

Quality assessment of circular weft knitted fabrics for female lingerie

Antoneta Tomljenović, Zlatko Vrljičak, Zenun Skenderi, Juro ivičnjak, Mateja Vlanić, Ivana Bonić

University of Zagreb Faculty of Textile Technology, Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia



Sveučilište u Zagrebu

INTRODUCTION

The number of European standards related to testing and characterization of knitted fabrics are low. Therefore, it is necessary to expand the research in the field of their quality assessment. Knitwear that are worn in direct contact with the skin, except of cotton, are often made of man-made artificial fibres from cellulose (eg. viscose, modal or lyocell) which provide silky touch, better hydrophilicity and exceptional contact comfort. Knitting for female lingerie were usually made of single cotton spun yarns produced by conventional ring spinning system. More recently in application were also spun yarns made by unconventional SiroSpun® ring, rotor and air-jet spinning systems. Different spinning systems provide spun yarns of different structure and properties.

In this paper four different weft double jersey knitted fabrics made of standard single cotton ring spun yarn; viscose single ring and rotor spun yarns, and SiroSpun® ring two-play yarn of the same linear density were analysed. The quality of raw and finished knitted fabrics were evaluated and their applicability assessed for the intended purpose. Along with the basic characterization of yarns, the testing of mass per unit area, thickness and number of wales and courses per unit length of knitted fabrics were carried out. Knitwear usage quality were analysed by determination of breaking strength and elongation, dimensional change and spirality after laundering, their propensity to surface pilling and abrasion resistance, all according to the standardized test methods.

MATERIALS AND METHODS

Four different yarns of the same linear density (20 tex) and twist number chosen for the knitting purpose were used: standard single cotton ring spun yarn as a reference; single ring and rotor spun yarns, and SiroSpun® ring two-play yarn, all made of bright staple viscose fibres of linear density of 1.3 dtex and length of 38/40 mm.

Properties of yarns used for knitting

Yarn/fibre type	Linear density (tex)	Breaking strength (cN)	Breaking elongation (%)	Tenacity (cN/tex)
1 ring cotton	20	302	3.7	15.1
2 ring viscose	20	312	13.8	15.6
3 rotor viscose	20	268	10.5	13.4
4 SiroSpun® viscose	20	394	13.6	19.7

Four samples of weft double jersey knitted fabrics were made using circular double-bed knitting machine with E17 gauge and needle bed diameter of 200 mm (8 inches). All knitted fabrics were finished in the production plant.

Characterisation of raw and finished knitted fabrics

Knitwear sample	Mas per unit area (g/m ²)	Thickness (mm)	Number of wales/cm	Number of courses/cm
1 Ring cotton/raw	167	0.64	21.5	12.5
1 Ring cotton/finished	177	0.66	21	13
2 Ring viscose/raw	170	0.61	22	12.5
2 Ring viscose/finished	146	0.42	21	12.5
3 Rotor viscose/raw	155	0.63	20	12.5
3 Rotor viscose/finished	175	0.54	20	13.5
4 SiroSpun® viscose/raw	188	0.65	21	13.5
4 SiroSpun® viscose/finished	152	0.42	20	12.5

Knitwear usage quality were analysed by determination of:

- **Breaking strength and breaking elongation** according to the EN ISO 13934-1 using the strip method.
- **Dimensional change** in the length and width directions of knitted fabric in tubular form, after one washing and drying cycle according to the procedure 4N (normal agitation during heating, washing and rinsing at 40 °C) of EN ISO 6330 with non-phosphate ECE reference detergent (without optical brightener) and open-air drying (procedure A, line dry).
- **Spirality** after one washing and drying cycle according to the ISO 16322-2 (procedure B).
- **Propensity to surface fuzzing and pilling** according to the Martindale method (EN ISO 12945-2). The knitted fabrics were rubbed with standardised wool abrasand and visually assessed by comparing with photographs (degrees of pilling: 1 - 5), after 125, 500, 1000, 2000, 5000 and 7000 rubbing cycle.
- **Abrasion resistance** by determination of specimen breakdown using the Martindale abrasion tester according to the EN ISO 12947-2. When using this method the specimens moves according to the Lissajous curve, and standard woven wool fabric is abraded over the entire surface.

CONCLUSION

On the basis of the results obtained, it was concluded that for selection of the spun yarns for female lingerie production is necessary to consider their price, composition and the characteristics, but also the fact that yarn spinning technique, as well as the process of knitting finishing significantly influence knitwear quality.

RESULTS AND DISCUSSION

Breaking strength and breaking elongation of raw and finished knitted fabrics

Knitwear sample	Breaking strength (N)		Breaking elongation (%)	
	in length	in width	in length	in width
1 Ring cotton/raw	415.7	121.2	50.573	142.367
1 Ring cotton/finished	373.8	103.6	56.513	183.284
2 Ring viscose/raw	304.8	65.1	50.867	131.264
2 Ring viscose/finished	182.7	60.6	37.743	121.263
3 Rotor viscose/raw	204.7	64.9	38.116	171.795
3 Rotor viscose/finished	203.0	63.7	47.752	146.117
4 SiroSpun® viscose/raw	317.7	76.9	50.718	135.899
4 SiroSpun® viscose/finished	194.4	73.3	37.288	126.958

Changes in dimensions in the length and width direction of raw and finished knitted fabrics after one washing and drying cycles

Knitwear sample	Dimensional stability in length (%)	Dimensional stability in width (%)
1 Ring cotton/raw	-18.8	-2.0
1 Ring cotton/finished	-5.9	+0.3
2 Ring viscose/raw	-17.9	+22.3
2 Ring viscose/finished	-12.6	+10.3
3 Rotor viscose/raw	-22.3	+6.3
3 Rotor viscose/finished	-11.1	-1.0
4 SiroSpun® viscose/raw	-12.6	+27.7
4 SiroSpun® viscose/finished	-10.9	+8.7

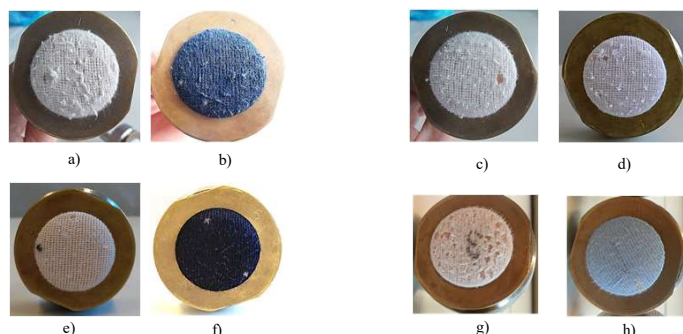
Visually assessed propensity to surface pilling of raw and finished knitted fabrics

Knitwear sample	Number of pilling rubs					
	125	500	1000	2000	5000	7000
1 Ring cotton/raw	4	4	3/4	3	2/3	2/3
1 Ring cotton/finished	4/5	4/5	4	3	2/3	2/3
2 Ring viscose/raw	4/5	4/5	4/5	3/4	3	2/3
2 Ring viscose/finished	4/5	4/5	4	3/4	3	3
3 Rotor viscose/raw	4/5	4/5	4/5	4/5	4	3/4
3 Rotor viscose/finished	5	5	4/5	4/5	4	3
4 SiroSpun® viscose/raw	4	3	3	3	2/3	2
4 SiroSpun® viscose/finished	4	3	3	3	2/3	2/3

Abrasion resistance of raw and finished knitted fabrics - determination of specimen breakdown

Knitwear sample	Number of rubs to reach endpoint
1 Ring cotton/raw	60 000
1 Ring cotton/finished	65 000
2 Ring viscose/raw	50 000
2 Ring viscose/finished	40 000
3 Rotor viscose/raw	35 000
3 Rotor viscose/finished	30 000
4 SiroSpun® viscose/raw	45 000
4 SiroSpun® viscose/finished	40 000

- After finishing the thickness of all viscose knitwear samples is reduced. Changing of mass per unit area additionally affects the dimensional change of knitwear.
- Breaking strength of knitwear is conditioned by breaking strength of the yarn used for knitting. In the length direction of all knitwear samples it has been found higher values of breaking strength and lower breaking elongation, and in the width direction the lower breaking strength and higher breaking elongation. After finishing the breaking strength of all knits in length direction is reduced.
- All raw knitted fabrics show high deformability after laundering (shrinkage in length direction and extension in width direction). Changes in dimensions are significantly reduced after finishing, especially for cotton samples.
- After laundering all the tested knitted samples do not show the tendency to spiral deformation.
- With increasing the number of abrasion cycles, in all knitwear samples increases the propensity to surface fuzzing and pilling. Best rated knitwear are those made of viscose rotor spun yarns. Knitwear samples made of cotton ring yarn show better abrasion resistance compared to knitwear samples made of viscose yarns. Unlike cotton knitted fabrics, in all tested viscose samples are reduced abrasion resistance after finishing. The knitted fabric samples made of viscose rotor yarns show the lowest abrasion resistance.



Comparative faces of test specimens at the end of the test: a) 1 Ring cotton/raw, b) 1 Ring cotton/finished, c) 2 Ring viscose/raw, d) 2 Ring viscose/finished, e) 3 Rotor viscose/raw, f) 3 Rotor viscose/finished, g) 4 SiroSpun® viscose/raw, h) 4 SiroSpun® viscose/finished

ACKNOWLEDGEMENT

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).