27 HSKIKI

VELI LOŠINJ
2021

27th CROATIAN MEETING OF CHEMISTS AND CHEMICAL ENGINEERS

WITH INTERNATIONAL PARTICIPATION • 5th SYMPOSIUM "VLADIMIR PRELOG"

5-8 OCTOBER 2021 • VELI LOŠINJ, HOTEL PUNTA, CROATIA

BOOK OF ABSTRACTS

27th Croatian Meeting of Chemists and Chemical Engineers

with international participation

5th Symposium Vladimir Prelog

5 – 8 October 2021

Veli Lošinj, Vitality Hotel Punta, Croatia

BOOK OF ABSTRACTS

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Croatian Chemical Society

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PUBLISHED BY

Croatian Chemical Society

EDITORS

Dean Marković, Ernest Meštrović,
Danijel Namjesnik, Vesna Tomašić

DESIGN & LAYOUT

Danijel Namjesnik & Andrea Usenik

ISSN: 2757-0754 (Online)

VENUE

Veli Lošinj, Vitality Hotel Punta, Croatia

https://www.losinj-hotels.com/hr/hoteli-i-vile/hotel-punta/

Zagreb, 2021.

USAGE DURABILITY OF KNITWEAR MADE OF MAN-MADE ARTIFICIAL FIBERS FROM CELLULOSE

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Cellulose is a raw material with a wide variety of uses in the chemical industry for producing man-made textile fibers. Conventional regenerated cellulosic fibers are generally produced by the indirect viscose process (viscose fibers), while high-tenacity modal fibers are produced using a modification of the basic procedure. Viscose production is based on deriving cellulose with carbon bisulphide. Lyocell fibers are produced by a more environmentally friendly procedure from a solution of non-derivative cellulose in a solvent spinning process, where cellulose is dissolved directly in the organic solvent N-methylmorpholine-N-oxide, without the formation of derivatives.[1] Different production processes cause differences in the structure of the fibers despite the same chemical composition.

Knitwear that are worn in direct contact with the skin, are often made of viscose, modal or lyocell fibers, that provide silky touch, high hydrophilicity and exceptional comfort. They were usually knitted with spun yarns produced by conventional ring spinning system. More recently unconventional rotor and air-jet spun yarns have been appeared, resulting with yarns of different structure and properties.[2] Therefore, in this paper circular weft double jersey knitted fabrics for lingerie made od single ring, rotor and air-jet spun yarns, all made of bright staple viscose, modal and lyocell fibers of the same linear density were evaluated. Raw and finished knitwear usage durability were compared by determination of moisture regain, breaking strength and breaking elongation, dimensional change after laundering, air permeability, propensity to surface piling and abrasion resistance, all according to the standardized test methods.

Acknowledgments. This paper is funding by the Croatian science foundation within the Project IP-2016-06-5278.

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[2] Z. Skenderi, et al., *Tekstilec* **2019**, *62*, 2019, 42-53.

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Introduction

Cellulose is a raw material with a wide variety of uses in the chemical industry for producing man-made textile fibers. Conventional regenerated cellulosic fibers are generally produced by the indirect viscose process (viscose fibers), while high-tenacity modal fibers are produced using a modification of the basic procedure. Viscose production is based on deriving cellulose with carbon bisulphide. Lyocell fibers are produced by a more environmentally friendly procedure from a solution of non-derivative cellulose in a solvent spinning process, where cellulose is dissolved directly in the organic solvent N-methylmorpholine-N-oxide, without the formation of derivatives. Different production processes cause differences in the structure of the fibers despite the same chemical composition.

a) b) c)

Figure 1. Microscopic images of longitudinal view and cross section of: a) viscose, b) lyocell and c) modal fibers

Knitwear

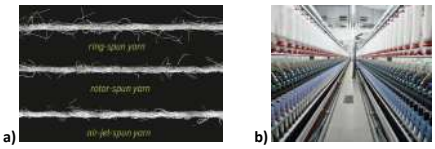
Knitwear and lingerie, that are worn in direct contact with the skin, are often made of man-made artificial fibers from cellulose (eg. viscose, modal or lyocell) which provide silky touch, high hydrophilicity and exceptional contact comfort.

a) b) c)

Figure 2. Knitwear products: a) T-shirts, b) turtleneck and c) underwear

Yarns

Knitwear were usually knitted with spun yarns produced by conventional ring spinning system. More recently unconventional rotor and air-jet spun yarns have appeared, resulting with yarns of different structure and properties. Therefore, in this paper circular weft double jersey knitted fabrics for lingerie made of single ring (P), rotor (R) and air-jet (A) spun yarns of same linear density (20 tex), all made of bright staple viscose (CV), modal (MD) and lyocell (CLY) fibers of linear density of 1.3 dtex and length of 38/40 mm were evaluated.



a) b)

Figure 3. Structure of ring, rotor and air-jet spun yarns a), spinning in the production plant b)

Materials

Knitted fabrics samples were made using circular double-bed knitting machine with E17 gauge and needle bed diameter of 200 mm (8 inches). All dry relaxed knitted fabrics (raw samples) were finished in the production plant: firstly washed thoroughly at 40°C, further with addition of stabilization agent at 95°C, then rinsed, cold washed with neutralization and softening; and dried at 150°C with a passage rate of 0.15 m/s.

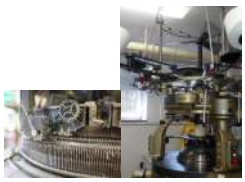


Figure 4. Circular double bed knitting machine

Methods

After the conditioning (at temperature: 20 ± 2°C and air relative humidity: 65 ± 4%), along with basic characterization, row and finished knitted fabrics usage durability were compared by determination of:

- moisture regain (ASTM D 2654-89a),
- breaking strength and breaking elongation (EN ISO 13934-1) using the strip method (Fig. 5 a),
- dimensional change after washing and drying in tubular form (EN ISO 6330, procedure 4M and A),
- permeability of fabrics to air (EN ISO 9237) (Fig. 5 b),
- propensity to surface pilling (EN ISO 12945-2) and abrasion resistance (EN ISO 12947-2) by determination of specimen breakdown using the Martindale abrasion tester (Fig. 5 c).

Figure 5. Testing instruments:
a) Strength Tester b) Air permeability Tester c) Martindale Abrasion and Pilling Tester

Results and discussion

Air permeability and the breaking strength of finished knitted fabrics are changed primarily because of their dimensional and structural changes. After laundering, the overall deformability is lower and dimensional stability is improved in all finished fabrics. Lower propensity to surface piling was observed in knitwear made of air-jet spun yarns because of their lower hairiness and specific structure. Knitwear samples made of ring spun yarns, that are highly twisted on the surface, show better abrasion resistance.

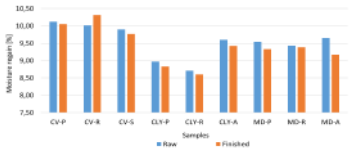


Figure 6. Moisture regain of raw and finished knits

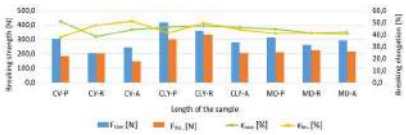


Figure 7. Breaking strength and elongation of raw and finished knits cut from the length of the sample

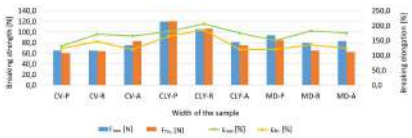


Figure 7.1. Breaking strength and elongation of raw and finished knits cut from the width of the sample

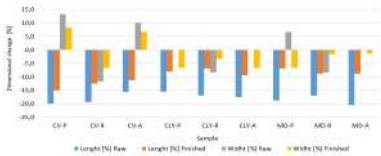


Figure 8. Dimensional changes in the direction of the length and width of raw and finished knits after one washing and drying cycle

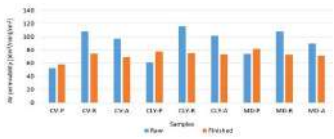
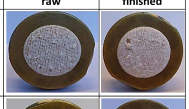
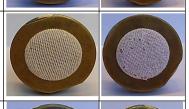
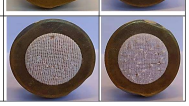


Figure 9. Air permeability of raw and finished knits

Table 1. Abrasion resistance of raw and finished lyocell knits – visual determination of specimen breakdown

Knitted fabrics sample	Abrasion resistance (endpoint)	
	raw	finished
Ring CLY		
Rotor CLY		
Air-jet CLY		

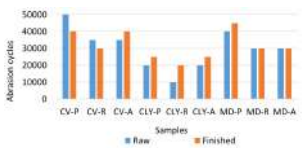


Figure 10. Abrasion resistance of raw and finished knits – visual determination of specimen breakdown

Table 2. Appearance of raw and finished knits made of lyocell fiber yarns after 7000 pilling rubs

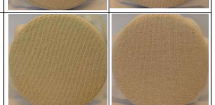
Knitted fabrics sample	7000 pilling rubs	
	raw	finished
Ring CLY		
Rotor CLY		
Air-jet CLY		

Table 3. Visually assessed propensity to surface pilling of raw and finished knits

Samples	Raw	Finished
CV-P	2/3	3
CV-R	3/4	3
CV-A	2	2
CLY-P	2/3	2/3
CLY-R	3	2/3
CLY-A	3/4	3
MD-P	2	1/2
MD-R	3	2
MD-A	3/4	3

Conclusion

On the basis of the results obtained, it was concluded that for selection of the spun yarns for knitted fabrics production is necessary to consider their structure and the characteristics, but also, the fact that yarn spinning technique, as well as the process of knitted fabric finishing significantly influence knitwear usage quality.

ACKNOWLEDGMENT

This paper is funding by the Croatian science foundation within the Project IP-2016-06-5278 (Comfort and antimicrobial properties of textiles and footwear, principal investigator: Prof. Zenun Skenderi, PhD).