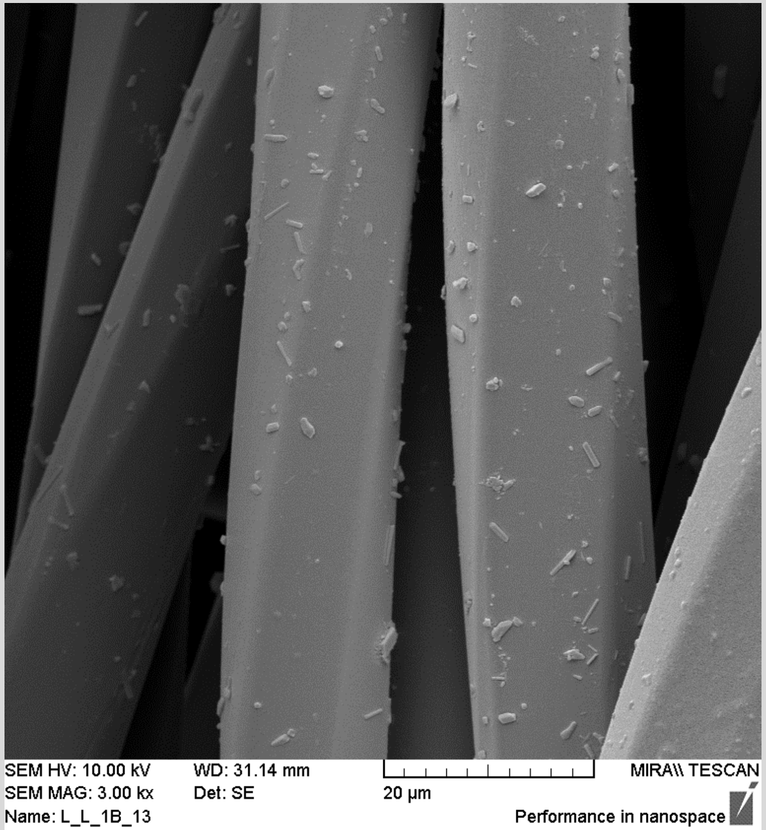
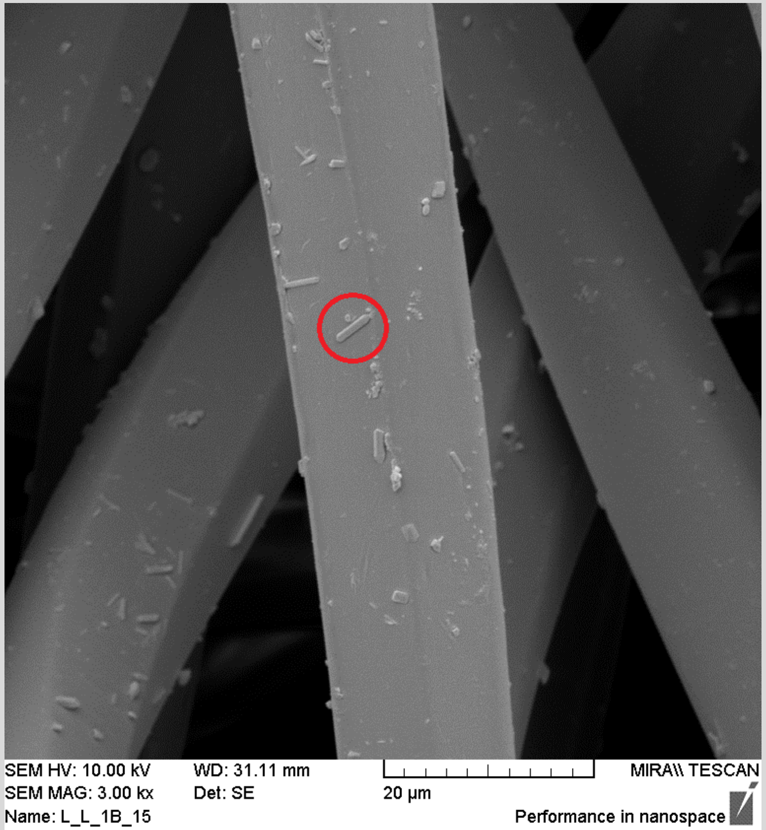
Under appropriate conditions of humidity and temperature, most medical textiles MADE OF natural fibers present an excellent basis for bacterial and fungal growth







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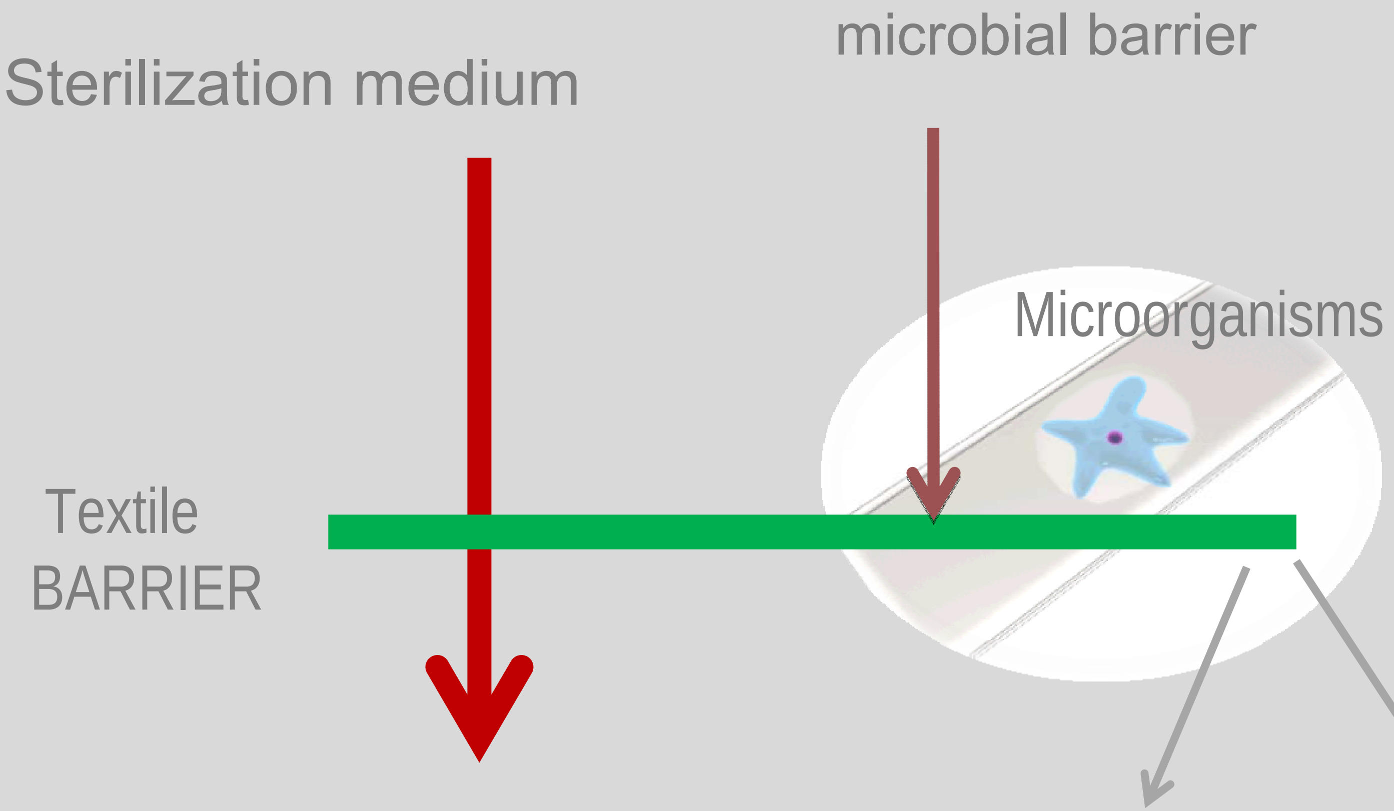
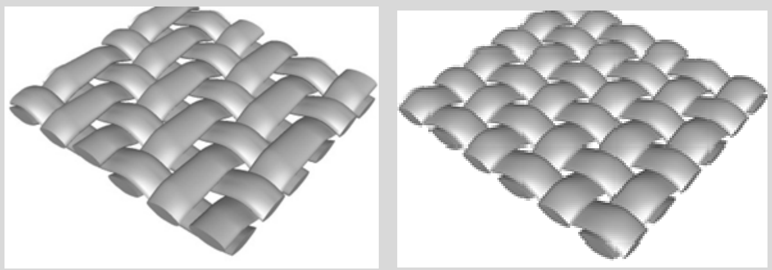
The requirements that must be met by the packaging materials together with the rules of handling are determined by

HRN EN ISO 11607-1:2010 [28].

WRAPPING MATERIAL

- easy packing
- effective sterilization
- reliable storage
- safe handling
- maintains sterility
- aseptic opening





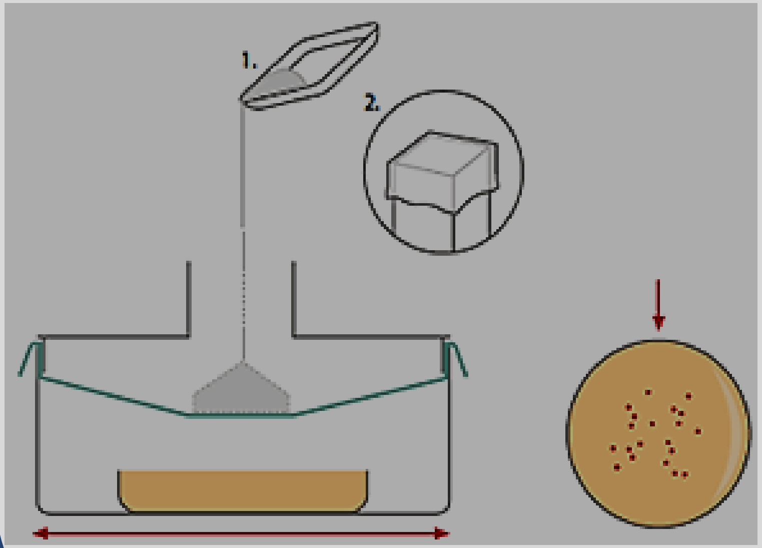
Requirements to provide microbial barrier

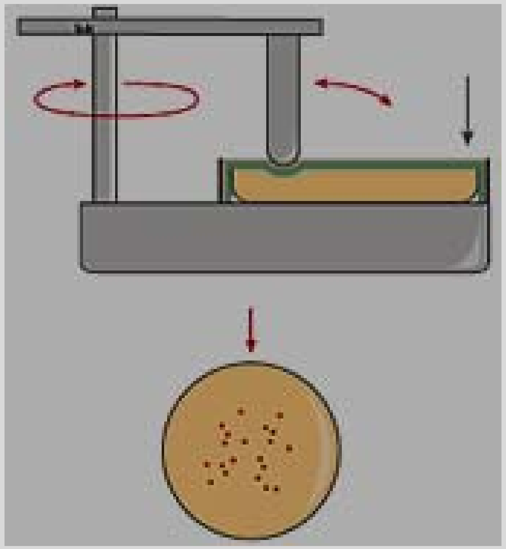
- Enable sterilization
- Provide a barrier to microorganisms
- Enable maintaining sterility

TEST OF RESISTANCE TO PENETRATION OF MICROORGANISMS IN DRY AND WET CONDITION FOR SURGICAL GOWNS

Dry condition
HRN EN ISO 22612:2008

Wet condition
HRN EN ISO 22610:2008





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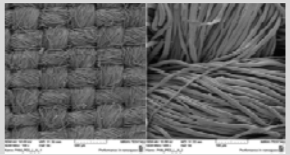
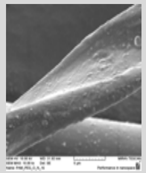
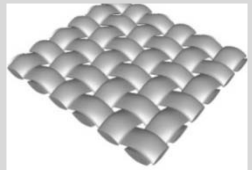
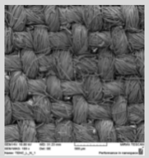
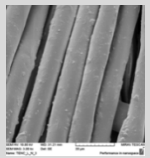
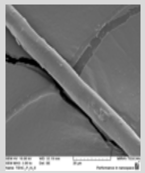
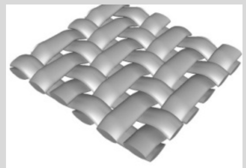
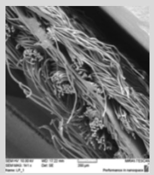
New medical textiles

Three types of textiles were selected for testing:

- Cotton/PES 50%/50%
- Tencel ® 100%
  (lyocell fibres with trade name)
- Three-layer textile laminate PES/PU/PES
  (known as operating, OP laminate)

All of declared and standardized quality

CHARACTERISTICS OF THE APPLIED TEXTILES

Samples	Raw material content	Weave
Sample I 	Polyester fiber/cotton 50%/50% 	Cloth 
Sample II  	Tencel® 	Twill 2/1 
Sample III  	Three-layer textile laminate PES/PU/PES: 1.weft right /right interlock knit, 2.PU membrane, 3.Warp's *charmeuse* knit (knitted back)	

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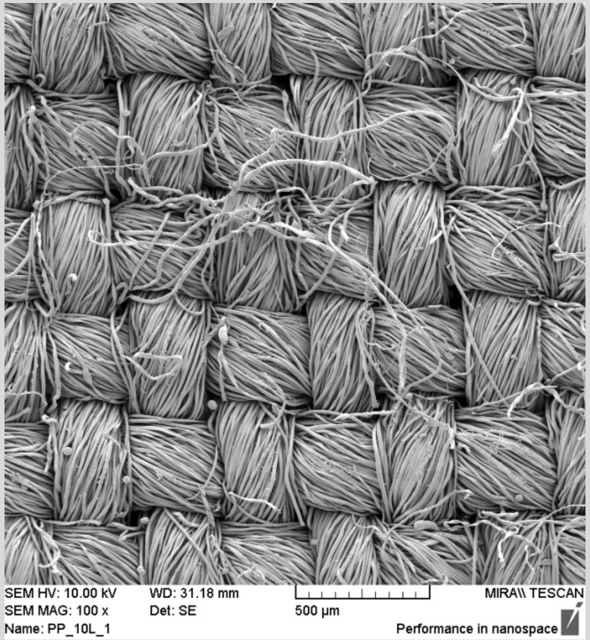
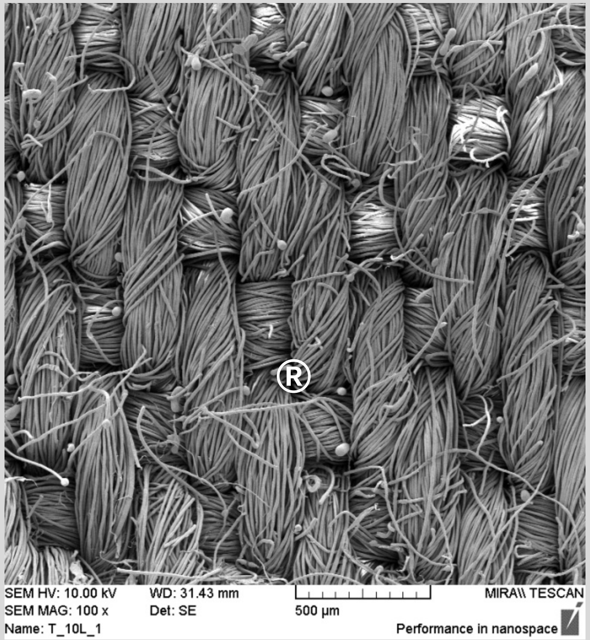
Differences in the structure and form

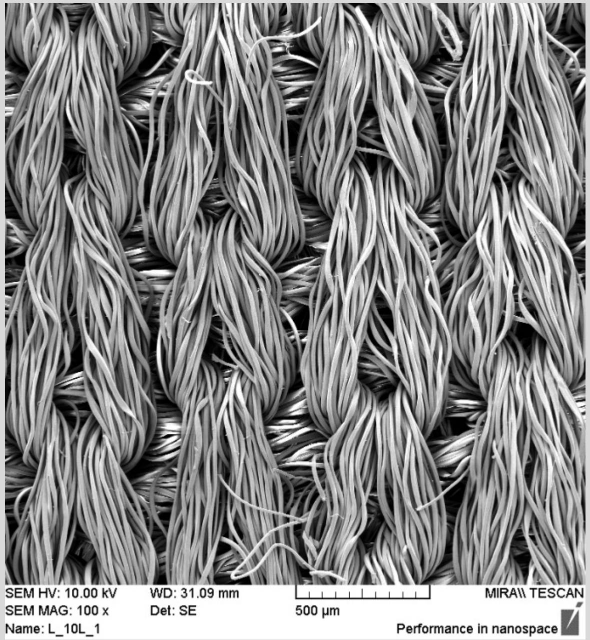
Cotton/PES



Tencel ®



OP Laminate



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All samples were tested after multiple washing and sterilization:

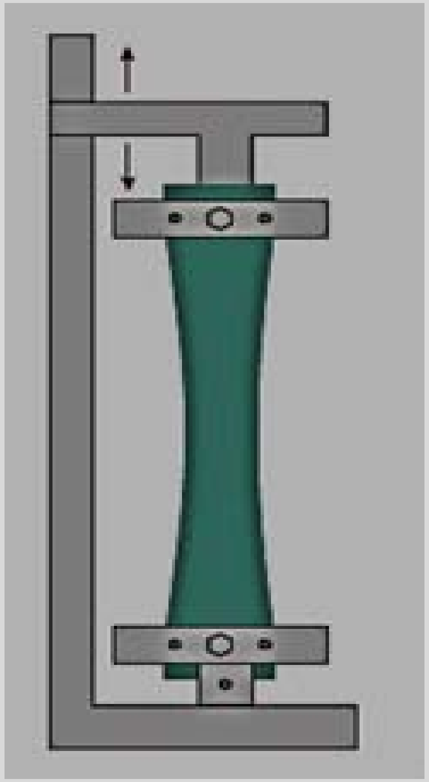
1. For mechanical influences (strength and elongation)
2. For air permeability
3. For permeability of microorganisms in dry conditions of extreme contamination
4. For permeability of microorganisms after storage in controlled storage conditions

Strength and elongation

Each sample was tested on a dynamometer for strength and elongation

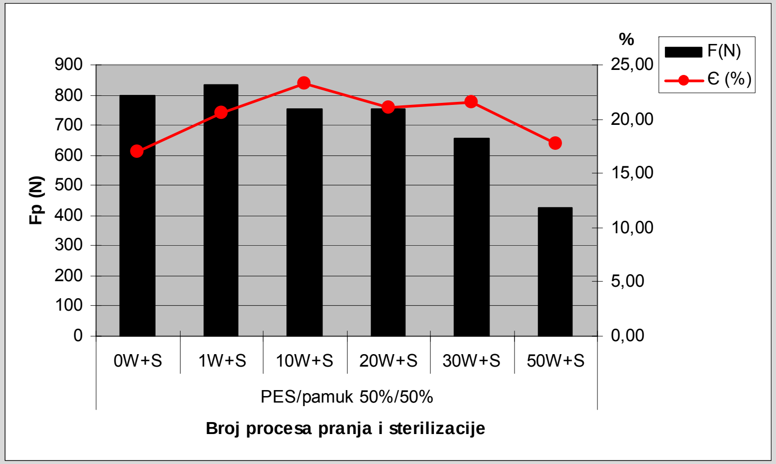
before washing and sterilization

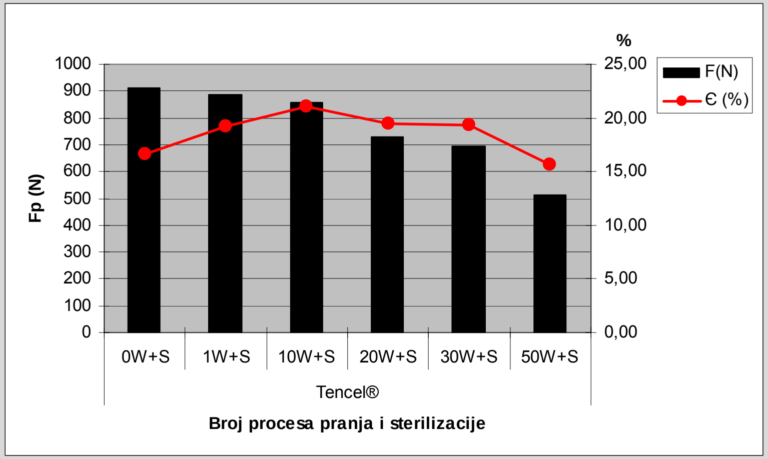
after the 1^{th}, 10^{th}, 20^{th}, 30^{th} and 50^{th} washing and sterilization

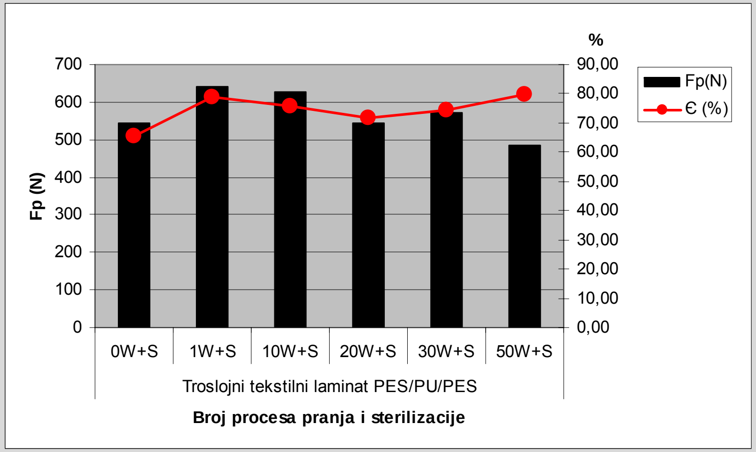


RESULTS 1 ,10, 20, 30, 50 W & S

Mechanical influences (strength and elongation)





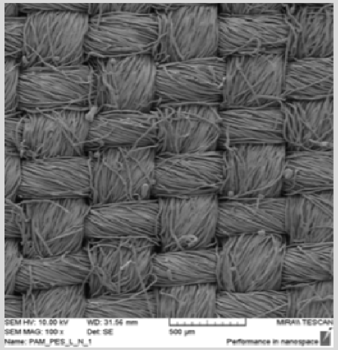
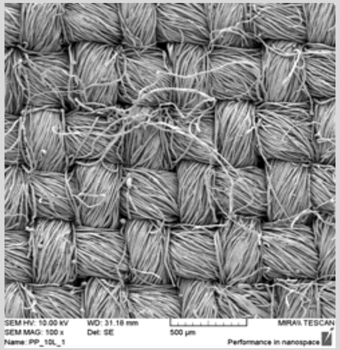


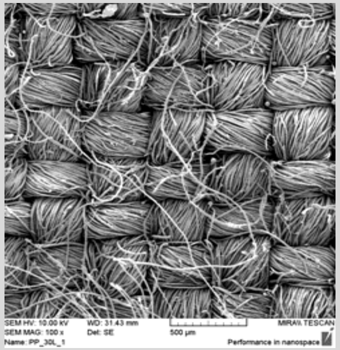
Air and Microorganisms Permeability

Textile material shrinks during washing and sterilization which results that the density of the fabric increases while the penetration of air and microorganisms decreases

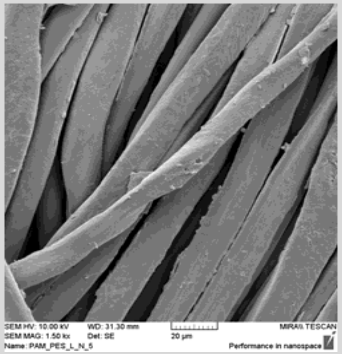
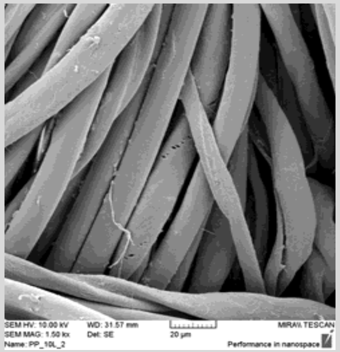
RESULTS

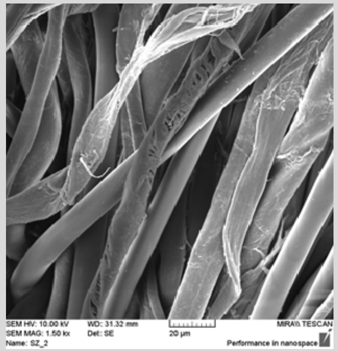
Changes in density of PES/cotton




0W+S | 10W+S | 20W+S | 30W+S | 50W+S

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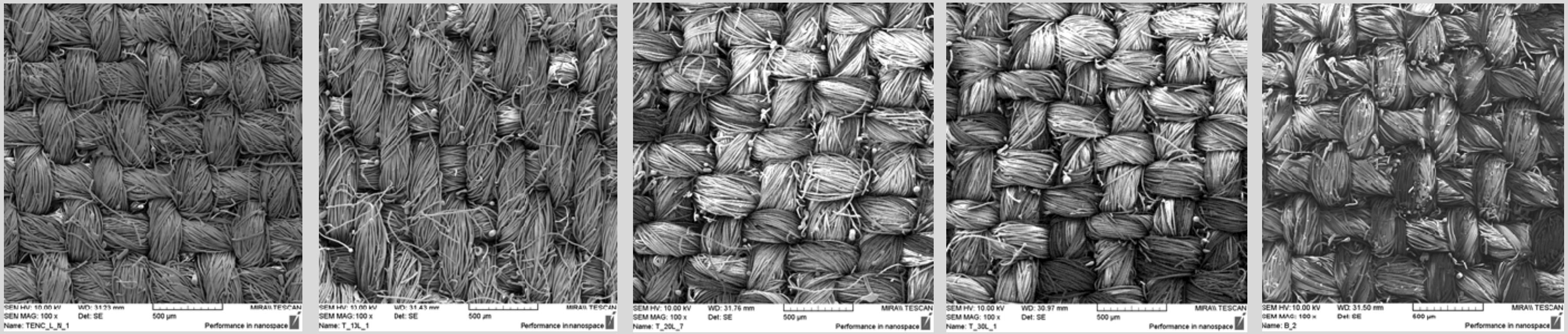
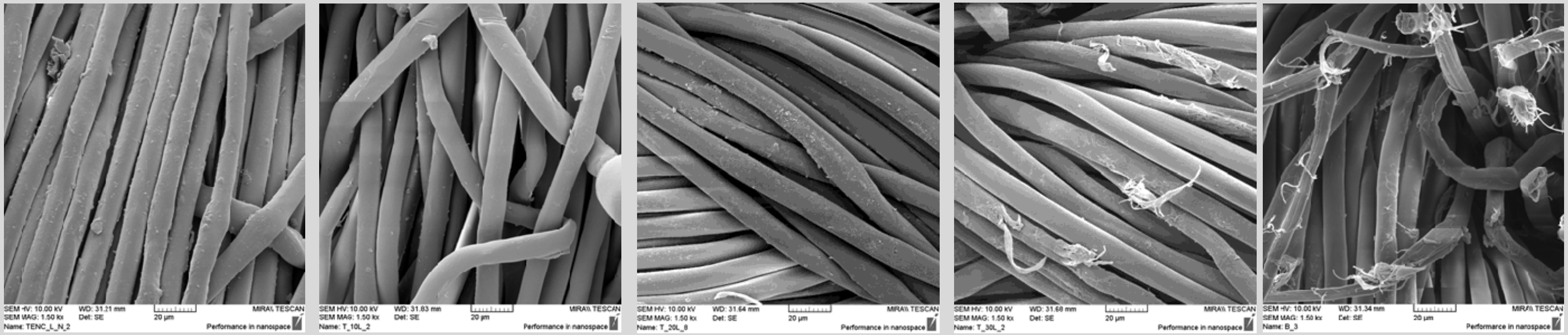
RESULTS

Changes in density of Tencel®



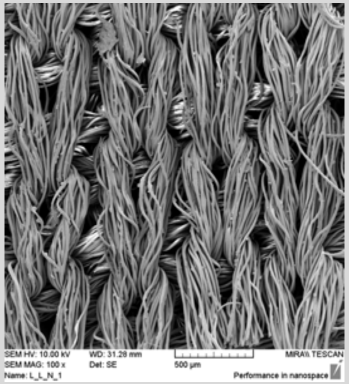
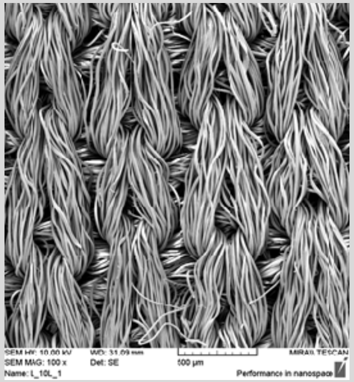
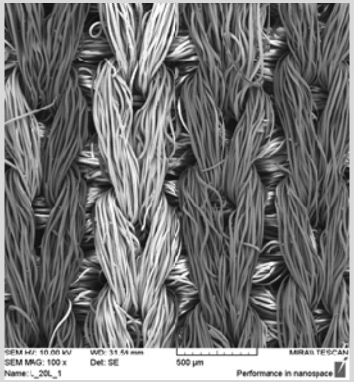
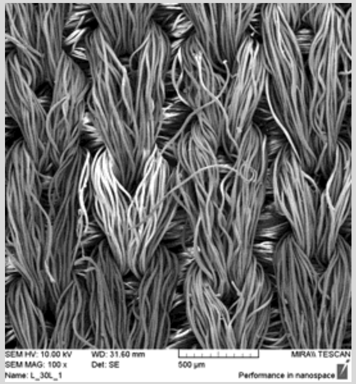
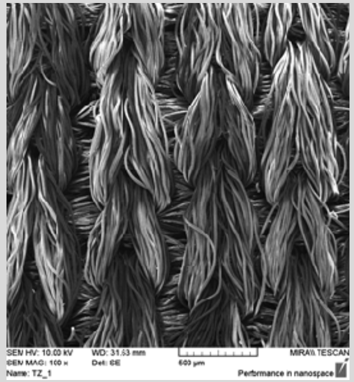
0W+S | 10W+S | 20W+S | 30W+S | 50W+S



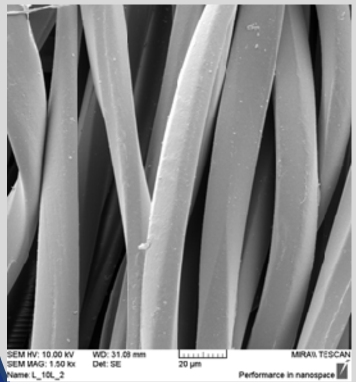
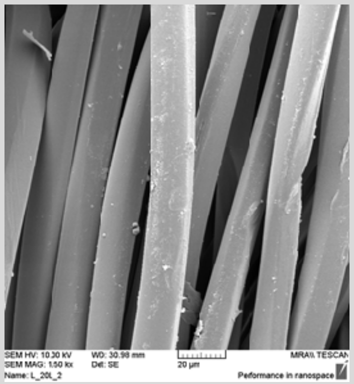
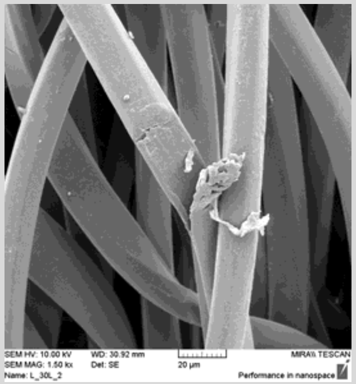
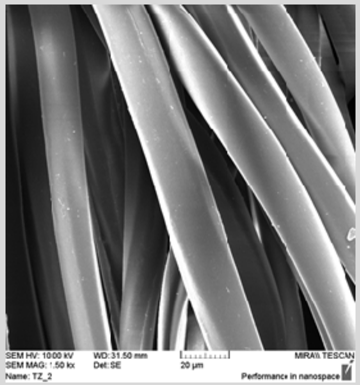
CROATIA

RESULTS

Changes in density of three-layer textile laminate PES/PU/PES

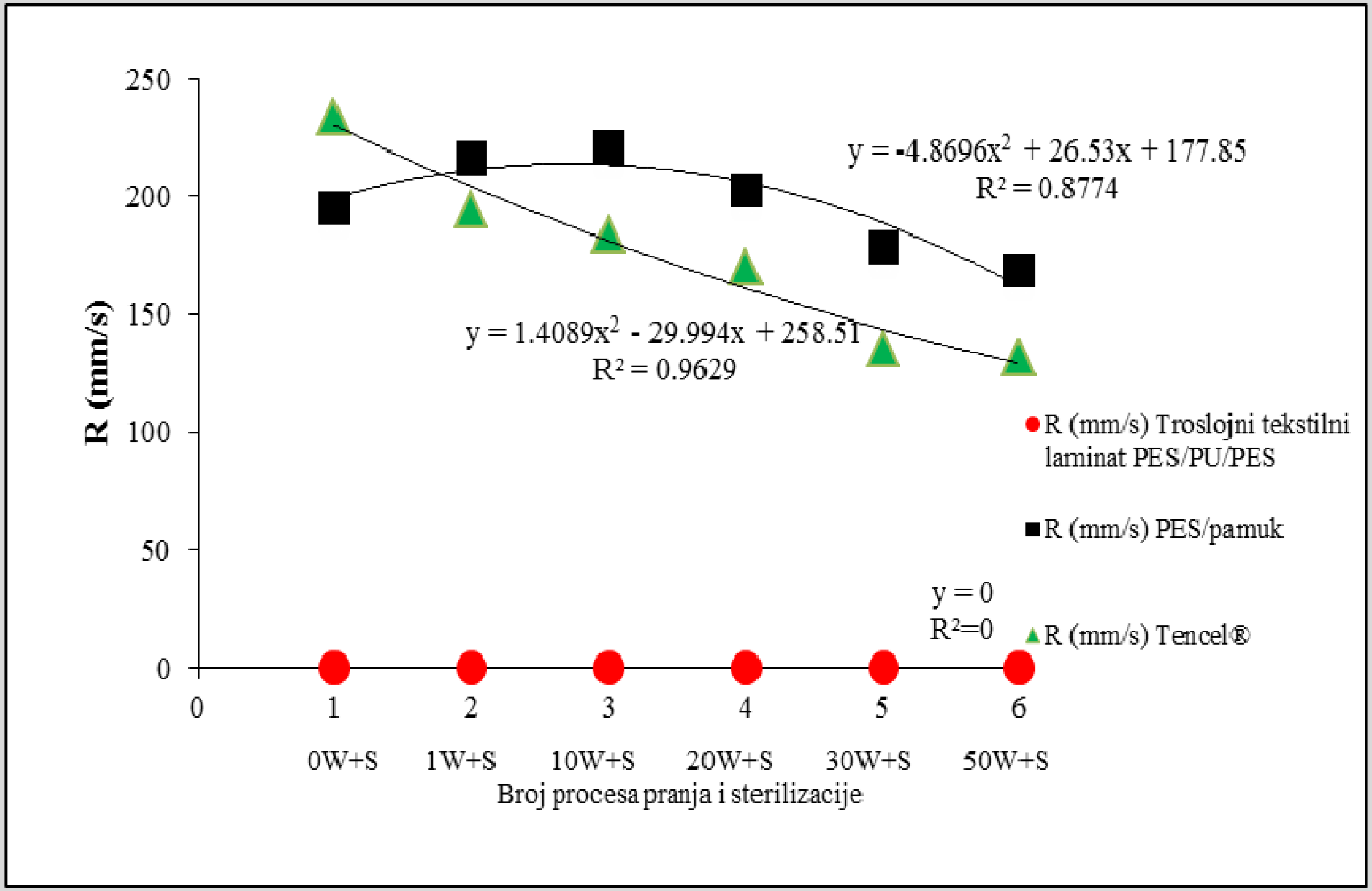






0W+S | 10W+S | 20W+S | 30W+S | 50W+S


RESULTS

2 AIR PERMEABILITY



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2

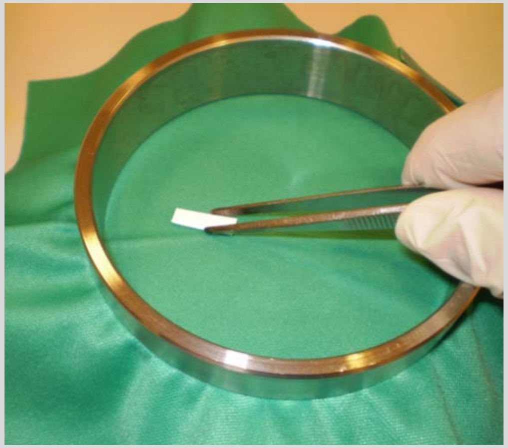
RESULTS

Air permeability

- Three-layer textile laminate is completely air impermeable due to its polyurethane membrane.
  However, it should be noted it is permeable to a sterilization medium which gives it a basic criteria for sterilization
- In the PES/cotton and Tencel® blend, it is visible that air permeability continuously decreases after washing and sterilization which can be explained with the fact that the textile shrinks during washing and sterilization

PERMEABILITY OF MICROORGANISMS

3. In dry conditions of extreme contamination



4. After storage in controlled storage conditions

RESEARCH PLAN

PES/Coton 50%/50%

Tencel®

Three-layer textile laminate PES/PU/PES

Process of washing and sterilization

Permeability test

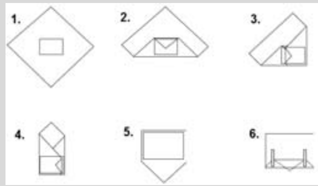
3 x 6 pcs
3 x 6 pcs
3 x 6 pcs
3 x 6 pcs
3 x 6 pcs

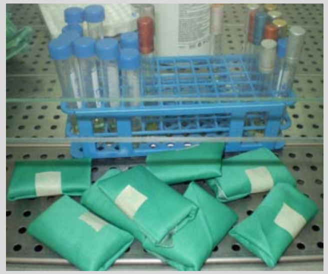
Σ 90 pcs

1W+S
10W+S
20W+S
30W+S
50W+S

Storage 1, 2 and 3 months

3 x 30 pcs
3 x 30 pcs
3 x 30 pcs
3 x 30 pcs

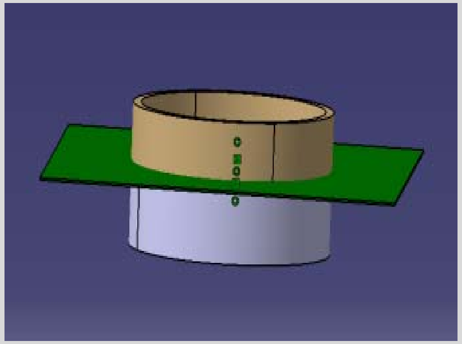


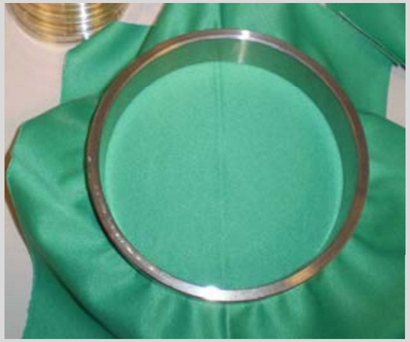


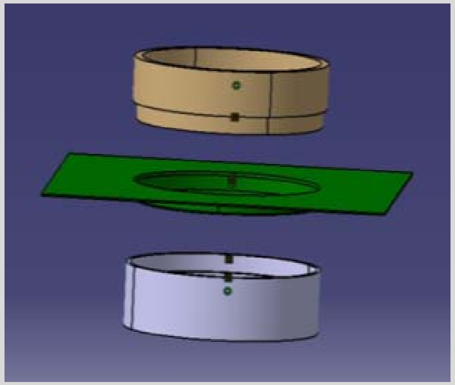
Σ 360 pcs

PERMEABILITY OF MICROORGANISMS

Constructed and executed device for testing microbial barrier efficiency of medical textiles





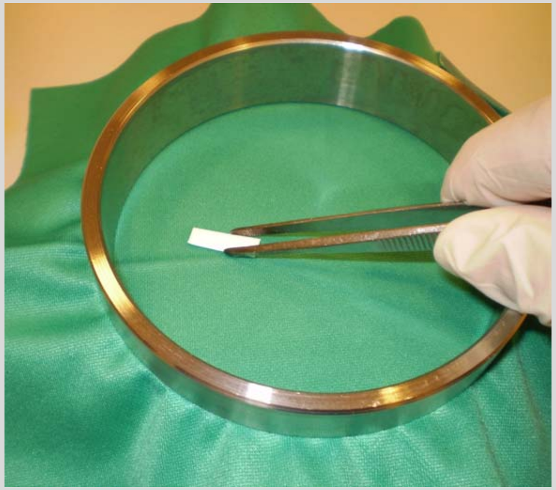


3

STERILIZATION

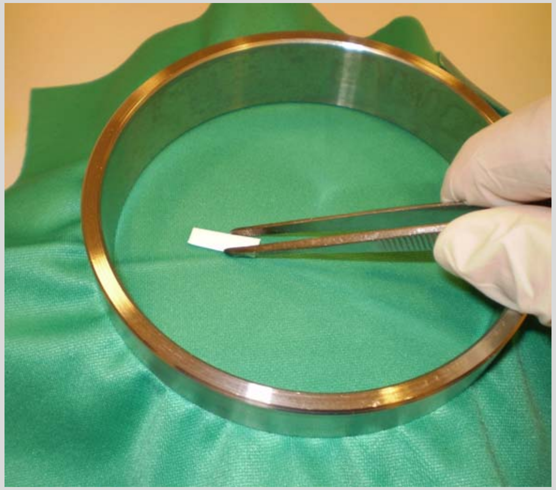
134 ^{o}C/5 min

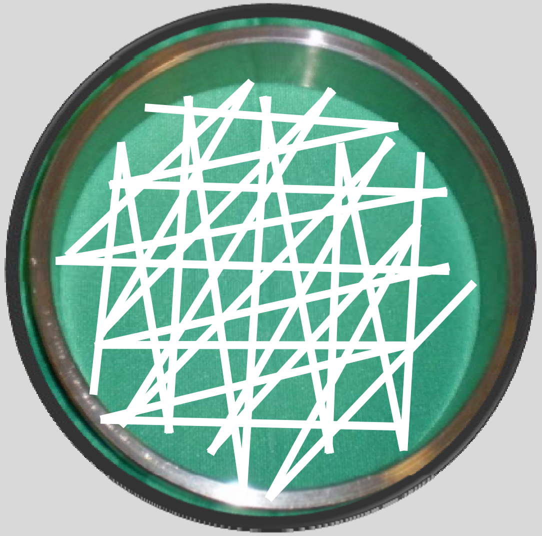
PERMEABILITY OF MICROORGANISMS IN DRY CONDITIONS OF EXTREME CONTAMINATION



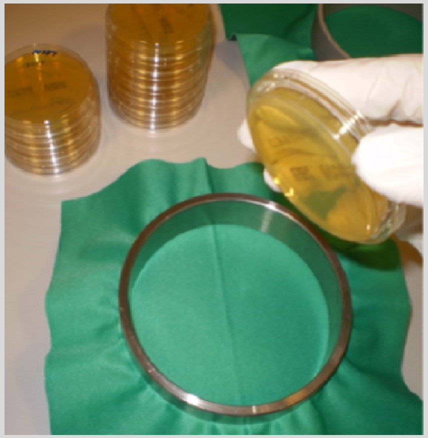
Bacterial endospores ***Geobacillus Stearotermophilus*** $\mathbf{10^5}$ and ***Bacillus Atrophaeus*** $\mathbf{10^6}$ were used

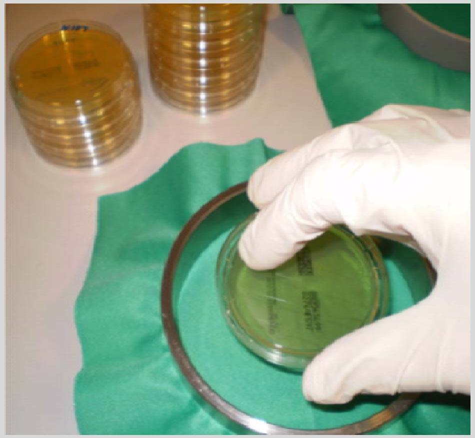
PERMEABILITY OF MICROORGANISMS



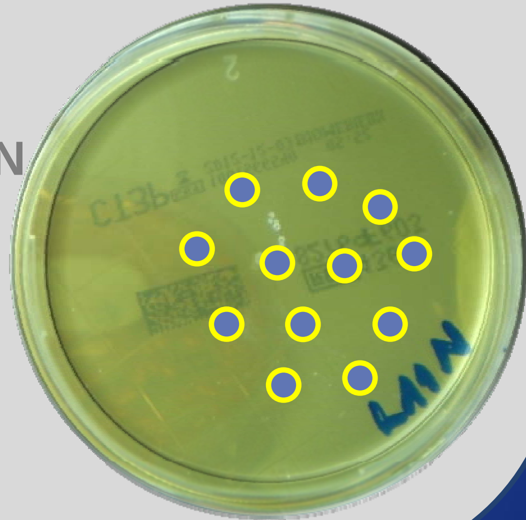


INCUBATION 24 h





INCUBATION
48 h + 35°C



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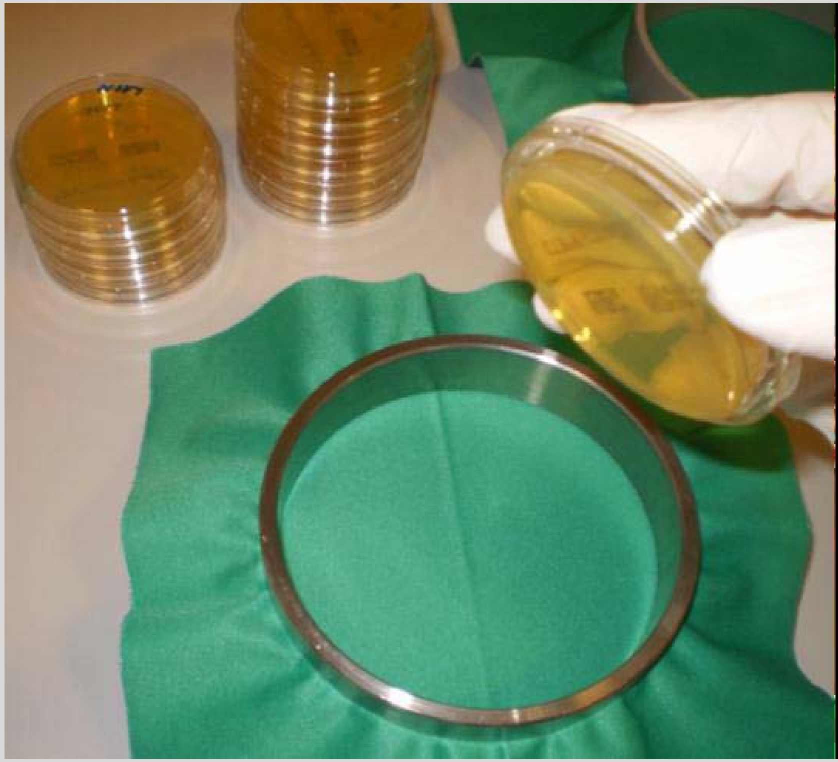
PERMEABILITY OF MICROORGANISMS



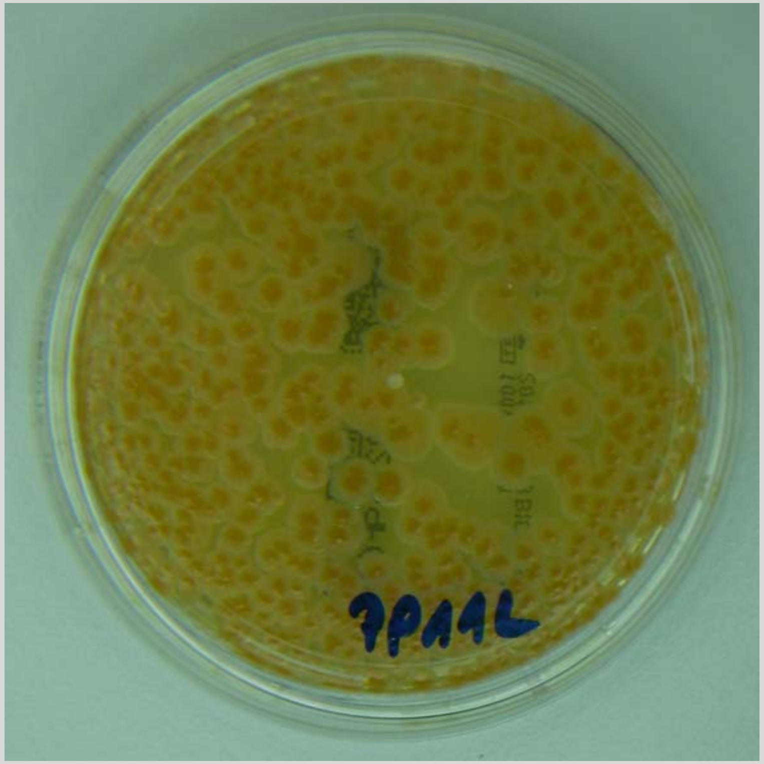
Lower side

Upper side

Process of collecting prints from the test samples, using CT3P agar plates

RESULTS

3 PERMEABILITY OF MICROORGANISMS



FRONT

BACK

PES/cotton

RESULTS

PERMEABILITY OF MICROORGANISMS

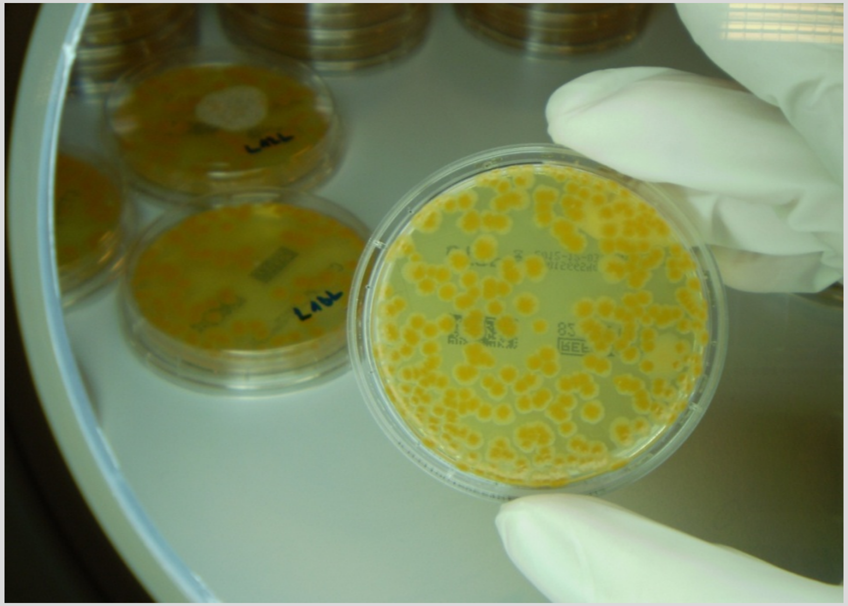
FRONT

BACK

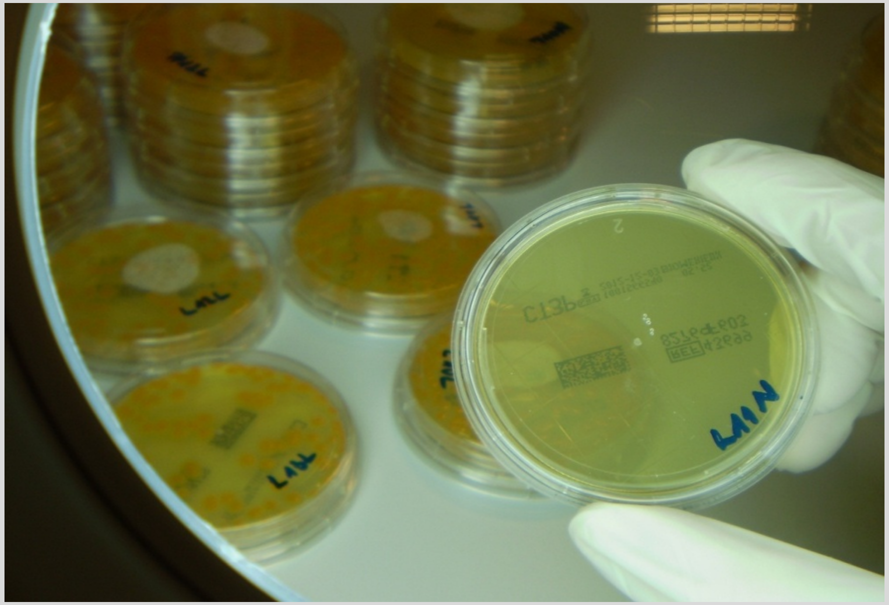
Tencel®

RESULTS

3 PERMEABILITY OF MICROORGANISMS



FRONT



BACK

Three-layer textile laminate

PES/PU/PES

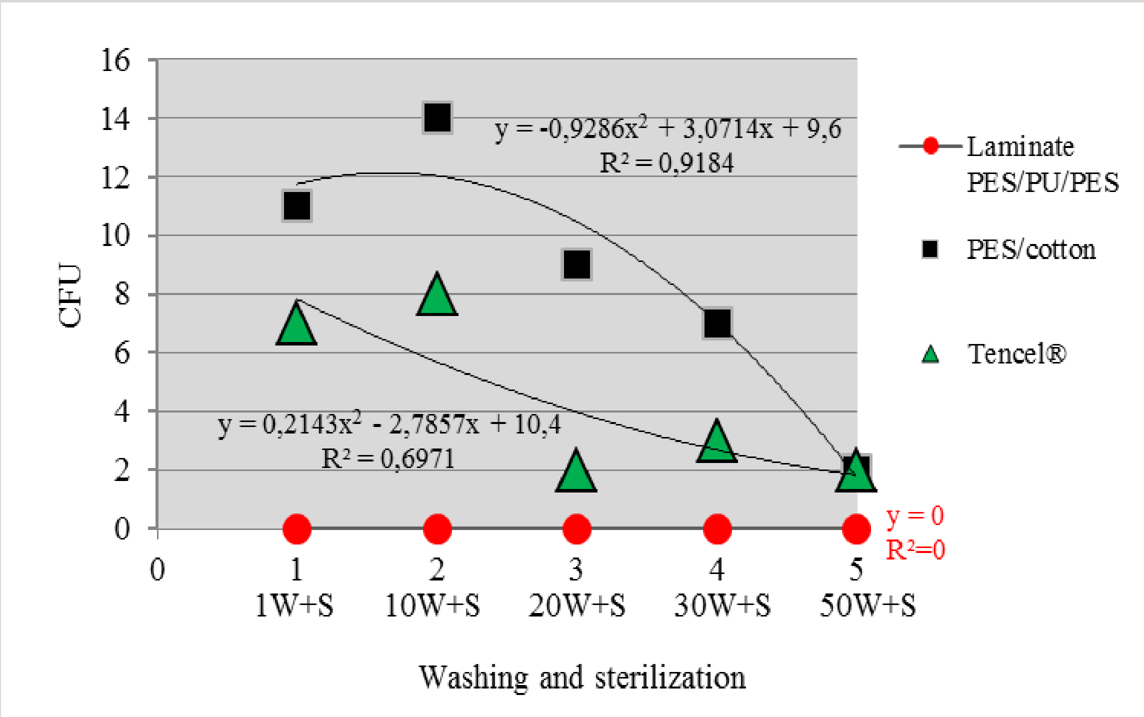
RESULTS

PERMEABILITY OF MICROORGANISMS

Samples	No. of washing and sterilization processses	CFU on the front of the taxtile	CFU on the back of the taxtile	Front - back ration CFU
Samples I PES/cotton 50%/50%	1 W + S	356	11	32:1
	10 W + S	275	14	20:1
	20 W + S	318	9	35:1
	30 W + S	286	7	41:1
	50 W ‘S	396	2	198:1
Samples II 100% Tencel®	1 W + S	419	7	60:1
	10 W + S	359	8	45:1
	20 W + S	294	2	147:1
	30 W + S	182	3	60:1
	50 W + S	341	2	170:1
Samples III Three-layer textile laminate PES/PU/PES	1 W + S	155	0	-
	10 W + S	167	0	-
	20 W + S	175	0	-
	30 W + S	132	0	-
	50 W + S	464	0	-

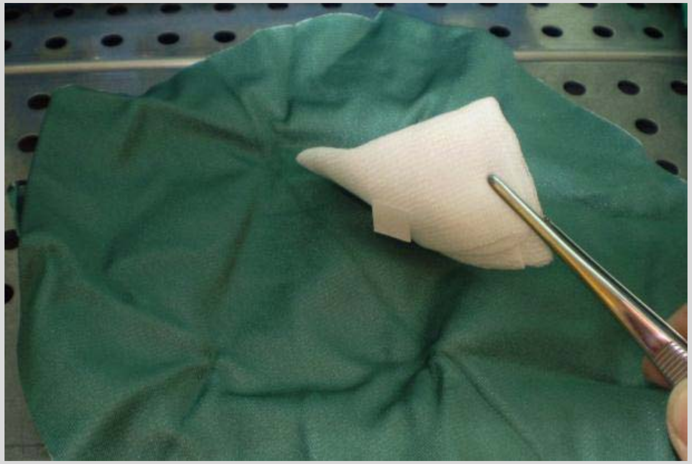
RESULTS

PERMEABILITY OF MICROORGANISMS



Regression analysis of how washing and sterilization affects microbial barrier permeability in medical textiles

PERMEABILITY OF MICROORGANISMS IN CONTROLLED STORAGE CONDITIONS



PERMEABILITY OF MICROORGANISMS IN CONTROLLED STORAGE CONDITIONS

Microclimate conditions

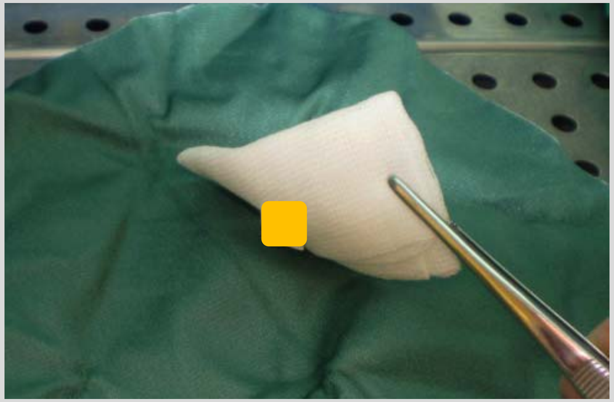
Temperature: 15 – 30 °C

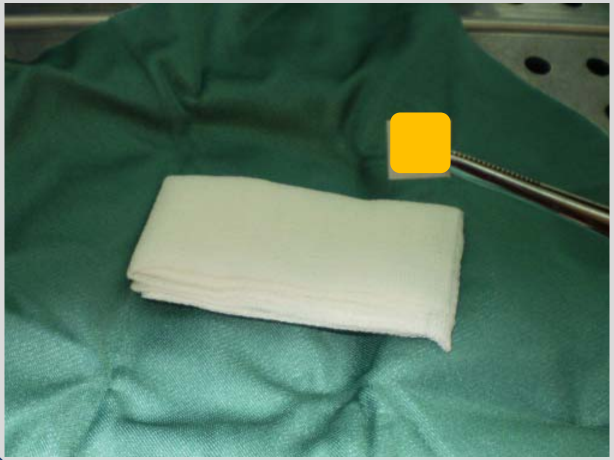
Relative humidity : 30 – 60%

The material to be stored on shelves must be located:

- 25 cm from the floor,
- 45 cm from the ceiling
- 5 cm from the walls

PERMEABILITY OF MICROORGANISMS IN CONTROLLED STORAGE CONDITIONS





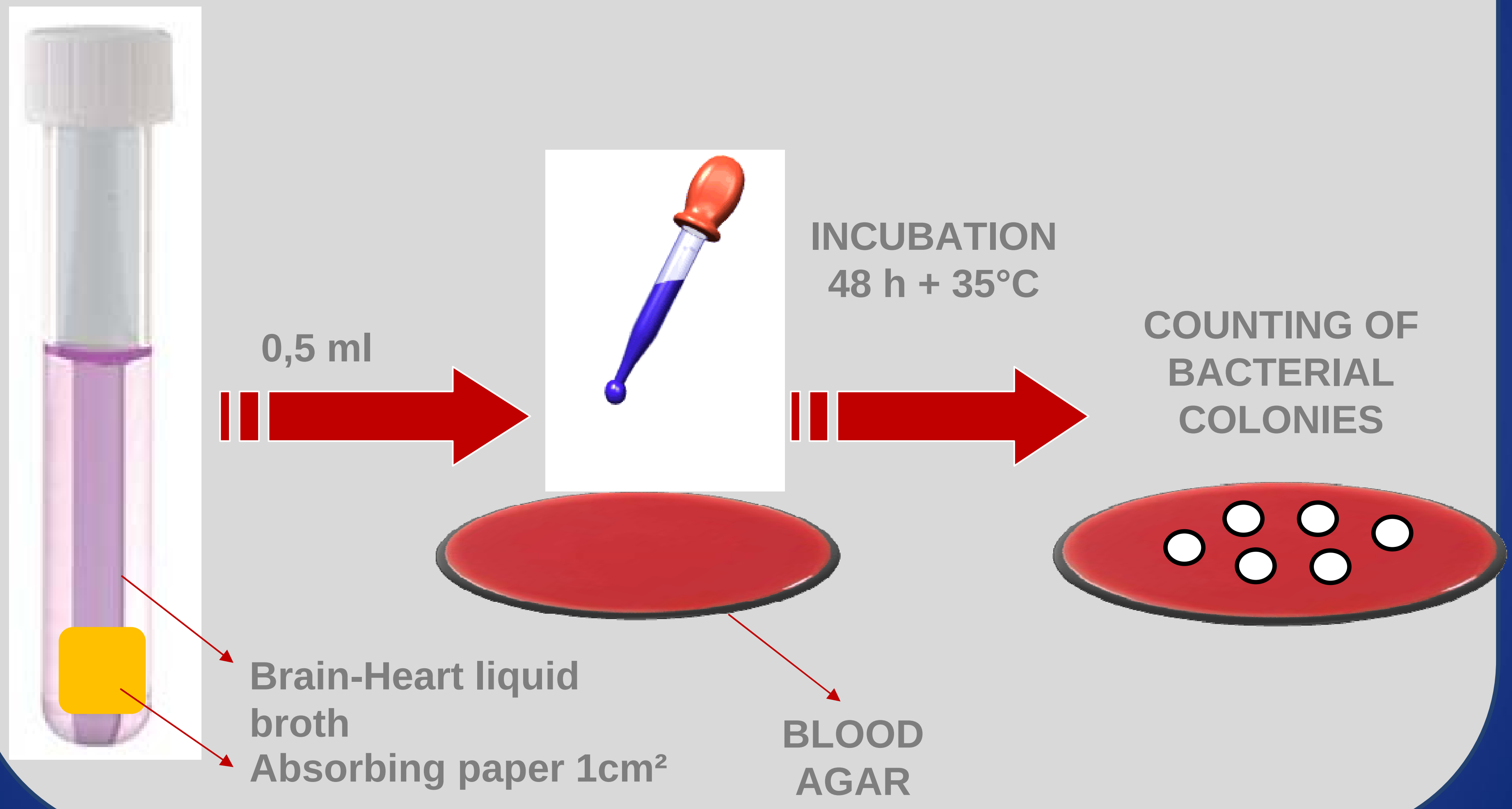
INCUBATION
48 h + 35°C

CLARITY OF THE BROTH

Brain-Heart liquid broth

Absorbing paper 1cm²

Permeability of microorganisms in controlled storage conditions



RESULTS

4 PERMEABILITY OF MICROORGANISMS IN CONTROLLED STORAGE CONDITIONS

Samples	Number of washing and sterilization procedures	Storage time		
		1 month	2 months	3 months
Samples I PES/cotton 50%/50%	10 washings & sterilizations	NMG	NMG	NGM
	20 washings & sterilizations	NMG	NMG	NMG
	30 washings & sterilizations	NMG	NMG	NMG
	50 washings & sterilizations	NMG	NMG	NMG
Samples II 100% Tencel®	10 washings & sterilizations	NMG	NMG	NMG
	20 washings & sterilizations	NMG	NMG	NMG
	30 washings & sterilizations	NMG	NMG	NMG
	50 washings & sterilizations	NMG	NMG	NMG
Samples III Three-layer textile laminate PES/PU/PES	10 washings & sterilizations	NMG	NMG	NMG
	20 washings & sterilizations	NMG	NMG	NMG
	30 washings & sterilizations	NMG	NMG	NMG
	50 washings & sterilizations	NMG	NMG	NMG

3 TYPES OF TEXTILES (cotton/PES, Tencel®, PES/PU/PES)

1	Strenght	Tencel ®	↑	Cotton/PES	↓
	Elongation	PES/PU/PES	↑	Tencel ®	↓
2	Air permeability	Tencel ®	↑	PES/PU/PES	0
3	Permeability for microorganisms	Cotton/PES	↑	PES/PU/PES	0
4	Permeability for microorganisms after storage				0

BETORE THE CONCLUSION

It is evident that Tencel is the most resistant one to tearing, while OP laminate recorded the highest level of elongation.

The most permeable to air is Tencel, while the three-layer laminate is completely impermeable to air and microorganisms. The worst characteristics showed a cotton / PES.

Nevertheless, none of the tested textile material is not permeable for microorganisms after storage of three months.

Electronic microscope recorded damages on membranes of the OP laminate after 50 washings and sterilization, which were not present after 30 procedures.

CONCLUSION

The tested cellulosic textiles and three-layer textile laminate, even in one layer can be used as wrapping material for sterilization under conditions described in the research and provide a microbial barrier after sterilization.

Microbial barrier is safe against contamination during the test period of 3 months and after 50 washing and 50 sterilization procedures.

Thank you for your attention

Have a nice rest of the day

CROATIA