Industria Textilă

ISSN 1222–5347

1/2015

Revistă **cotată ISI** și inclusă în **Master Journal List** a Institutului pentru Știința Informării din Philadelphia – S.U.A., începând cu vol. 58, nr. 1/2007/
ISI rated *magazine, included in the* ***ISI Master Journal List*** *of the Institute of Science Information, Philadelphia, USA, starting with vol. 58, no. 1/2007*

Editată în 6 nr./an, indexată și recenzată în:
Edited in 6 issues per year, indexed and abstracted in:
Science Citation Index Expanded (SciSearch®), Materials Science Citation Index®, Journal Citation Reports/Science Edition, World Textile Abstracts, Chemical Abstracts, VINITI, Scopus, Toga FIZ technik ProQuest Central

Recunoscută în România, în domeniul Științelor inginerești, de către
Consiliul Național al Cercetării Științifice din Învățământul Superior
(C.N.C.S.I.S.), în **grupa A** /
Aknowledged in Romania, in the engineering sciences domain,
by the ***National Council of the Scientific Research from the Higher Education***
(CNCSIS), in ***group A***

Contents

Journal edited in colaboration with **Editura AGIR**, 118 Calea Victoriei, sector 1, Bucharest, tel./fax: 021-316.89.92; 021-316.89.93;
e-mail: editura@agir.ro, www.edituraagir.ro

A research on various comfort properties of interlock knitted fabrics

EMİNE UTKUN

REZUMAT – ABSTRACT

Studiu privind varietatea proprietăţilor de confort ale tricoturilor interloc

Tricoturile, care au avut o mare popularitate în ultimii ani, sunt printre materialele textile preferate pentru realizarea îmbrăcămintei de zi cu zi, a îmbrăcămintei sport şi a lenjeriei. În cadrul acestui studiu au fost examinate şi comparate permeabilitatea la aer, permeabilitatea la apă şi capacitatea de alungire pe direcţia rândurilor şi a şirurilor de ochiuri din structura tricotului interloc din bumbac, acesta fiind unul dintre cele mai preferate tricoturi pentru domeniile menționate. Se știe faptul că preţul firelor mai subţiri este mai ridicat decât cel al firelor mai groase. Scopul acestui studiu a fost de a prezenta textilele din bumbac cu proprietăţi optime pentru realizarea îmbrăcămintei de zi cu zi şi a celei sport şi, pe de altă parte, de a face o evaluare ţinând cont de factorul cost.

Cuvinte-cheie: tricot interloc, permeabilitate la aer, permeabilitate la apă, proprietăţi de alungire

A research on various comfort properties of interlock knitted fabrics

Knitted fabrics, which have been very popular in recent years, are amongst the preferred fabrics in casual wear, sportswear and underwear. Within the scope of this study, air permeability, water permeability and course & wale elongation amount of the texture of cotton interlock fabric, which is one of the most preferred fabric textures in casual wear and sportswear, were examined and compared. As it is known, the prices of thinner yarns are higher than thicker yarns. The purpose of this study was specifying the cotton fabrics which have the optimum properties for casual wear and sportswear, and on the other hand to make an evaluation by taking the cost factor into consideration.

Key-words: interlock knitted fabric, air permeability, water permeability, elongation properties

INTRODUCTION

When designing fabrics, the functional properties and the main structural parameters of fabrics must be fully understood [1]. Turan and Okur (2008) examined the model studies, which were developed by different researchers, in the light of literature in order to estimate the relationship between the fabric's structural parameters and the product performance, the parameters that affect the air permeability of the fabric. In the study, it was emphasized that taking the place and conditions of the product use into consideration, evaluating them considering the relationship of the structural factors and progressing with the product development stages under control would gain advantage to the manufacturers in terms of time and cost [2].

Clothing comfort is an important factor in the stage where people make their clothing selections [3]. There are many studies in literature regarding the research of the comfort properties of knitted fabrics. Uçar and Yılmaz (2004) examined the thermal properties of 1×1, 2×2 and 3×3 rib knitted fabrics [4]. Güneşoglu et. al. (2005) researched the thermal contact properties of 2-yarn fleece knitted fabrics which are widely used in outerwear [5]. Marmaralı et. al. (2007) examined the effect of the elastic yarn amount in knitted fabric structure on the thermal properties of the fabrics [6]. Oğlakcioğlu and Marmaralı (2007) researched the thermal comfort properties of single jersey, rib and interlock knitted fabrics, which were produced from cotton and polyester yarns, by using Alambeta and Permetest devices [7]. Özdil et. al. (2007) examined the thermal comfort properties of knitted fabrics with 1x1 rib structure by using yarns with different properties [8]. Çil et al. (2009) studied the comfort properties of cotton, acrylic and cotton-acrylic mix knitted fabrics, such as water vapor permeability, transfer and longitudinal wicking abilities, drying properties [9]. Hes et. al. (2009) researched the thermo-physiological and thermal contact properties of knitted fabrics with single jersey structure, which were produced from non-traditional natural fibers such as maize, soy and bamboo viscose fibers, under dry and wet conditions [10]. Mavruz and Oğulata (2009) determined the air permeability values of cotton knitted fabrics with different yarn count, knitted type and loop density, and tried to form regression equations in order to estimate the air permeability value with definite fabric parameters before the production [11]. Majumdar et. al. (2010) analyzed the thermal comfort properties of fabrics with single jersey, rib and interlock structure, which were produced from cotton, bamboo and cotton-bamboo mix yarns [12]. Ramachandran et. al. (2010) examined the thermal properties of knitted fabrics with single jersey, rib and interlock structure, which were produced from ring and compact-spun yarns [13]. Bivainyte and Mikucioniene (2011) researched the effect of the knit structure, fiber type and yarn properties in double-layered knitted fabrics on the air and water vapor permeability properties [14]. Cubric et. al.

(2012) produced single jersey knitted fabrics and analyzed the significant fabric parameters that affected the heat transfer of fabrics through a porous structure [15]. Onofrei (2012) researched slowness of drying, intrinsic fabric thermal insulation, fabric permeability and fabric wicking properties of knitted fabrics, which were contained Outlast® and Coolmax® yarns [16].

The purpose of this study was to compare the air permeability, water permeability and course & wale elongation amount of cotton interlock fabrics, which were manufactured with different yarn counts. Thus, this could allow the manufacturers to manufacture cost-efficient fabrics with optimum properties. Unless there were statistically significant differences amongst the fabrics in terms of the required properties, it was possible to prefer the cost-efficient fabric. In this way, consumers would have the opportunity to purchase the products, which have the required properties, for a better price.

EXPERIMENTAL PART

Materials

Values related to yarns of the fabrics within the scope of the study are shown in table 1.

All the fabrics were produced in circular knitting machines. Technical data of the knitting machines, in which the fabrics were produced, are given in table 2.

The fabrics were subjected to the commercial finishes used in the market. Grease remover, wetting, antipilling enzyme, acetic acid, fabric protector, respectively were applied on fabrics. After the wet finishes, they were dried and sanforized. The weight, thickness and density values of the fabrics are given in table 3.

Method

All the experimental studies in this section were performed in the Textile Laboratories in the Technical Chieftaincy of Denizli Textile Laboratory of Turkish Standards Institution. All the fabric samples were conditioned by being kept under the atmosphere conditions (20 ± 2 °C temperature and % 65 ± 5 relative humidity) for at least 24 hours before the experimental studies. The analysis of the obtained data was made by using SPSS 15.0 statistical packaged software. The properties studied on the manufactured fabrics were as follows.

The weights of the fabrics were determined according to TS EN 12127 standard and the thickness values of the fabrics were determined according to TS 7128 EN ISO 5084 standard.

Air Permeability

Air permeability is the airspeed that vertically passes through a test piece, the conditions of which such as test field, pressure drop and time are specified [17].

Table 1

CHARACTERISTICS OF THE YARNS OF THE FABRICS

Yarn Code	Raw Material	Yarn Count (Nm)	Twist Coefficient (αe)	Direction of Twist
Y1	%100 Cotton	30/1, ring	3.6	Z
Y2	%100 Cotton	40/1, ring	3.6	Z
Y3	%100 Cotton	50/1, ring	3.6	Z
Y4	%100 Cotton	60/1, ring	3.6	Z

Table 2

CHARACTERISTICS OF THE KNITTED MACHINES

Fabric code	Knitted type	Brand	Model	Production year	System count	Needle count	Inch	Fineness (inch)
1	Interlock	S Sangyoung	U-1.2.8	2007	96	2568	34	24
2	Interlock	S Sangyoung	U-1.2.8	2007	96	3000	34	28
3	Interlock	S Sangyoung	U-1.2.8	2007	96	3000	34	28
4	Interlock	S Sangyoung	U-1.2.8	2007	96	3000	34	28

Table 3

CHARACTERISTICS OF THE FABRICS

Fabric code	Weight (g/m²)	Thickness (mm)	Wales per cm	Courses per cm	Loop density (loops/cm²)	Yarn code
1	265	1.086	15	16	240	Y1
2	221	0.954	16	19	304	Y2
3	193	0.911	18	18	324	Y3
4	171	0.838	19	22	418	Y4

The air permeability of the fabrics was measured according to TS 391 EN ISO 9237 – Textiles – Determination of Air Permeability on Fabrics standard. The measurements were conducted by applying 100 Pa pressure on the surface area of 20 cm^2 in Textest FX 3300 air permeability measuring device.

Water Permeability

Water permeability is the water pressure amount at the time when the water pressure, which is applied on fabric under specific conditions, is discharged from fabric [18]. The water permeability of the fabrics was measured according to TS 257 EN 20811/T1 – Textile Fabrics – Determination of Resistance to Water Penetration-Hydrostatic Pressure Test standard. The measurements were conducted by applying 60 mbar/minute rate of increase of water pressure in Textest FX 3000 Hydrostatic Head Tester measuring device.

Elongation Properties

The elongation property of fabric is the increase of length, which is expressed with the percentage of the initial length of the fabric as a result of the load applied on fabric under specific conditions [19]. The determination of elongation properties of the fabrics was performed according to TS 10985 – Textiles – Knitted Fabrics – Low Force Applied – Permanent Elongation and Determination of Stretching Properties standard. The measurements were conducted by applying a tensile load of 45 Newton in 4–6 seconds on Instron 4465 measuring device.

RESULTS AND DISCUSSION

The mean values, standard deviations and measurement units of air permeability, water permeability, wale elongation, course elongation, which were obtained from the standard measurements conducted on the fabrics, are shown in table 4.

The significance value within the study was acknowledged as (p) 0.05. If significance value (p) of a parameter was greater than 0.05 ($p > 0.05$), it was interpreted that the parameter did not make a statistically significant difference.

One Way Analysis of Variance (ANOVA) was conducted on the independent samples in order to determine if yarn counts of the fabrics showed statistically significant differences on the air permeability, water permeability, wale elongation and course elongation values.

The hypotheses of ANOVA analysis, which were conducted for each property, were as follows.

“H0”: There is not any difference between the fabrics in terms of analyzed property.

“H1”: There is a difference between the fabrics in terms of analyzed property.

Before the variance analysis, Levene Test was conducted and variance homogeneity was tested. It was seen that the variances were homogeneous, and in this instance, in order to define the relationship between the fabrics, Tukey HSD multiple comparison test was conducted.

Air Permeability

According to the results of Levene Test, $F = 0.877$ and significance level was $p = 0.474$; in this case, it was observed that distribution variances were homogeneous. According to the results of ANOVA, $F = 164.345$ and $p = 0.000$. Therefore, “H1” hypothesis was accepted; in other words, there was a statistically significant difference between the air permeability values of the fabrics. According to Tukey HSD multiple comparison test, which was conducted after ANOVA test, while the fabrics 1 and 2 made one group, the fabric 3 made the second group, and the fabric 4 made another group.

Water Permeability

According to the results of Levene Test, $F = 2.131$ and significance level was $p = 0.136$; in this case, it was observed that distribution variances were homogeneous. According to the results of ANOVA, F = 46,647 and p = 0,000. Therefore, “H1” hypothesis was accepted; in other words, there was a statistically significant difference between the water permeability values of the fabrics. According to Tukey HSD multiple comparison test, which was conducted

Table 4

RESULTS OF THE STANDARD MEASUREMENTS OF THE FABRICS

Fabric code	Air Permeability (l/m²/h)			Water Permeability (mbar)			Wale Elongation (%)			Course Elongation (%)		
	N	Mean	Standard deviation	N	Mean	Standard deviation	N	Mean	Standard deviation	N	Mean	Standard deviation
1	5	2898	230	5	9.5	0.4	5	40.9	2.7	5	115.3	0.5
2	5	2662	98	5	8.8	0,8	5	32.4	1,4	5	101.3	2.2
3	5	4292	147	5	11.2	0,3	5	43.6	0,5	5	151.8	4.1
4	5	4694	198	5	11.8	0,3	5	43.8	0,5	5	141.3	2.5

after ANOVA test, while the fabrics 1 and 2 made a group, the fabrics 3 and 4 made another group.

Elongation Properties of Wale

According to the results of Levene Test, F = 2.705 and significance level was p = 0,080; in this case, it was observed that distribution variances were homogeneous. According to the results of ANOVA, F = 59.163 and p = 0.000. Therefore, “H1” hypothesis was accepted; in other words, there was a statistically significant difference between the wale elongation values of the fabrics. According to Tukey HSD multiple comparison test, which was conducted after ANOVA test, while the fabrics 1 and 3 made one group, the fabric 2 made second group, and the fabrics 3 and 4 made another group.

Elongation Properties of Course

According to the results of Levene Test, F = 2.274 and significance level was p = 0.119; in this case, it was observed that the distribution variances were homogeneous. According to the results of ANOVA, F = 375.666 and p = 0,000. Therefore, “H1” hypothesis was accepted; in other words, there was a statistically significant difference between the course elongation values of the fabrics. According to Tukey HSD multiple comparison test, which was conducted after ANOVA test, each of the fabrics 1, 2, 3 and 4 made a separate group.

CONCLUSIONS

Interlock fabrics have a closer texture compared to single jersey and rib textures. The fabrics with such texture have often been used in casual wear and sportswear in recent years. Heat and moisture transfer properties as well as elongation properties of these fabrics should be good so that they can have optimum properties.

At the end of the evaluation of the measurements and analysis which were conducted on the properties examined within this study, table 5 was generated.

Table 5

EVALUATION OF THE MEASUREMENTS				
Fabric code	**Air perme-ability**	**Water perme-ability**	**Wale Elongation**	**Course Elongation**
1	3	2	2	3
2	3	2	3	4
3	2	1	1-2	1
4	1	1	1	2

Note: While the number 1, which is used in the table for evaluation, indicates that the fabric provides the highest value for the mentioned property, an increase on the number indicates that the mentioned value lowers.

As it was understood from the results, fabric 4 provided the best values in terms of the analyzed properties. However, it was observed that fabric 3 did not have statistically significant differences compared to fabric 4 in terms of water permeability and wale elongation properties, and that it followed fabric 4 in terms of air permeability, and that it provided better values than fabric 4 in terms of course elongation.

Acknowledgement

My profound thanks to the Technical Chieftaincy of Denizli Textile Laboratory of Turkish Standards Institution that helped to carry out the experimental studies, and to Denizli Kaya Textile in the presence of Kürşat ARIKAN in the production of the fabric samples.

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Author:

Asist. prof. dr. EMİNE UTKUN
Buldan Vocational Training School
Program of Fashion Design
Pamukkale University
Denizli 20400
Turkey

Corresponding author:

EMİNE UTKUN

e-mail: eutkun@pau.edu.tr

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